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# Migration, Risk of Death, and Time: Mortality among Immigrants from the Former Soviet Union in Israel 1990-2004

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*This dissertation is dedicated to my family. Above all to Hannah, whom I have made to wait for it all of our life together, too long; To Khayyam and Freda, who did not live to see me repay them; To Jeremy, Candy and Ora, who if they doubted, never let on; and to Tori and Yotham who are relieved that it is over, and may have wished, sometimes, that it never began. They all gave me, each in their own way, love and encouragement. Others will judge this work's scientific worth – only they can assess its cost.*

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# Section 1.0 Introduction

## 1.1 Objectives of the Study

This is a case study of how the mortality patterns of a group of migrants changed through time in their destination. It examines changes in the aggregate and cause-specific risk of death in the very large wave of migration from the Former Soviet Union (FSU) that arrived in Israel from 1990 to 2003 in greater socio-demographic detail than has been achieved until now. Using administrative data, it follows their mortality until the end of 2004, comparing it to that of the Israeli population. Documenting these patterns is a worthwhile goal in itself, because this migration wave was remarkable in its size relative to the receiving population, and because it is an example of transition from a relatively high mortality environment to a country with one of the highest life expectancies in the world. But this study has a theoretical goal as well. In the migrant health literature, the most common type of temporal change in relative risk which is examined is change over duration of residence. This study is distinct because it attempts to disentangle and identify patterns of change in the relative risks occurring within three temporal dimensions – calendar year and period of arrival, as well as duration of residence, and to determine their relative importance. It does so based on a critique of previous approaches to temporal change in migrant mortality risks in the epidemiological literature, a critique which shows how a multidimensional temporal approach provides a richer and more faithful depiction of change in immigrant mortality patterns.

## 1.2 Motivation and Background for the study

Alteration in migrant mortality patterns over time has been central to the study of migrant health for decades and an extensive literature has amassed, which frequently argues that migrant health tends to deteriorate after migration, and sometimes argues the contrary, that it improves. The study will begin by presenting an extensive critical review of the literature in epidemiology and in the social sciences generally on how migrant characteristics, and changes in them over time, affect migrant health through the three temporal dimensions. The review focuses on the lack of realism and inappropriate reductionism, of unidimensional and even dual dimension depictions of temporal effects in the migrant health literature, and the misplaced focus on environmental transition rather than on processes of change specific to migrants and migrating populations themselves. A new perspective, emphasising the importance of a multidimensional approach to changes in migrant health through time is described. This approach informs a brief review of research on social and economic changes over time in the population of FSU immigrants in Israel, which provides the context for our analysis of aggregate relative mortality trends. The introductory review is followed by a description of the data sources, and then by a detailed statistical analysis of the temporal patterns in the cause-specific mortality of FSU immigrants in Israel relative to the rest of the population of Israel. Patterns by calendar year, period of arrival and duration of residence are described, and statistical models are compared in order to determine the relative importance of calendar year, period of arrival or duration of residence effects in altering immigrant cause-specific mortality patterns by age and gender. The findings of this analysis will be discussed in the light of the multidimensional perspective on changes in mortality risk following migration that were developed in the introductory review.

By any standard, the migration wave from the FSU to Israel in the 1990s was extraordinary, not least in its relative size. During these 14 years over 900 thousand immigrants arrived from the FSU, nearly

37% of whom arrived in 1990-1991. By the end of 2004 they (and their Israeli-born children) constituted 13% of the total population of Israel, and 16% of its Jewish population (ICBS 2005). By 2004 the wave had dwindled to less than 1000 arrivals a month, and was over. But however unusual it was in its size and its impact, this migration was not *sui generis*; It can be placed in the category of "diaspora migration" which was relatively common in the 1990s (Markowitz 2012; Shuval 2002; Titzmann and Stoessel 2014; Tsuda 2009), and like any other migrating population the immigrants from the FSU in Israel went through processes of selection, social and cultural adaptation and economic adjustment which they share with other migrant groups in other countries, processes which shaped and altered their mortality patterns. They can be studied for themselves and for possible generalizations, contributions to the wider field of the determinants of migrant health.

But what are these determinants? Migration has accompanied, resulted from, and sometimes driven, social, economic and political developments over the last two hundred years. So it is not surprising that generations of scholars have tried to put theoretical order into the circumstances which give rise to migratory movements and the processes by which migrants themselves are changed and create change in their countries of origin and destination (Eisenstadt 1953; Fussell 2012; Hoffman-Nowotny 1981; Lee 1966; Massey et al. 1993; Ravenstein 1885; Thomas and Znaniecki 1918-1920). But despite repeated attempts, no single coherent and over-arching theoretical framework has emerged in migrant studies, whether because the processes themselves are too complex to grasp in a single theory that applies to all places and times, or because the single term 'migration' embraces such a varied assortment of dissimilar social processes and institutions that the emergence of a single theory is precluded. Again and again, new examples and new perspectives have led to challenges and revisions of existing theories, generalizations have been shown to be limited to a certain time or place, to certain groups and countries, to certain types of international migration. It should come as no surprise that a similar theoretical uncertainty exists in the study of the impact of migration on health, where both the causes of migration and the changes which migrants experience are relevant to the outcome. This introduction will not attempt to give a thorough review of all this theoretical literature but rather to gather together and critically examine perspectives, findings and hypotheses relating to the fundamental question of how the health and mortality rates of migrants change over time in response to factors which are particular to, or associated with, migratory processes.

Sections 1.2-1.6 of this introduction will be devoted to the topic of migration, time and health, developing a new analytic scheme encompassing multiple temporal dimensions, Section 1.7 will describe the wave of immigration to Israel from the FSU, focusing on those aspects of this immigration wave which are relevant to testing dynamic relationships between characteristics of migrant groups and health. Section 1.8 will present previous findings on the relative health of this migration wave, and Section 1.9 will present hypotheses deriving from the new analytic scheme.

## 1.3 Migration, Health, and Temporal Patterns

### 1.3.1 As time goes by: change is the constitutive characteristic of migration

In the epidemiological literature, being an international migrant[1] is sometimes depicted as a fixed status, with the implication that there is a set of stable properties which virtually all migrants share (Anson et al. 1996; Parkin and Khlat 1996). However, if there is a single quality which characterizes both individual migrants and migrant groups, that quality is fluidity. The characteristics of migrants and of migrant groups are in a state of flux and transformation. Of course all life involves change and transformation, but what characterises migration is that these changes involve the disruption of routine expectations, of institutionalized social structures and rituals which ease and support life course transitions and which allow these changes to appear temporally ordered and stable (O'Rand and Krecker 1990).

This abstract quality, fluidity, derives from the common predicament of international migrants, the requirement to adjust to new and sometimes radically different social and economic circumstances from those which they experienced in their place of origin, and often to a new climate, landscape and language. It is not only the personal characteristics of individual migrants which may change after migration, characteristics which include their occupation, their income, their housing arrangements, their network of friends and relations, their language, their personal habits, and more. As migration streams form and mature, collective characteristics change as well. These include the qualities and composition of successive cohorts of migrants arriving in a country, and the formal and informal resources and services offered by the social groups to which migrants belong, both in their origin and in their destination. The personal and collective adjustments that migrants actively make as individual social and economic actors, and the demands to which they are subject in the social institutions and structures where they are placed, can alter the characteristics both of their immediate primary groups such as their families, as well as of the communities in which they live. And just as these individual and collective characteristics change, the wider social and cultural environment which they confront will be changing as well. While individual migrants, and the groups to which they belong, attempt to adjust to their new circumstances, the receiving society is not a static background. Its social, economic, political and legal contexts will change, independently and also in response to the presence of the migrant population. Migrants themselves often alter the characteristics of the receiving society, requiring it to adjust both socially, economically and, at times, politically, to the presence of new groups, whether harmoniously or with some degree of conflict. Nor will the sending society remain immobile: it will change through, for example, the economic response to remittances from abroad, through the re-absorption of returning migrants, or through the outflow of human capital, or by the exchange of ideas and culture. And these changes may themselves influence future migrant flows in a self-reinforcing feed-back process which sustains migration levels and has been termed "cumulative causation" (Massey 1990; Massey et al. 1993). These complex adjustments which migration imposes on individuals and families transform material circumstances (such as occupations, income or housing) social relationships (such as family and social networks), and the regular course of life, as expressed in the paths of occupational careers or family building. This disruption of previous patterns of social roles and social

[1] The following discussion refers to international migrants, even when this is not specified. Although internal and international migrants can be viewed as sharing the same continuum, the processes of change which will be discussed here are most evident and most acute in the case of migrants who travel across international boundaries. Similarly, this study focusses on migrants themselves and not on the second generation, their offspring who were born in the destination, who are sometimes included in the migrant population.

identity goes hand in hand with the attempt to construct new ones, an attempt which takes time and carries no guarantee of success (Bar-Yosef 1968).

Potentially, all the major spheres of life may be affected by migration and by the individual and social response to it – family structure, housing, employment and income, language-use, political relationships, religion, values and conceptions of the world. The processes of change in these domains can proceed in sequence or in parallel, they may be coordinated or discordant. Moreover, the changes that migrants undergo do not occur in a stationary context: the specific patterns of change that migration entails are superimposed on parallel "routine" patterns of change – the historical changes we have just mentioned, and the biologically determined age-related changes of health status. Thus, unless by chance all the factors neutralise each other, on aggregate the results of these adjustments will have a complex temporal structure. The determinants of migration outcomes, in health as in other spheres, are multifactorial, and the factors themselves alter over time. This multidimensionality creates tremendous challenges for anyone seeking to explain how migrant health changes over calendar time or with duration of residence, challenges which are often sidestepped or ignored.

### 1.3.2 Change in the study of migrant health

The spheres of life which can change in response to migration –family structure and social support networks, housing, diet, education, social status, occupation and income, to name some of the most salient – are known to have a potential impact on health, as risk factors or as effect modifiers. Since these factors change gradually and at different paces, we should expect that changes in the level of health following migration, for individuals and for groups, should also reflect this multidimensional temporal complexity. And consequently, we would expect that in the literature on migrant health, both theoretical and descriptive, temporal factors and longitudinal measurement should command a prominent position. There should be some suggestions as to the theoretical mechanisms which govern changes in health with duration of residence and the advance of calendar time.

However, recognition of the multidimensional temporal complexity of migration and of the relationship between migration and health is more evident in the sociological and economic literature on migration than in its epidemiological counterpart. Such sweeping statements as "all the processes associated with migration are rooted in time" (Jasso 2003), or that "time…is a structural characteristic" of the process of migration (Shuval 2007) are typically found in the sociological literature on migration and health, whereas within the epidemiological literature the impact of the temporal dynamics of migration has generally played a secondary role, as successive reviews of the extensive literature on migrant health over the last four decades have noted (Abubakar et al. 2018; Hull 1979; Hyman 2001; Kasl and Berkman 1983; Kliewer 1992; Lassetter and Callister 2009; McKay et al. 2003).

Only since early in the new millennium have attempts been made to depict the relationship of migration to health within integrated multifactorial explanatory frameworks which take temporal dynamics into account and acknowledges their importance. These are found in the USA (Acevedo-Garcia et al. 2012; Jasso 2003; Jasso et al. 2004; Jasso et al. 2005) in Germany (Boulogne et al. 2012; Kohls 2010; Razum and Spallek 2009; Schenk 2007; Spallek et al. 2011) and in Canada (Beiser 2005; Gushulak and MacPherson 2006; Trovato 2003). These attempts differ in detail, but they share an emphasis on the potential impact on health outcomes not only of a multiplicity of fixed factors in the country of origin and in the destination, but of a variety of processes that distinguish the situation of individual migrants from that of non-migrants, as well as on the structural transformations which migratory groups undergo. An attempt to integrate these theoretical statements will be made here. But before doing so,

and to highlight the novelty of these approaches, a review will be presented of how, until relatively recently, temporal factors and migration dynamics were treated in the epidemiological literature regarding the impact of migration on health, and how the new perspectives emerged from the problems which were encountered in applying a reductionist scheme.

### 1.3.3 Three rationales in studies of migration and health: 'environmental transition', 'public health', and 'multidimensional temporal dynamics'

In comprehensive reference works on epidemiological methods "Migrant Studies" are placed within the broad field of "descriptive epidemiology" and are presented as having two principal rationales: in the first place they are a method for generating (rather than testing) useful hypotheses concerning the relative importance of genetic and environmental risk factors for the aetiology of particular diseases; and secondly, they identify the health problems of particular migrant populations (Buiatti and Balzi 2000; Parkin and Bray 2005). I will call the first rationale the "environmental transition" rationale, and the second the "public health" rationale. The first treats migration as a natural experiment in which "heredity" or genetic endowment is held constant so that the consequences of replacing one environment with another can be examined (Reid 1975). In this rationale migrant health appears to be, principally, a function of place, and only secondarily of time (if at all). The second treats migration as creating circumstances that produce populations with specific health problems, and here time is also a secondary factor at best. In practice both perspectives are related, since the second rationale often emerges from the first, and vice versa: using a migrant group as the study population to examine the possible environmental risk factors and causes of a particular disease or group of diseases often identifies the relative health problems of that group in a particular country; and equally, the association of a particular health problem (or its absence) with a migratory group raises the question of the particular exposures which that group experienced.

The public health rationale of migrant health studies is of considerable importance in contemporary societies, an importance which increased from the 1990s onwards with emerging recognition of the variety of migrants from new source-areas in developed countries, with new entries to the category of receiving countries and the general acknowledgement in Europe of new, permanently-settled, migrant groups. Over the last two decades survey after survey of migrant health and/or mortality in a wide variety of countries has appeared in the literature, covering the situation globally (Abubakar et al. 2018), in the USA (Singh and Miller 2004; Singh et al. 2013), Canada (De Maio 2010; Gushulak et al. 2011; Newbold and Danforth 2003)in European countries in general (Mladovsky 2007; Rechel et al. 2013; Solé-Auró and Crimmins 2008) and in specific ones such as the UK (Wallace and Kulu 2015), the Netherlands (Bos et al. 2004), Norway (Diaz et al. 2015) Sweden (Albin et al. 2006; Rostila and Fritzell 2014) or France (Boulogne et al. 2012). Although their primary purpose was to identify the health challenges and burdens posed by migrants in specific contexts, the puzzling features of the health status of migrants as well as differences between groups of migrants by country of origin have led researchers to consider the impact of processes inherent in migration itself to mortality patterns and disease burdens. Unavoidably, they have also addressed the question of how health levels change over time.

Close reading of the studies motivated by both rationales suggests that a third perspective is present although it was not mentioned explicitly in surveys of epidemiological methods, a perspective that guides an increasing share of research on migrant health. I will call this third approach the "multidimensional temporal dynamics" rationale. It focuses directly on the health consequences of the complex transformations engendered both by the experience of migrants and by the social processes that accompany migration, transformations and process which unfold through several dimensions of

time (age, period of arrival, historical period, duration of residence). The very absence of this rationale from the reference works mentioned here indicates that it was not prominent or explicitly acknowledged. Although it was routinely stated that the health of migrants is determined by what was referred to as "the process of migration" (Marmot et al. 1984; McKay et al. 2003), this factor was often regarded as a methodological disturbance in the overall scheme, or confined to the period of movement itself. The problem has not been in recognizing the importance of dynamic processes (along with the environment of origin and destination) but in how the influence was conceived and the weight given to them. The rather foggy conventional term, "the process of migration", is not a single factor. The term only embraces and conceals the many forms and components of social and psychological transformation that migration entails, and it does not add any explanatory power of its own.

### 1.3.4 Blind spots in the environmental transition paradigm

The environmental transition rationale expresses epidemiology's central objective of identifying the risk factors and aetiology of diseases (Gordis 2004). Within this disciplinary context the object of study is a particular disease, health problem, cause of death, or population at risk, rather than migration itself and its health consequences. Ideally, in order to test the hypothesis that some environmental determinant is important, there should be a substantial difference in risk of the disease between the origin and destination country (Parkin and Bray 2005; Parkin and Khlat 1996). The term "environment" is used here in the very broad sense which is traditional in epidemiology, embracing not only the physical environment but behavioural, social, economic and cultural factors of disease causation as well (Bonita et al. 2006). The underlying assumption is that migrants will alter their behaviour by gradually acquiring the norms and social practices of the population in the destination and abandoning those of their origin, in addition to altering their physical environment and their exposure to pathogens and other physical and biological risk factors. This process is usually referred to as "acculturation" or "assimilation", and I shall say more about these concepts below. In this perspective time enters explanatory models only as a measure of exposure to risk (Palloni and Morenoff 2001). Duration in the country is either an indication of "dose-response", the effect on disease risk of the cumulated exposure to the new socio-cultural environment (Kliewer 1992; Parkin and Bray 2005), or, alternatively, duration in the country or age at migration can be a measure of the stage in the disease process at which environmental exposure (in either the origin or the destination) can alter risk (Parkin and Bray 2005; Parkin and Khlat 1996).

The focus of the environmental transition rationale is on the contrasting outcomes of each of the two pre-existing environments on a specific disease, disease group, or health problem. Framing the investigation in this way places the origin and destination environments beyond the touch of migration itself and ignores its properties as a social, economic, and personal process which dynamically changes environments. Within the environmental transition rationale there is no consideration of the possibility that migration may itself bring about new economic relationships, new social and cultural practices and institutions, a new and persistent "environment", one which is neither that of the country of origin nor that of the country of destination without its migrants. This absence is consistent with the surprising conclusion reached by one of the most frequently cited reviews of the literature on migrant health, written many decades ago but still largely true today: "studies of health status of migrants often do not try to answer questions about the impact of the migration experience!" (Kasl and Berkman 1983). The point of departure and the general conclusion of studies in this tradition has been that migrant populations tend to converge to the destination population's disease pattern by adopting the host population's health-related attitudes and behaviours, or by abandoning the attitudes and behaviour of

their origin, thus revealing the impact of these behaviours. Migrants who are in the midst of this process display health and mortality rates intermediate to the origin and destination countries in proportion to the time elapsed (Kliewer 1992; Marmot et al. 1984).

One must be careful not to oversimplify or caricature this research tradition. Even when researchers are writing within the environmental transition tradition, they are aware of the wide variety of social and individual factors that influence and modify health outcomes for migrants, and this awareness is reflected in the use of the phrase "the migration process". At times this refers only to the burdens of the technical arrangements of moving from one country to another (eg. in (Spallek et al. 2014)), including the administrative process of seeking and waiting to receive legal status. But it is often used more widely, to embrace the social and economic processes which accompany adjustment to life in a new country (as in (Marmot et al. 1984). Aspects of the process in this last sense have, inevitably, entered all serious attempts to study the health of migrants. Although this breaks down the polar logic of the rationale and the unilinear representation of duration effects, a conscious recognition that the "environmental transition" rationale has been abandoned *de facto* has not fully emerged, although it can be glimpsed in a recent study of the Healthy Migrant Effect (HME) which states that previous studies are: "more interested in the role of genetic predisposition and the local environment in disease etiology" than in the broader social determinants of migrant mortality (Wallace and Wilson 2019).

These broader complexities emerge when looking at three themes which encompass central features of migration, themes that have accompanied the "environmental transition" approach from its beginning. These themes are: first, migrant selectivity and the HME; second, migrant stress; and third, the impact of acculturation/assimilation. In studies exploring each of these themes awareness has grown of the multiplicity of factors which influence social and health outcomes of migrants and the consequent complexity of the temporal dimension.

All three themes have methodological and substantive consequences for the underlying transition model. Selectivity is a problem because if migrants are not a representative sample of exposures to the origin environment, or of the genetic makeup of the origin population, then migration will provide a biased test of environmental effects. Stress is a problem because if migration *itself* is a risk factor (and not merely a mechanism that alters the risk environment) then once again migration does not provide a straightforward test of the effects of environmental transition. In the case of acculturation, the model will be compromised if acculturation proves to be a more complicated process than the gradual abandonment of origin behaviours and values and their replacement by those of the destination; if, for instance, a complex mix of retention of old practices with adoption of new ones arises; if these processes are affected by interactions with age, gender, employment status or residence in ethnic enclaves, or by any other factors that can alter the unilinear model. Each of these themes has explored hypotheses of how migrant health changes over time. These will now be examined in greater detail.

### 1.3.5 Three themes of the "migration process" and the environmental transition rationale: selectivity, stress, and acculturation.

The first theme, selection by health status, arises as a direct consequence of the social and economic context of migration. Migrants are never a representative sample of the population of their area of origin (Lee 1966). Their collective characteristics are shaped directly and indirectly. They are shaped directly, through laws and administrative regulations which are designed to select the particular qualities which a particular country deems desirable in authorized migrants while excluding individuals who possess undesirable characteristics. These may include educational and occupational characteristics,

family connections to already settled immigrants, co-ethnic origin, and for refugees and other humanitarian migrants - war and persecution in the country of origin. Health may be one of the characteristics by which migrants are directly selected. In certain countries, such as Australia, Canada, and the United States, immigrants are directly screened for health (Biddle et al. 2007; Chiswick et al. 2008; Gushulak and Williams 2004; Walker and Jaranson 1999). Indirect selection (or self-selection) of individual and group characteristics is equally important. Consideration of the nature and the determinants of migrant selectivity has been a permanent element in the social-demographic and economic literature on migration and in attempts to formulate general explanatory theories of migration sources, destinations and volumes. They emerged in Ravenstein's classic formulation of the "fundamental laws" of migration well over a century ago (Ravenstein 1885), and reached a pinnacle in labour economics' focus on how "immigration markets" sort and select immigrants by observable attainments such as education and occupation, and unobserved abilities and attributes such as skill or resourcefulness (Borjas 1994; Chiswick 1978; Chiswick 1999; Duleep and Regets 1999; Jasso et al. 1998). Incentives to migrate will differ for individuals and families due to a wide variety of social and economic factors; these or additional factors may create barriers to migration for others. The outcome of both sets of factors, acting together, is indirect self-selection. Return or onward migration of immigrants will also be associated with particular demographic, and socio-economic, and health characteristics so that selective forces continue to act on a migrant population after migration.

#### *1.3.5.1 Are healthy or sick migrants selected?*

The wide factors which determine selection by social and economic characteristics may be associated with health levels, whether positively or negatively (Chiswick et al. 2008; Jasso et al. 2004; Kennedy et al. 2006). In addition to indirect self selection, health, or the prospects of improved health, may be one of the factors on which the decision to migrate is based, or the decision to return to the country of origin (Findley 1988; Kibele et al. 2008). However, within the logic of the environmental transition rationale this universal characteristic of migration, which has been noted since the earliest migrant health studies (Reid 1971; Reid 1975), was invoked principally because it creates a bias which can complicate or invalidate the "natural experiment". Since flows of migrants do not create a random sample of the population of the country of origin, the advantages or disadvantages which they display in relation to the origin or destination populations are a biased assessment of the impact of each of the environments. When a health advantage is found, it is seen as evidence for the HME, an effect which is sometimes deemed a paradox because of the social and economic disadvantages which migrants from lower income countries often face, and/or the poorer health of the population in their countries of origin. A parallel tradition has claimed that migrants, and in particular refugees and "involuntary" migrants, are selected for ill health – what has been called the "sick" or "unhealthy" migrant effect (Beiser 2005; Constant et al. 2018; Potarca and Bernardi 2018). The latter view was particularly prevalent in the 19th and early 20th century when poor migrants from less developed countries were viewed as potential hosts of disease and unhealthy practices (Beiser 2005), but lingers in the contemporary fear that migrants may import infectious diseases into receiving countries (Bowleg 2012; Gushulak and MacPherson 2004; Zimmerman et al. 2011).

Whether the direction of the effect is found to be negative or positive, what is considered a bias within the environmental transition approach remains a focus of research. Evaluating whether a HME exists, the mechanisms by which it arises and its consequences, has become a flourishing field of study[2], and

[2] In September 2022 PubMed listed 1021 journal articles referring to the healthy migrant or healthy immigrant effect appearing between January 2015 and December 2021 inclusive.

is perhaps the principal context in which temporal effects by duration of residence are examined with a variety of outcome measures, including mortality, birthweight, self-assessed health, disability and various measures of morbidity. A recent comprehensive meta-analysis has confirmed the existence of a mortality advantage to international migrants (with the exception of external causes and infectious diseases) but it did not examine temporal effects (Aldridge et al. 2018). Additional examinations of the HME include instances from the USA, Germany, France, Canada, the UK, Spain, Switzerland, Australia, Belgium, Sweden, and European countries in general: (Abraido-Lanza et al. 2005; Aldridge et al. 2018; Antecol and Bedard 2006; Biddle et al. 2007; Boulogne et al. 2012; Chiswick et al. 2008; Deboosere and Gadeyne 2005; Farré 2016; Hyman 2007; Jasso et al. 2004; Kennedy et al. 2014; Khlat and Darmon 2003; McDonald and Kennedy 2004; Ng 2011; Potarca and Bernardi 2018; Razum 2009; Razum and Twardella 2002; Razum et al. 2000; Riosmena et al. 2014; Solé-Auró and Crimmins 2008; Wallace and Wilson 2019; Wallace and Wilson 2021).

This literature has focussed on two sets of questions:

1. Are the observed levels of health in migrant populations consistent with (negative or positive) selection effects or can other explanations be found for unexpected health levels? What are the mechanisms of selection and what aspects of health do they affect? Are these effects homogenous or differential by age and gender? Is this a true finding or a data artefact?
2. Do initial health levels converge with those of the destination with increasing duration of residence, equaling or "overshooting" (positively or negatively) destination rates, or are they preserved over time? What explains these temporal patterns: are real mechanisms at work or are they too a data artefact?

The validity of the findings in this literature will not be assessed here, nor will the evidence be weighed in favour of the different hypotheses that have been proposed to explain it. Rather it will be shown how some of the factors assembled to support competing answers to both sets of questions have broken the bounds of the environmental transition paradigm, by enlisting explanations that belong in an emerging "multidimensional temporal dynamics" paradigm.

There have been four alternative families of answers to these questions, which are not mutually exclusive. Each is associated with distinct temporal-duration effects, and age and gender profiles (Guillot et al. 2018; Wallace and Wilson 2019):

1. *Direct or indirect selection of relative health*. Migrants, and especially economically-motivated migrants, are self-selected for health itself or for qualities that are associated with better health. These qualities may include directly measurable attributes like occupational skills or education, but also more elusive psychological or personality attributes such as hopefulness and resourcefulness. If what is positively selected is only the migrants' current state of health, which is transitory, it follows that over time average levels of health of migrants will decline with increasing frailty through "regression to the mean", eventually converging with the population average (Biddle et al. 2007; Chiswick et al. 2008; Jasso et al. 2004). However self-selection may entail an element of permanent physiological "robustness", perhaps through the complementarity of migration with education, labour market skills and health (Akresh and Frank 2008). Alternatively, it may arise through the self-selection of immigrants for positive psychological traits such as "hopefulness" (Anson 2004) or "self-investment" and "energy" (Jasso 2003; Jasso et al. 2004; Kennedy et al. 2006). These forward-looking orientations would lead to more pro-active investment in health-promoting behaviour, which might be sustained over a lifetime. Physiological robustness or positive personality traits may result in a long-term advantage which would only decline over time to the extent that the destination presented a harsh social environment with accumulating risk-factors.

If self-selection for favourable health is tied to economically-motivated migration, it follows that the advantage will not be shared by refugees, who are not subject to the same selective forces (Akresh and Frank 2008; Chiswick et al. 2008). Likewise, age and gender should be strong modifiers of the effect, since spouses, children and the elderly, who are not selected for their labour market skills, will not be affected by it. In fact, older relatives accompanying economically-motivated migrants might be self-selected for poor health, actively seeking or expecting to receive better care in the destination country (Choi 2012). For migrants who did not undergo positive selection there will be no reason to expect convergence to local health patterns through "regression to the mean". Duration effects may be more complex for family members and non-labour migrants, and especially refugees. For example, as the traumas of refugee experiences recede, an initial mental health disadvantage may disappear at first, only to re-emerge many years later (Beiser 2009).

All these possible patterns point to complex, diverse and dynamic factors associating selection effects and duration patterns, modified by age, gender, and type of migration independently of environmental transition effects and the boundaries of a unidimensional model.

2. *Distinctive protective factors*. Migrants may have socio-cultural protection through a variety of proposed factors: a healthier diet; life-style habits such as physical activity or low cigarette consumption, especially for females (Maclean et al. 2013; Singh and Hiatt 2006; Singh and Siahpush 2002); or through the buffers provided by social networks, community and family relationships (Abraido-Lanza et al. 2005; Abraido-Lanza et al. 1999; Khlat and Darmon 2003). In some formulations socio-cultural protection is an attribute that is brought with the migrants from their origins, but in others it is ascribed to the qualities of the emerging migrant communities in the destination country. It will presumably be greater the older the age at migration – and the more firmly the cultural patterns and behaviours are held. If the advantage is due to diet and health-promoting behaviour, these will be lost over time to the extent that the migrants' diet and behaviour come to resemble those in the host country. If it is due to initial self-selection on health, combined with buffers provided by community and familial support, the advantage may be preserved over time and even enhanced, as the migrant community grows and develops and provides more resources, or lost as ties to the origin country/population weaken. If socio-cultural protection is the principal mechanism for the HME then there will be no necessary difference between economic migrants and other groups, nor should the duration effects differ between them. There might in fact be advantages to low-skilled migrants over the highly-skilled, since the former are more likely to live in immigrant enclaves (Finch et al. 2007). However, modes of social and economic adaptation which entail structuring migrants as a distinct ethnic group, together with residence in immigrant enclaves, may have a more complex effect on health, with the enclave providing social and cultural support while at the same time shielding immigrants from positive influences on health behaviour in the wider community (Maclean et al. 2013; Schenk 2007).

In the context of the HME, the hypotheses and findings regarding the role of socio-cultural protection or buffering point to a complex relationship between health levels, duration effects, and the developing concrete social and economic circumstances of specific migrating populations. They indicate that the "environment" for migrants may be neither that of the country of origin, nor that of the native population in the destination, and that this environment itself will change over time.

3. *Epidemiological transition.* Migrants may experience a personal rapid epidemiological transition (Razum and Twardella 2002). They tend to move from poorer countries, where infectious diseases are still endemic and the risk factors for cardiovascular diseases (CVD) and other chronic conditions are low.

After migration they enjoy immediately the benefits offered by an environment relatively free of infectious disease vectors, advanced medicine's tools for treating infectious conditions and CVD, while the influence of slow-acting risk factors to which they were exposed in their early life remain latent. Thus an initial advantage may disappear over time as prenatal or early exposures (either to infectious agents such as helicobacter pylori and HPV, or to physiological factors such as low birth weight associated with poor maternal nutrition) emerge in later life as diseases such as liver or cervical cancer, or harmful conditions such as obesity (Spallek et al. 2014). In addition, childhood exposures associated with CVD may lead to higher morbidity or mortality in later life, but in the short and medium term no effects may be seen. Just as there are risk factors associated with specific conditions and diseases, for other diseases early exposures or lack of them in a pre-epidemiological transition context may provide advantages. These effects will differ by age at migration, which determines the length of exposure to the origin environment. Equally, they will differ between country of origin groups and the risk factors present in each of them.

The expected duration effects that derive from this hypothesis are complex, since they will vary, depending on the relative burden of specific diseases and conditions in specific countries of origin and in the destination, on the strength of latent exposures, and on the differences in the levels of health care between origin and destination.

This is manifestly an environmental transition hypothesis, but its specification places it within a broader, life-course framework, which draws in a wide variety of health-related factors which act on migrants before, during and after their transition from one country to another (Spallek et al. 2014). In doing so it introduces *timing* and interactions of exposures as a critical factor. Here too the unidimensional environmental transition model was abandoned.

4. *Out-migration selection and data artefacts*. A wide variety of data artefacts may explain and invalidate findings concerning migrant health (Antecol and Bedard 2015). The most frequently discussed are such factors as unrecorded or unadjusted return migration which inflates denominators of rates, (Wallace and Wilson 2021) or selective remigration of the unhealthy who leave behind a relatively healthy population, (or vice versa, in the case of the "sick migrant effect"). In addition, changes in orientation from origin to destination country expectations and behaviours may create a reporting bias in self-reported health variables. When the measure is overall self-reported health, newly arrived migrants may compare their health relative to the standard in their (less healthy) origin country while veteran migrants come to compare their health to levels in the (healthier) new country, creating an apparently negative time trend (Gong et al. 2012). When the measure is self-reported prevalence of chronic disease, new arrivals may underestimate their presence because their access to diagnosis by physicians is lower; and as access to health services increases, more chronic disease will be detected and reported, creating a false time trend (McDonald and Kennedy 2004). A further data challenge is that duration effects are sometimes estimated from cross-sectional data, which may confound duration and cohort effects (see below section 1.3.5). Data artefacts may lead both to false estimation of health levels and false trends. These artefacts are themselves introduced by the dynamic processes which are created by migration - remigration, changing orientations and changing behaviour.

Much of the literature on the HME appears to accept an environmental transition model. The central contention of the environmental transition paradigm appears to be confirmed when gradual convergence of migrant health levels to those of the destination is interpreted as being due to adoption of the destination's patterns of behaviour, and growing distance from origin exposures, whether the

initial level of health is above or below that of the host population. Although the direction of convergence can be either positive or negative (Marmot et al. 1984), because the most common finding in the literature has been that the direction is towards worse health, the process has been characterised as "unhealthy assimilation" (Antecol and Bedard 2006) or "negative acculturation" (Riosmena et al. 2014), phrases which underline the presumed direction of influence of the new environment.

In recent years closer critical examination (and comprehensive reviews) have shown that the confirmation of the HME paradigm through negative convergence is partial at best (Ro 2014). In conformity with our argument, the Report of the UCL–Lancet Commission on Migration and Health stated that the HME literature " neglects the diversity and complexity of migration-related factors that influence people's health and how these affect individuals at different stages of the life course" (Abubakar et al. 2018). The multiplicity of factors brought to bear in each type of explanation underscores the inadequacy of a bipolar linear model to capture the complex determinants of migrant health and the ways it may change over time. "Regression to the mean" in health levels "mimics" harmful assimilation (Palloni and Morenoff 2001), and provides an alternative explanation. It accounts for change over duration of stay as a purely stochastic process of increasing frailty, a mechanism independent of the adoption of local health behaviours. Similarly, the hypotheses that migration mechanisms select individuals with positive personality traits or self-investment behaviour, or that the creation of migrant communities provide effective buffers, lie outside the paradigm and rely on a more complex model of temporal relationships. These hypotheses suggest that among the determinants of migrants' health are interactions between the qualities that migrants bring with them and social and economic structures which they create or generate. These structures are, therefore, neither the origin nor the destination environment, in as much as the latter is thought of as distinct from and uninfluenced by the migrants themselves. The creation of such structures introduces a "period effect", since they are the product of the evolution of the migrant community as a whole, rather than then duration of stay of an individual migrant. Similarly, findings that HME is heterogenous by country of origin, type of migrant, by age, and by gender (Hamilton et al. 2015; Kennedy et al. 2014; McDonald and Kennedy 2004) all point to the need for careful accounting of differential effects of "the dynamics of migration" in specific contexts, as do the differential and even opposing (positive or negative) directions of influence by type of illness or condition. Finally, the potential causes of the data artefacts themselves, selective return migration and changing orientation of migrants from their former homeland to their new one, are themselves created by the complex social processes of migration. They underline our contention, that the diverse processes of change which are specific to migration have complex effects on health levels, and the study of migrant health should focus on how these jointly impact health outcomes in a particular context, as much as on a broadly conceived and static "origin" and "destination" environment.

#### *1.3.5.2 Stressful Migration*

The second theme, "migrant stress" refers to possible negative psycho-physiological reactions by migrants to the challenges of social and economic adjustment to their new physical, social and cultural circumstances, and the consequences of these for both mental and physical health. Stress may be associated with elevated substance abuse and external cause mortality (Deckert et al. 2015). The theme has been evident from the earliest exemplars of the "environmental transition rationale" (Marmot et al. 1984; Reed et al. 1970; Reed et al. 1982b; Reid 1971). As with the previous theme, the study of migrant stress has engendered a large literature (Beiser and Hou 2006; Berry 2006; Ritsner and Ponizovsky 1999; Rumbaut 1997; Shuval 2007), although with few exceptions (Akresh and Frank 2008;

Jasso et al. 2004; Jasso et al. 2005) it has focussed on the field of mental health, rather than on outcomes for physical health. The temporal pattern of how stress-determined outcomes alter with duration of residence is a central research question. Quite a number of conflicting hypotheses and findings have been published concerning the time pattern of stress, whether it is a short-term or long term phenomenon, and why increasing duration of stay may lead it to decline (Rumbaut 1989), rise (Beiser and Wickrama 2004), or leave it unaffected (Kuo 1976; Lerner et al. 2005). Detailed studies of stress have found that it is associated with a very wide variety of factors. These include obvious demographic factors that affect migration experience, such as gender and age at immigration; administrative factors such as type of migrant ("voluntary" or "refugee") or the uncertainty of awaiting for approval of legal status (Jasso et al. 2004); and social factors, such as membership in a visible minority, overt discrimination, downward occupational mobility, difficulties in language acquisition and the presence and strength of family and social networks, to name only some of the factors examined.

No issue better illustrates the mistake of placing the study of migrant health into a simplified, bi-polar framework of origin and destination environment. Within the multidimensional process of adaptation to a new society migrants experience diverse potential sources of stress and psychological challenges, which often overlap. Some of these may be felt as painful loss; familiar routines are disrupted and new ones may make time to emerge; often a new and unfamiliar language must be mastered, along with new cultural conventions; migrants must cope with new occupations and work circumstances, and frequently, unemployment, downward mobility, inferior housing conditions and poverty and sometimes overt discrimination; migration may entail disturbance to family and social relationships, changes in social status, and in climate and physical surroundings.

The abundance of these potential stressors would seem to imply that a great many migrants and most refugees would suffer mental health damage and the physical consequences of adverse psychosocial factors. Yet this does not appear to be the case. One comprehensive longitudinal study of Vietnamese "boat people" in Canada found that only a minority of severely challenged refugees become "mental health casualties", in particular, those lacking personal and social supports (Beiser 2005; Beiser 2009). Although, undeniably, some migrants succumb to these risk factors, facing this wide variety of potential stressors immigrants tend to build an array of coping mechanisms and strategies, whether individual, familial or social. Immigrants tend to show "remarkable resilience" (Shuval 1993; Shuval 2007). While often facing real and severe challenges, they do not do so as "passive tools of fate" (Beiser 2005), rather they respond in a variety of ways to the challenges they meet, often anticipating and adapting to these challenges as the inevitable accompaniments of migration itself. Migrants will tend to regard a variety of potential stressors, such as unemployment, downward occupational mobility or poor housing, as inherently transitional and therefore acceptable, at least in the short or medium term (Shuval 2007).

This last point leads to an avenue of enquiry which connects migrant health to the social determinants of health approach. Recent studies have begun to explore the connection between the degree of voluntariness and planning in migration and the psychosocial effect of potential stressors (Gong et al. 2011; Gong et al. 2012). These studies should be seen against the background of the hypothetical pathway between socioeconomic inequality and health outcomes, which runs through lack of social cohesion and stress induced by psychosocial factors (Brunner 2007; Marmot et al. 1997a; Marmot and Wilkinson 2001; Marmot et al. 1998; Siegrist and Marmot 2004). The theory proposes that the inverse social gradient found in CVD and all-cause mortality is due, at least in part, to psychological consequences of the social hierarchy itself, including the degree of social cohesion, personal autonomy, power and control experienced at different levels of the social hierarchy. The factors that are relevant

in our context which have been shown to be related to CVD mortality, (and perhaps to cancer mortality as well), would include anxiety and distress, as well as work characteristics such as high demands and low job control (Kuper et al. 2005; Pikhart and Pikhartova 2015). On the face of it, immigrants should be subject to psychosocial risk factors for negative health outcomes which are higher than non-immigrants', since they tend to take up, at least in the short term, low-status jobs, with relatively low pay and adverse working conditions.

However, challenging situations are not objectively negative and stressful. They must be defined as such subjectively, and there must be a perception that the individual is unable to cope with this situation (McEwen 1998; Shuval 2007). Migrants may perceive their situation differently than natives do, and in ways that have consequences for stress. For instance, it has been shown that many voluntary migrants, at least in the early stages of their residence, do not regard the bottom-level jobs they take up as having negative implications for their status and self-esteem. There are at least two reasons for this "immunity": either they do not (yet) regard themselves as full members of the receiving society and view their status and low wages against the yardstick of their origin community (where these wages may be considered to be high and provide prestige); or they may regard their low status as a temporary, necessary and unavoidable stage on the road to greater economic achievements, seeing their job purely instrumentally as a source of much needed income (Massey 1999; Massey et al. 1993; Piore 1986). If this is so then immigrants who moved in order to improve their economic circumstances would enjoy protection from some of the negative psychological impact of lower socio-economic status, protection which would help to explain why immigrants are found to have better health than expected, given their relatively low income and occupational status. Likewise, migrants would be expected to be much less likely to share one of the factors which has been proposed as creating or reinforcing poor health outcomes for the disadvantaged, what has been labelled "socialised fatalism" (Bosma 2014), a belief, engendered in childhood, that one is not able to control events and one's environment. The very act of voluntary migration is evidence that fatalism is not a typical migrant's subjective disposition!

The hypothesis associating lower than expected stress levels with a positive outlook and perceptions should have duration effects. It is likely that such coping mechanisms can only be effective in the short and medium term, or to the extent that migrants continue to view themselves against the standards of their society of origin. Nor would they be available to the second generation, who were never part of that society. We would expect the decline of this protection over time, and its disappearance in the second generation. This potential duration effect on migrant health is peculiar to the distinctive characteristics of the migration experience and cannot be assigned to the influence of either the origin or the destination environment. On the other hand, if the social context of reception may be a potential stressor then period effects should be expected as well, with the level of potential stress varying with the degree to which the atmosphere in the destination is welcoming or hostile. In other words, migrant stress should also be investigated within a multidimensional temporal framework, embracing duration and period effects.

#### *1.3.5.3 Acculturating migrants*

The third theme in which one can see the emergence of recognition multifactorial process impacts on migrants health outcomes, and in which temporal change is multidimensional is that of "assimilation" or "acculturation". Assimilation or acculturation are the proposed adjustment mechanisms for changing health outcomes in the environmental transition rationale, and each of the two concepts represents complex social processes. The relationship between these two concepts is not straightforward. Sometimes they are used interchangeably (Lara et al. 2005); at times "assimilation"

may be given either a positive connotation as a desirable strategy of adaptation for migrant groups (Alba and Nee 1997) or a negative one, as a less desirable strategy of adaptation (Berry 2003); alternatively, "assimilation" may be referred to as one possible outcome of "acculturation" (Biddle et al. 2007). This diversity reflects one of the major difficulties with these widely-employed concepts: they are often used without any definition or clear formulation (Hunt et al. 2004; Salant and Lauderdale 2003; Thomson and Hoffman-Goetz 2009). The concept of acculturation may refer narrowly to changes in the domain of beliefs, norms and values (Koneru et al. 2007), or it may be widened to social change more broadly, encompassing behaviour and social interaction, including diet, language use, friendship networks and membership in organizations (Lopez-Class et al. 2011). The process may refer specifically to changes experienced by individuals, changes which follow and accompany migration, or refer more broadly to changes experienced by "ethnic groups" with or without a migration background (Berry 2003; Hunt et al. 2004).

While the epidemiological literature on possible impacts of acculturation on health outcomes has expanded exponentially over the past decades with hundreds of articles now published yearly[3], reviews of the literature have repeatedly expressed general dissatisfaction with conceptualization, measurement and specification of the processes involved, and specifically with the oversimplified, unidimensional "environmental transition" model which characterises much or the literature that uses this term (Abraido-Lanza et al. 2006; Alegria 2009; Hunt et al. 2004; Lara et al. 2005; Lopez-Class et al. 2011; Ro 2014; Rogler et al. 1991; Salant and Lauderdale 2003; Schwartz et al. 2010; Thomson and Hoffman-Goetz 2009). While at least one of the reviews finds that the concept of acculturation in its current use is so deeply flawed that its use should be abandoned altogether (Hunt et al. 2004), all the reviews are united in their conclusion that the adjustment processes involved are diverse, multi-dimensional and complex, although exiting studies do not reflect this. They recommend that research on the impact of cultural change through migration on health should be based on theoretical approaches that specify this complexity and are aware of the contingency in possible outcomes. The outcomes are dependent on context: on the variety of socio-economic and political circumstances in which specific migratory groups find themselves, and on the circumstances of their reception in the destination. In addition, the reviews find that the temporal patterns through which acculturation is linked to particular health outcomes (among them self-assessed health, prevalence of chronic disease, obesity, or cause-specific mortality), may differ both in pace and direction (Riosmena et al. 2014; Ro 2014; Unger and Schwartz 2012). The principle conclusion of one review is that approaches are required that can deal with "constantly changing" individuals and communities, that provide "dynamic" models that deal with "a process of sociocultural change and adaptation across time" (Lopez-Class et al. 2011). Once again, practical research experience has led to recommended changes of approach consistent with a "multidimensional temporal dynamics" rationale, to a growing awareness that temporal complexity in several dimensions is an inherent feature and consequence of the concrete circumstances of migrant adjustment, and that this temporal complexity must be considered in any analysis of the determinants of the health status of migrants.

### 1.3.6 The environmental transition rationale: time for a change

In the environmental transition rationale, the passage of time since migration measures the cumulative influence of a single, all encompassing, "causal factor", the progressive adoption of the destination

[3] PubMed lists over 900 articles yearly from 2015 to the end of 2021 when searching for journal articles mentioning ("migrants" or "immigrants") and ("acculturation" or "assimilation").

'environment' through acculturation, in a dose-response relationship. Such phenomena as migrant selectivity and migrant stress are intervening or biasing factors. In the alternative "multidimensional temporal dynamics" rationale the passage of time marks the combined and interacting effects of a variety of factors at differing levels of aggregation, each of which has its own pattern of change over individual time, and collective time. Migrants actively adapt to their new location and to its characteristics in a variety of ways, while this new location is changing as well. They do not necessarily adopt all aspects of their destination, and the characteristics and behavior which they do acquire will depend on personal factors, on cultural and social attributes brought with them from their country of origin, on the socio-economic and political factors they encounter in the destination and which are themselves changing, on how all these alter the migration stream to which they belong, and how this stream alters the destination itself. When looked at in aggregate, the temporal pattern of the health response to migration is a complex summation of the influence of these individual and collective adaptive responses (Shuval 2007). In both rationales the health status of the migrant population may depend on the composition of the population by duration of residence. But the interpretation of the impact of the passage of time is far more complex once more than one explanatory factor needs to be considered (Jasso 2003), and when time advances simultaneously on an individual, collective and socio-historical level.

For the epidemiologists who pioneered these studies, migration appeared to open an attractive opportunity to isolate the impact of environment on disease. When disease rates differ by location the movement of migrants between them appeared to offer the possibility of assessing the impact of environmental factors, to distinguish "nature" from "nurture". But this possibility has proved to be a chimaera, because it ignores the distinctive characteristics of migration, both the forces that create distinctive migratory populations and the forces that alter the circumstances of migrants in their destination (Appendix A.1 provides a critique of one of the classic studies in this tradition). Of course, researchers in this tradition were aware of factors that distinguish migratory populations, such as selectivity and migrant stress, but they were portrayed as "analytic" difficulties, biases that might be overcome with appropriate controls. These factors have been found to be substantive, because migrants are not random representatives of their origin, and not passive objects of a natural experiment, but active subjects who create and respond to their circumstances, thereby creating and altering an environment that is neither the "origin" nor the "destination". The "environment" of a migratory community has qualities of its own, qualities which are altering in a complex way over time. Nor is "assimilation", in the sense of a complete loss of a former cultural and social identity an inevitable or even a common outcome of migration. Empirical analysis shows rather that mutual adjustments and accommodations of migrants and their new social location are the norm.

Moreover, the focus on contrasting environments shifts attention away from the need to consider "timing variables" in several dimensions when analyzing the immigrant experience and its effects on health, namely age, age at migration, period of exposure, duration since migration, and arrival period. The health outcomes of migrants should be considered in the light of time-defined exposures, the cumulative adjustments that migrants make, and the adjustments that migrant-receiving societies make to the presence of migrants. They should not be defined by a predetermined environmental 'endstate'. Growing recognition of the inadequacies of the environmental transition rationale has led, in recent years, to the development of wider conceptual frameworks that have attempted to put order in the complexity we have presented. We shall now look at them.

## 1.4 Multidimensional temporal dynamics

### 1.4.1 Attempts to capture the relationship of migration dynamics to health

The environmental transition paradigm has the desirable analytic feature of simplifying reality to a small set of variables. Within the last two decades, with the growing recognition that the simplicity was inadequate, several attempts have been made to organize the new-found complexity and construct what is called here a "multidimensional temporal dynamics" paradigm. Several similar and overlapping analytic schemes or conceptual models have been presented, designed to summarize the types of factors that impact immigrant health and mortality, and their temporal character. They include two from Canada (Gushulak and MacPherson 2006; Trovato 2003) three from Germany (Kohls 2010; Schenk 2007; Spallek et al. 2011; Spallek et al. 2014) and two from the United States (Acevedo-Garcia et al. 2012; Jasso 2003; Jasso et al. 2004). Their common features will be pointed out, where they differ, and how they might be combined and augmented. For the most part these are not theories, but rather compilations of the salient factors (and in all but two cases they are illustrated by graphic schemes), which need to be considered when analysing the impact of migration on health, factors which should play a role in present and future theories. Jasso's studies differ from the rest because they are linked to a formal theory of health selectivity and health trajectories, although her analytic scheme is less comprehensive. The schemes overlap, and there was some mutual influence in their development. Kohls' scheme was based on that of Trovato and Schenk, Spallek et al. refer to Schenk, and Acevedo-Garcia et al. refer to Jasso. The differences between them derive in part from their differing disciplinary orientations, including social epidemiology (Spallek et al., Acevedo-Garcia et al.) population heath (Gushulak and MacPherson), sociology and demography of migration and health (Trovato, Jasso, Schenk, Kohls) as well as different national contexts and concerns. The orientations colour the emphasis placed on various elements in the schemes, and the outcome variables differ as well, whether morbidity, cause-specific mortality, or health situation in general. They share their interest in a preliminary question: how do migrants' health outcomes differ from natives'? But they differ in the emphasis they give to two related sets of questions, the socio-demographic question being: how does the health of migrant populations alter over time, and what factors explain these changes? While the second question, characteristic of epidemiology, is: how can migration help us identify definite risk factors for specific diseases?

Figure 1.1 is an attempt to summarize these schemes (or "conceptual frameworks") graphically based on the different illustrations which each scheme provided on its own. As shown, all the schemes place country of origin and country of destination (with blocks of modifying factors ascribed to each location) at two poles of a temporal process, with a transitional period assigned to migratory movement itself (which might be through a third country or in particularly burdensome conditions). These three periods are accompanied by a variety of intervening factors such as selection processes, or the factors

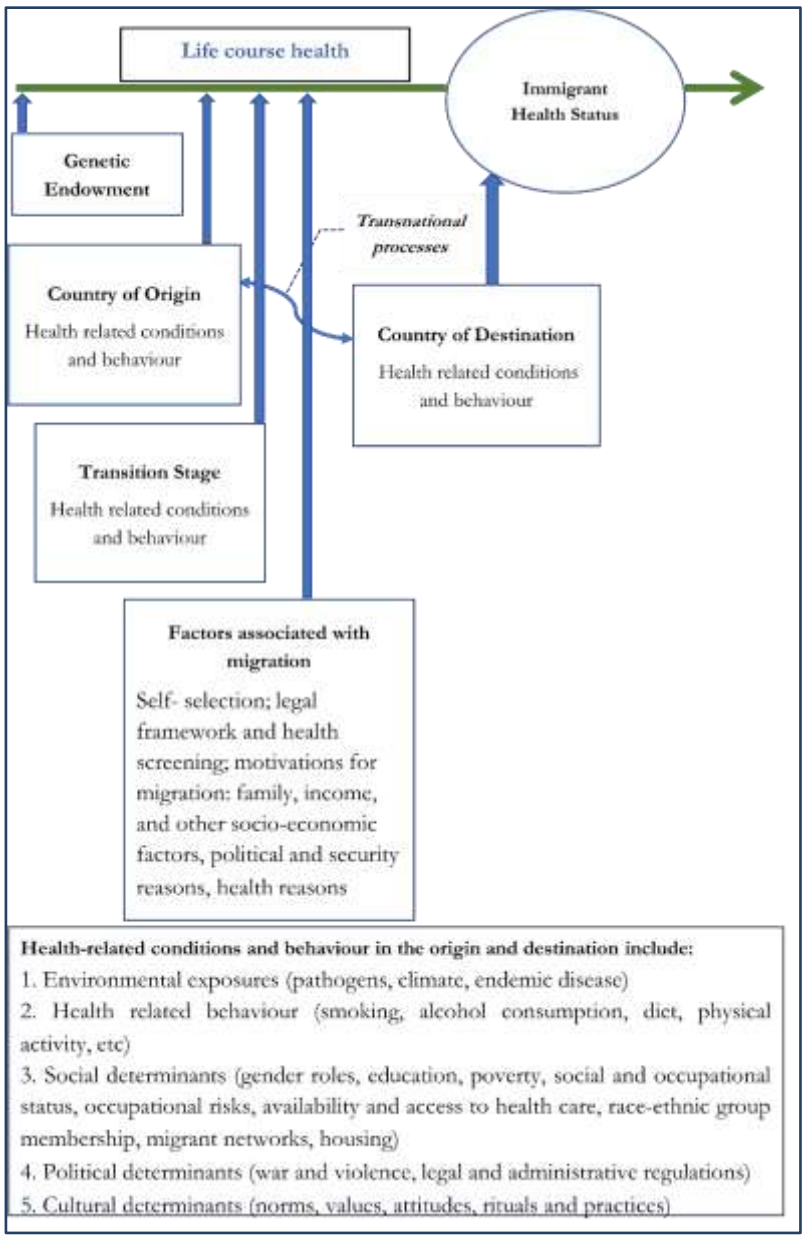



*Figure 1.1 A synthesis of factors affecting migrant health over the life course*

affecting the decision to migrate. Each scheme mentions acculturation and alteration of values and behaviour as one of the factors affecting changes in immigrant health over time, but for none of them is it the dominant factor. In three of the schemes (Spallek et al., Acevedo-Garcia et al. and Jasso) a life course perspective provides a framework for understanding temporal processes across the transition from location to location, although, as we shall see, there are differences between the sociological and the epidemiological conception of the life course perspective.

Each scheme understands the impact of the factors in origin and destination in terms of its disciplinary orientation, but they all share the perception that the level of migrant health is determined by a complex interaction of genetic, environmental social and economic factors which distinguish migrants in general and specific migrant groups in particular from the non-mobile populations, whether in the country of origin or in the destination. Each scheme is illustrated by specific examples of the relationships and mechanisms specified by it. We will briefly present their distinctive characteristics, omitting these details.

#### *1.4.1.1 Characteristics of seven "multidimensional temporal dynamics" schemes*

For Spallek et al., the country of origin and destination each impart broadly-defined and differing individual, environmental, and contextual exposures; the outcome variable is an individual immigrant's health status as it develops along the life course. Their scheme conforms to the classic epidemiological approach of analysing the connection of risk and exposures (in all their variety) to the incidence and prevalence of specific diseases or health conditions in populations. They set apart the circumstances

(individual, economic, political) which induce migration as a distinct set of factors, not included in either the origin or destination exposures.

In the scheme developed by Acevedo-Garcia et al., the explanatory factors focus on a compilation of the social determinants of health (in brief, socio-economic factors and gender inequality), along with environmental exposures and disease prevalence both in the origin and the destination. But unlike the other schemes, they identify and stress structural socioeconomic factors in each location, including migration 'push and pull' factors, as well as *transnational* processes which link the origin and destination and can affect health. In their scheme, health status itself interacts with the decision to migrate or re-migrate, as both a determinant and outcome. Thus, the outcome variables unite migrant health both in the origin, before migration, and in the destination, since their life course approach recommends that both be considered together.

In conformity with their population health perspective, Gushulak and Macpherson's outcome variables are conceived in the aggregate, both the health of the migrant population itself and the impact of migrant health on the populations in both origin and destination countries. These have implications for health policy and the interventions required from health services. The relevant factors in both the origin and destination countries are genetic factors, differences in endemic disease prevalence, the level, availability and access to health care in both locations as well as how these are affected by administrative, socio-economic and cultural factors, and occupational risks. Central to their scheme is the recognition that these relationships are dynamic. In their view the study of migrant health must take account of rapid temporal changes in the rates of global population mobility and the composition of migrant flows, changes in the disparities of health determinants and outcomes between countries (affecting cohort comparability), and national and international political changes that affect migration. Longitudinal analysis is required not only to investigate the positive and negative health characteristics acquired by migrants after arrival, but because of the long latency and delayed diagnosis of some illnesses.

The schemes which derive from a socio-demographic perspective present eclectic lists of country of origin and destination variables, each scheme highlighting the factors which it considers salient. Schenk, whose outcome variable is health inequality, specifies a wide variety of factors that may influence the outcome, most of which overlap those mentioned by Acevedo-Garcia et al., while putting great emphasis on the social processes of formation of ethnicity, minority status and ethnic community in the destination country and the resources and barriers to health these create for migrants. Kohls and Trovato, for whom the outcome variable is mortality rates, highlight selectivity processes as a separate factor, together with their key role in forming the HME, both through initial self-selection and through return migration.

Jasso's scheme is worth presenting in greater detail because it is grounded in an explicit micro-economic theory (the background to which we will discuss below, in Section 1.4). It explains migration flows in terms of the relative costs of migration and the potential gains to the migrant due to the varying price of labour-market skills between countries. Skill price differentials in the labour market have both direct and indirect impacts on health-selective factors, and on subsequent health trajectories, and are themselves associated with health status. Good health increases both skill levels and skill utilization (labour supply), which implies that when economic motivations are primary, healthier individuals have more to gain from migration. Higher skills lead to greater health, and vice versa; and the more health is positively selected at the point of migration, the more should we expect it to decline

to average levels, through "regression to the mean". The "trajectory" of health along the life course is explored with the following econometric model. The "stock" of an individual's health at any time has a permanent and a variable component, and the variable component is affected by a variety of inputs: genetic endowment, health related behaviour, use and quality of medical care, education (which will enhance both behaviour and access to care) and environmental factors (air, water, food, pathogens). The trajectory of the "stock" of health will depend on health in the previous period, depreciation, and investment to improve it. Such investment includes altered behaviour (exercise, better diet), but health will also be a function of the price of medical care, the price of other inputs, education, income, and genetic endowment, and thus it will be a function of prices and income. Since one of the typical results of migration is increased income (at least relative to the country of origin), then we should expect that it will bring about health *improvements* proportional to the rise in income. But although higher absolute income may buy better health, low relative income (in relation to the destination) may induce stress with its negative health consequences. Moreover, health selection is not always positive: in the case of migration of spouses and persons for whom labour factors are not relevant (the elderly and children), positive selection effects will not be present. And differences in health care itself between origin and destination might in themselves be a migration incentive. The legal framework in which migration to the USA takes place provides further incentives and barriers for migration and for selection of economic skills, and this too has a direct and indirect impact on health. The travails of applying for and waiting for a US immigrant visa are sources of stress which may have temporary negative impacts on health.

Jasso's theory assembles a wide variety of social and economic factors and is explicit about the migration-specific and time-related mechanisms that it specifies. It is a dynamic theory, in which all these factors may alter over several dimensions of time: individual life-course, duration of stay, period and arrival cohort. However with the exception of the effects of stress on health, and unlike the epidemiologically-based schemes, hers does not specify mechanisms that connect particular environmental, social and economic factors to specific health outcomes (Jasso 2003; Jasso et al. 2004).

The schemes reflect the national context of migration in which they were conceived. Trovato, and Jasso, from a positive North American perspective, emphasise that migrants bring with them industriousness, dynamism and energy and these should have a positive impact on health in the long run, since for most immigrants deprivation is a temporary phenomenon and income-growth is likely. For them, the common assumption in the migrant health literature that duration of stay should lead to *adverse* (rather than beneficial) health effects is unwarranted (Jasso et al. 2005). Unlike the North Americans, Schenk views downward social mobility as characteristic of migration, at the very least in the short term. Reflecting a different European experience, Schenk, Kohls, and Spallek et al. stress the consequences of persistent socio-economic disadvantage and social exclusion on the health status of migrants, and their schemes reflect the need to uncover the factors determining "health inequality".

#### *1.4.1.2 Migrants from a life course perspective: the view in epidemiology and socio-demography*

All the schemes recognize that the impact of the factors they have identified may be altered by duration of stay, but those that embrace a life course perspective propose it as a method to integrate time in a more fundamental and systematic way, to reflect the fact that health itself, for both migrants and natives, unfolds over time and unites the past with both the present and future (Jasso 2003). Spallek et al. understand the life course in terms of its epidemiological conception, as elaborated by Ben-

Shlomo and Kuh (Ben-Shlomo and Kuh 2002; Kuh et al. 2003). Jasso bases herself on the sociological conception of the life course (Elder 1994), whereas Acevedo-Garcia borrows from both conceptions.

What are the differences between these perspectives? The epidemiological conception of the life course was proposed to integrate, within a single framework, the impact of long-term effects of biological and social exposures from the moment of gestation and throughout the life-span. It appears to be particularly relevant to migration studies because it makes timing central, and because the exposures that migrants encounter, and the timing, duration, sequence and cumulative impact of these exposures, set migrants apart from other members of the population. Spallek et al. argue that the life course approach allows one to consider how exposures in each of the three periods they have identified will jointly impact migrant health through the mechanisms proposed by the approach: timing, accumulation and sequence. To illustrate with one of their examples, the factors determining the risk of adult migrant obesity should not be situated in poor nutrition and low physical activity in the destination country alone; migrants may bring with them prenatal exposures such as restricted fetal growth and low birthweight, risk-factors for obesity which are more prevalent in low-income countries. The life course approach requires one to consider whether health risks are determined by a complex joint effect of pre-migration and post-migration factors in early and later life, unlike the environmental transition paradigm, in which country of origin factors are gradually replaced by those of the destination. Timing concepts such as age at exposure, duration and sequences are crucial factors in life course epidemiology for non-migrants as well. But for migrants a further set of factors intervenes, since critical exposures may fall in each of the migratory periods (and thus in differing environments), depending on the migrant's age at migration. Thus age at migration becomes a factor that must be considered along with age itself.

Cohort effects are another important timing concept of life course epidemiology (although these are not emphasized sufficiently by Spallek et al.) The life course approach draws attention to birth cohorts, which have distinctive locations in historical time and may define for their members distinct exposures and risk factors from gestation to adult life, including environmental conditions, political, social and economic conditions, or changes in behaviour (Kuh et al. 2003). But migration further complicates the picture by creating cohorts by period of arrival as well, and these too may have long term effects on health. The period in historical time in which migrants arrive locates the specific selective factors to which they were subject, the conditions in the country which they left and those which greeted them on arrival and in their early years of adjustment to their new location. Even the relative size of a birth or migration cohort may be a factor which conditions the exposures to which they are subject, through relative crowding and competition for resources.

The epidemiological conception of the life course focuses on the individual and her/his changing characteristics. The socio-demographic conception focuses on how social groups are formed and transformed through both individual and historical time. Jasso seeks to adapt this conception to migrant studies(see also (Edmonston 2013)). She combines what she regards as the four central questions of migrant studies (characteristics of migrants at entry, the progress of migrants after migration, the progress of migrant children, and the effects of migration (Jasso 2003) ) with the four central themes of the sociological life course perspective as proposed by Elder (lives and historical time, timing of lives, linked or interdependent lives, human agency – i.e. choices and actions (Elder 1994) ). For example, combining the first question, migrants at entry, with the theme of historical time yields a concern with the characteristics of migrant cohorts and the forces that create them. Migration is, in her words, "quintessentially about human agency": migrants are actively seeking a better life, and

thus combining the theme of migrant agency with the question concerning the progress of migrants after entry points to such elements as the strategies migrants employ to adjust and succeed in their destination. In order to determine the impact of migration on health this perspective points to the importance of timing concepts such as cohorts, specific historical (period) context, age and duration of stay, together with the consequences of legal frameworks and adjustment strategies, all against the background of the many relationships which impact the migration process. As we have seen, a central concept which she uses is that of *health trajectory (*Jasso et al. 2004*)*, a metaphor which, in contrast with the environmental transition paradigm, points to the non-linear paths of health which proceed together and interact with other life course trajectories: education, family life, occupation, income, etc.. Unlike health, which alters continuously along the life course, mortality (the subject of the present study) cannot have a trajectory since it is a single event, an outcome contingent on these individual health trajectories and their determinants. But in a population, in aggregate, the temporal patterns of alteration in the risk of death, in total and by specific cause, can be viewed as the combined result of these trajectories. This will result in a collective trajectory of mortality risks for a migrant group.

The epidemiological concept of the life course points research in the direction of exploring long term impacts of specific exposures on individuals, in both the origin and destination, on specific diseases and health conditions. The socio-demographic perspective focuses on aggregates, distinguishing characteristics of cohorts, the influence of historical context, changing social institutions and relationships and how all these interact with, promote and constrain the importance of the plans of human agents and the outcomes of individual lives, in which health is one, but only one, outcome. In Acevedo-Garcia et al.'s framework there is an attempt to integrate both the epidemiological and the sociological approach, and in doing so emphasising the need to consider socio-economic structural factors that lie behind the proximal determinants of health status (Acevedo-Garcia et al. 2012). They too call for the application of the conceptual models proposed by Ben-Shlomo and Kuh (2002), but they widen them. They argue that the socio-economic factors impacting immigrant health across the life course need to be understood in terms of the push and pull factors governing migration systems, linking the two locations cross-nationally. Moreover, the social determinants of health in the sending and receiving countries must be considered separately and together. The exposures in origin and destination may be linked through social aspects of migration systems that have been ignored hitherto: transnational ties, such as remittances and networks of social support, may also have health consequences (in both origin and destination).

### 1.4.2 Increased complexity: migration creates its own changing environment.

All these frameworks propose a dynamic and much more complex approach to investigating migrant health then the traditional environmental transition paradigm – they specify a very wide variety of factors that may affect migrant health, many of which cannot be assigned either to an unchanging "origin" or "destination" environments, untouched by the impact of migration itself. They recognize that migration, through various social structural mechanisms, creates its own environment. Those that embrace a life course paradigm place temporal factors at their core and go beyond the simplifying claim of the environmental transition paradigm that "acculturation increases with duration". A more complex conception of time is an integral component of these schemes; age, cohort and historical time are included as relevant factors; and it is recognized that duration effects are not necessarily linear.

But the full implications of embracing this conception is not yet recognized in these frameworks, and this is evident in the graphic summary provided in figure 1.1, in which time is one-dimensional. There

is no sense of the interdependence of the temporal dimensions of age, period and cohort. With the partial exception of Jasso's scheme, the temporal dynamics of the migration system and their impact on the origin and destinations settings is not made an explicit element in the model. For instance, such factors as selection processes or cultural values and norms are depicted as 'timeless', unchanging elements which are not dependent on specific historical circumstances.

To examine how health in general and relative mortality risks in particular are likely to change in each temporal dimension, a compact categorization of the set of factors determining health in general and relative mortality risks in particular is helpful. The health field concept is one such classification (Andreev et al. 2003b; Lalonde 1974), and it identifies four categories: 1. genetic and biological factors; 2. behavioural and life-style factors; 3. environmental factors (in the broadest sense: the social and economic environment alongside the physical environment); and 4. health care systems and provision of services. Together these four elements encompass the factors which alter mortality risk. The first category remains unchanged by migration, accompanying an individual throughout his life course, and unfolding as she/he ages. In aggregate, however, migrant cohorts may be characterised by distinct mixes of bio-genetic endowments, insofar as their composition by place of origin or ethnic group alters over time. These fixed factors may provide permanent contrasts in relative risk to the destination population. Each of the other three categories is subject to alteration, in a positive or negative direction, by calendar period and by duration of residence. By and large the second category, behavioural and life-style factors, are more amenable to deliberate personal modification, whereas individuals have little control over environmental factors and health systems. Nevertheless, they may try to alter environmental and institutional factors deliberately through collective efforts, and they will be modified through routine or non-routine processes of social, economic, and political change. The last category will change over calendar period if the provision of services or their nature changes, but it may also alter over duration if migrants are able to improve their access to services over time. Thus the impact on individual and collective migrant health outcomes of the factors classified in these four categories is modified in the temporal dimensions: over the life course, through calendar period, through duration of residence in the destination, and across cohorts of arrival.

### 1.4.3 Multiple temporal dimensions: age, age at migration, period, cohort, duration

Figure 1.2 offers an attempt to provide a more complete depiction of temporal dimensions and timing factors in an analytic scheme for studying migrant health. Building on standard lexis-surface models in demography, such a scheme must include age, period and cohort dimensions, both on methodological and on substantive grounds. The lexis-representation "reduces" the depiction of three temporal dimensions to two (justified by the fact that any two of the dimensions determines the third (Vandeschrick 2001)) so that age a period are represented as perpendicular axes, and cohort is represented as a diagonal on a two dimensional surface(see below, Section 1.4.4)

As in the scheme outlined by Spallek et al., the migrant life course, setting out from specific genetic endowments, passes through three sequential periods in which it is subject to a variety of exposures: the country of origin period, a transition stage which may pass through several countries, and the period in the destination. Within these periods additional temporal dimensions are represented. The trajectory of a migrant's health along her/his life course progresses both superimposed and in interaction with other aspects of the life course. It advances diagonally through age and historical time, while the period of arrival locates age at migration. These temporal variables will help define the mix of exposures, behaviours and structural characteristics in each setting. These may be risk factors themselves (such as age and duration of exposure to a pathogen), effect mediators or modifiers (such as age at uptake and duration of smoking), or protective processes (such as age and year of exposure to advanced medical services, and/or duration of exposure to such services). They may be concrete factors such as changing economic conditions, policy changes, or changing capacities of health systems, or more difficult to define and measure socio-cultural factors such as value systems and social exclusion. When migrant life courses are considered in the aggregate they represent cohort trajectories, both by period of birth and period of migration. These cohorts will have characteristics defined by the period in which they were initiated (birth, or arrival in the destination), by their relative size, by the place of origin and by their socio-demographic composition. The arrow of historical time changes the distal structural factors that can affect migrant health in each period, factors such as the economic conditions in the origin and the destination, legal and administrative regulations, developments of migrant-specific social institutions, health knowledge and delivery, etc. So as not to complicate the scheme unduly, we have not represented how these health determinants interact with each other, but this possibility could be recognized with additional links between the arrows.

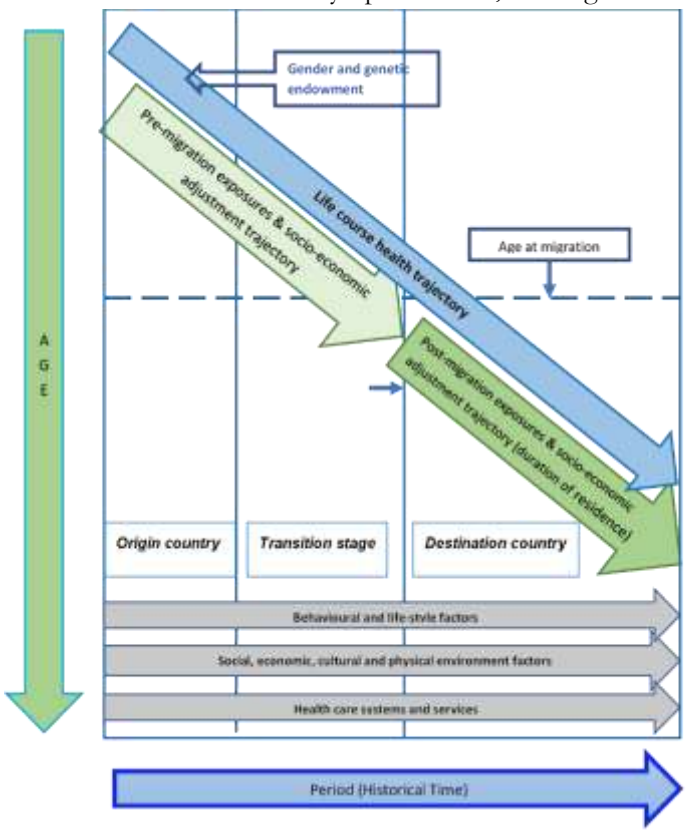



*Figure 1.2 Factors affecting migrant health in a multidimensional framework*

### 1.4.4 From time to time: the interdependence of temporal dimensions

At any given instant in calendar time migrant populations have different compositions by year of birth, by age, period of arrival, length of residence, and age at arrival, each of which has a potential impact on aggregate health. Each of the dimensions may confound the other. Assessing the impact of any of these without controlling for the other temporal dimensions will inevitably result in bias. Analysis of the effects of duration of residence (whether viewed through the acculturation lens of the environmental transition paradigm or within a multidimensional temporal dynamics paradigm) must

take account of and control for other temporal factors.[4] Using a life course perspective for immigrants means tracking two clocks, one set by the date (and place) of birth, the other by the date (and place) of immigration (Pitkin and Myers 2011). However, the classic problem posed by these temporal dimensions is that they are jointly defined and inseparable statistically. Since calendar year=year of birth (cohort) + age, any single temporal dimension in this identity is fixed by the combination of the other two. For the time dimensions relevant to migration the problem is compounded, since duration of residence = calendar year – year of arrival (immigration cohort), and this is superimposed on another identity defining age at immigration, since duration of residence = age – age at migration. When all six time dimensions are taken together, knowing any three determines the other three. Thus, for cross-sectional observations of a given year, if year of migration (immigration cohort) and age are given, then so are year of birth (birth cohort), age at migration and duration in the destination.

The interdependence of the temporal dimensions means that any cross-sectional analysis cannot separate cohort from duration effects, and cross-sectional analysis necessarily ignores period effects (since it refers to a single period alone). However, even longitudinal studies will face severe problems: duration of residence proceeds in tandem with aging, and yet one might want to distinguish the causal influence of each of the two; a statistical model investigating the relative influence of duration of residence on different immigration cohorts(by period of arrival) will not be able to investigate the possible influence of historical period, since the latter cannot be measured separately from the combined influence of the other two variables; it will not be possible to differentiate between the effects of age and age at migration when controlling for duration of residence and arrival cohort. Given these difficulties, the choice of which temporal variable to focus on will depend on the theoretical choices of the investigator, which will determine which temporal factors will be likely to be salient for specific outcomes. To give a straightforward example: when studying language acquisition by migrants and its long-term consequences it is likely that controlling for age at migration (the age at which a new language was needed) will be more important than controlling for age itself. But whatever choices are made, the potential confounding by other temporal variables must not be ignored, as a uni-dimensional model does inherently.

## 1.5 Time works wonders: lessons from the study of 'earnings assimilation'

The methodological problems posed by the interdependence of temporal dimensions can be illustrated and explored through a now classic set of studies of progress of immigrant earnings by duration of residence. Although earnings are a narrower and more easily defined variable than health, these studies provide valuable lessons and insights for the study of health and migration, since they have coped with similar issues and methodological challenges. Moreover, since several studies of migrant health have used these theories as models, (for instance: (Antecol and Bedard 2015; Biddle et al. 2007; Chiswick et al. 2008; Jasso et al. 2004; McDonald and Kennedy 2004)) they are not merely a distant analogy, and therefore they will be described in some detail.

Using what were at that time novel human-capital models, a study by Barry Chiswick, based on the cross-sectional data of the USA 1970 census, showed that although foreign-born men earn less than American-born men immediately after their arrival (controlling for labour-market experience and

[4] For a thorough analysis of the types of temporal variables that must be taken into account when studying migrants and the potential sources of temporal biases, on which this account is based, see Pitkin, J. and Myers, D. (2011). **A summary period measure of immigrant advancement in the U.S**. Demographic Research *24*, 257-292..

education), after 15 to 20 years their earnings equal or exceed those of the native born (Chiswick 1978). This finding was consistent with the human capital-based theory which he adapted to immigration experience. Newly arrived immigrants are less likely to have the skills and certificates which lead to higher earnings: the education and experience they acquired abroad (which will vary by country of origin) will not be valued as highly as skills and experience acquired in the destination, and thus their initial earnings will be lower than similarly educated and experienced natives. However, Chiswick's theory holds that economic immigrants (those motivated by the prospect of higher wages for their formal skills in the destination) are likely to be more able and motivated than natives (qualities which are not directly observable - in econometric terms these are "unmeasured skills"), and more motivated than natives to invest in "human capital", including language training, formal schooling, and knowledge of local institutions and practices. The need to invest in oneself immediately after migration will require immigrants to spend time on training and less time working, which will depress earnings in the short term, but raise them in the long term. Consequently, the trajectory of earnings of immigrants (controlling for education and experience) will show relative disadvantage initially but rise more quickly than native earnings, resulting in a steep but decelerating, non-linear, age-earnings curve. According to the theory, immigrant earnings will eventually catch up with ("assimilation"), and even exceed, those of natives (of comparable age and education), reflecting their higher average innate ability and motivation. A corollary of this theory is that for those immigrants whose motivation for migration is not primarily economic (e.g. refugees and family members), one should not find this steep assimilation curve.

The theory is not confined to economic assimilation alone but argues that assimilation is related to the characteristics which determine selection of migrants in general and by particular country, since both assimilation and selectivity are governed by differences in the potential monetary benefits of economically relevant skills. There is an implicit analogy to health outcomes and non-linear health trajectories (an analogy developed by Jasso, 1994 , Antecol and Bedard 2015, and Biddle et al. 2007, among many others), where criteria for selection, conditions in origin countries, temporary difficulties at arrival, and long-term change in health outcomes are integrated into a single theory.

Chiswick's model was challenged by Borjas, who argued both against the theory itself and disputed the findings, by attempting to demonstrate that they were based on the false assumption that cross-sectional data could accurately reflect longitudinal relationships (Borjas 1985). He argued that the high earnings growth Chiswick had found was an illusion created by differences in 'cohort-quality' (unmeasured earning-ability) between immigrants who arrived over 10 and 15 years before 1970 (who were mostly European and had relatively high earnings), and those who had arrived more recently (many of whom were of Asian and Latin American origin, whose earnings were lower). Hence the finding of positive "assimilation" with increasing duration was really the result of a sharp decline in the (unmeasured) skills and abilities of incoming cohorts of immigrants over time. He extended his challenge to the relationship between selectivity and assimilation, arguing that these cohort effects themselves were due to changes in the immigration market in the source countries and in the destination. He held that changes in American immigration policy, which after 1965 favoured entitlement to visas based on kinship connections (family preference), led to higher immigration of persons with lower skills and abilities. In addition, (for theoretical reasons that will not be repeated here) he argues that persons immigrating from countries in which relative income inequality is higher than that in the USA will be less skilled. They will be selected from the lower tail of the skill distribution. In his view both factors had led, in more recent years, to the arrival of immigrants with lower skills and

abilities than US natives, which explained why their initial earnings had declined over time relative to the native born (Borjas 1988). Moreover, he showed that when analysed by cohort, earnings growth over duration of residence appeared slower than that which Chiswick had estimated. In contrast with Chiswick's findings he claimed he could show that since they were starting from a lower initial position, more recent immigrants to the US would never catch up with native earnings (Borjas 1995).

Borjas' challenge provides three lessons for the study of changes in health by duration of residence, which echoes the multidimensional schemes presented above: the impossibility of distinguishing arrival cohort effects from duration of residence effects in cross-sectional data, and the potential importance of the former; the possibility that period effects (i.e. changes in policy and contextual conditions in the origin and in the destination) might generate arrival cohort effects; and finally, that these cohort effects may include not only observed characteristics, but unobserved (motivation, skill, etc) characteristics as well. Indeed, Borjas' methodology has been applied directly to health data in order to distinguish duration effects from arrival cohort effects, eg. (Antecol and Bedard 2006; Biddle et al. 2007; Hamilton et al. 2015; Kaushal 2009; Read et al. 2019).

### 1.5.1 Is longitudinal data the solution?

Borjas' challenges were disputed, both on methodological grounds and with regard to his substantive findings (Chiswick 1986; Chiswick 1999; Duleep and Regets 1999; Jasso and Rosenzweig 1990; Jasso et al. 2000). Crucially, Borjas himself did not have access to true longitudinal data. His analysis was based on what he called "synthetic cohorts", pooling successive cross-sectional investigations of immigrants (in his case censuses) by year of arrival. The income of immigrants who were age 20 in the first census and arrived in year X can be compared with that of immigrants who were age 30 in the second census, ten year later, who also arrived in year X. The weaknesses of this solution are apparent: not only is one dealing with independent samples whose members differed along many unmeasured variables, but also, crucially, successive cross-sectional samples are unable to account for attrition between the investigations, attrition through the processes of re-migration, death, or exit from the labour force. These processes are bound to be selective on the variables of interest – earnings and the factors which determine earnings (and by analogy on health and its determinants). Hence the results of synthetic cohort analysis may not reflect 'cohort quality' (only), but the influence of survivor bias. The obvious conclusion is that only true longitudinal data can establish the facts and test theories that refer to duration variables.

The controversy has led to a large and expanding literature discussing the existence and determinants of wage assimilation in a variety of countries, but much of it was not able to test the alternative hypotheses directly (Duleep 2015). This is because there were relatively few sources with the required longitudinal data, and even when they existed they tended to be of short duration or small sample size. As more longitudinal data became available, analysis did indeed show that census-based and cross-sectional studies overstated and distorted the pace of growth of immigrant earnings with duration of residence, principally due to attrition bias (Duleep and Dowhan 2002; Hu 2000; Kaushal et al. 2015; Lubotsky 2007). The parallel with the "salmon-bias" effect for health data is obvious: the impact of selective attrition of less healthy immigrants through return migration, which creates an apparent relative health advantage of immigrants at long durations (Palloni and Arias 2004).

Nonetheless, analysis based on true longitudinal data has shown that the methodological challenge to confirming these theories is deeper and more complex than the need to account for attrition and survival bias. Linking individual records from the 1983 and 1995 censuses of Israel, researchers

compared estimates of earnings growth with all three methodologies, cross-sectional, synthetic cohort and longitudinal (Beenstock et al. 2010). Unusually, they were able to account fully for attrition due to mortality and emigration and assess each of their effects. When using the cross-sectional analysis, and even when using synthetic cohort methodology, strong confirmation was found for the hypothesis that earnings of immigrants increased between the censuses, at a decreasing rate with increasing duration of residence. However, survivor bias was found as well – immigrants who died between the censuses had lower earnings to begin with. Survivors had better labour market earnings than "dropouts" – and it was shown that this bias enhanced the duration effect. But unexpectedly, and challenging previous studies, when a true longitudinal analysis was performed the duration effect on earnings growth disappeared completely, and this was not attributed to survivor bias, but to another source: powerful period effects. The proposed period effect was that mass migration to Israel in the early 1990s, of immigrants with no local labour market experience and with non-western, Soviet education, raised the demand for workers with Israeli experience and education, thus increasing the demand for workers who had greater durations of residence at the later point of observation. This increased their relative earnings. This distortion of the slope of the earnings curve by age and duration in 1995, canceled out the expected differences between the rate of income gains for immigrants at shorter versus longer durations. The entry of massive numbers of immigrants to Israel altered the labour market, altered the value of experience, and changed the expected relationship between duration of residence and income. The study demonstrated both that synthetic cohort analysis was vulnerable to survival bias and that it could not be a substitute for true longitudinal data, because of the potential importance of period effects alongside cohort and duration effects.

The authors chose not to reject their duration hypothesis but to argue for exceptional circumstances. The interpretation was that even if there were theoretical grounds to expect an immigrant assimilation effect with increasing duration, in practice it appeared to have been swamped by historical circumstances, by the larger (period) effect of increased returns to destination-specific skills, which, unusually, brought about relatively higher rewards to immigrants who had been in the country longer. However, this study also demonstrates how difficult it is to test duration of stay hypotheses given changing powerful period effects. Unfortunately, consideration of such effects and controls for them are seldom present in migration studies.

### 1.5.2 Temporal aspects in structural and contextual factors

Before the implications of the economic literature for analysis of migrant health are discussed, one additional theme in the economic literature should be added. The theories of wage assimilation focus on how individual attributes determine immigrant wages, but additional factors exist that cannot be measured by individual traits. The impact of changes in the labour market on the relationship between duration of residence and income growth points to the importance of contextual and structural factors in explaining economic adjustment of immigrants. Many of these concepts were first introduced by sociological research, and have passed from there into economic research (Duleep 2015). They include the concepts of "segmented assimilation" and the dual labour market, the importance of migrant networks, economic enclaves, and transnationalism and remittances (Piore 1986; Portes 1981; Portes and Zhou 1993; Portes and Zhou 2012). To generalize, all these concepts refer to social processes and institutions that emerge as migration groups develop, and as they do so they may handicap migrants or provide them with resources and opportunities that smooth adjustment and reduce the costs and barriers to migration. The lowering of barriers to labour market success in the destination may lower positive self-selection of formal and informal skills. The presence of special economic niches for

migrants influences their economic adjustment: some arguing that it enhances and facilitates it, allowing migrants to enjoy the benefits and support of a cohesive community, others showing that linguistic and cultural isolation have detrimental consequences for the long term economic success of some migrants (Xie and Gough 2011).

Socio-economic structural processes and institutions such as these have been considered as factors impacting migrant health (Finch et al. 2007). What is relevant here is that these structural attributes must also be seen in a dynamic, temporal context. As was argued in the presentation of the multidimensional schemes, they themselves alter through calendar time, as migration streams grow, peak and decline, and as the structure of the economic context between origin and destination changes. Through feedback mechanisms operating between the origin and destination, they either perpetuate migration streams, or, eventually, provide alternatives to migration in the origin or the destination (Fussell 2012; Massey et al. 1993). Several studies have addressed the impact of structural factors on health outcomes, but without the dynamic framework proposed here – (eg. (Acevedo-Garcia et al. 2012; Finch et al. 2007)). In a health-determinants context the insight missing in these studies is that in addition to duration of residence effects (most importantly, cumulated exposure to a changing environment), and in addition to arrival cohort effects (created by policy changes and changing social and economic circumstances in the countries of origin and destination), there are structural aspects of socio-economic life that are evolving over historical time and which affect both natives and migrants at all durations, and from all cohorts, collectively.

### 1.5.3 Implications of 'wage assimilation' models for migrant health studies

Several methodological lessons arise for migrant health studies from wage assimilation theory. The first of these is that longitudinal hypotheses cannot be confirmed by cross-sectional data since arrival-cohort effects can create apparent duration of stay effects. Secondly, these arrival cohort differences may be created by (period) policy changes and patterns of social and economic change which may themselves be an outcome of migration. The third lesson is that although creating "synthetic cohorts" with repeated cross-sectional surveys appears to provide a convenient substitute for cross-sectional data, these are subject to attrition and survival bias, which may invalidate the findings. The fourth methodological lesson is that arrival cohort effects and duration of residence effects are not the only possible factors which need to be considered. Even when true longitudinal data are available, period effects may overwhelm duration of residence effects, making them unmeasurable. Indeed, the findings of the Beenstock et al. study raise the possibility, given the six-fold arithmetical identities of temporal factors that were mentioned above, that in the presence of strong period effects, by strict formal standards duration theories are *untestable in principle* – since one cannot hold all the other temporal dimensions constant while examining any given dimension. Some subjective judgement of the plausibility of the results is inescapable. And the final lesson is that in order to describe factors impacting migrant health it is not sufficient to focus exclusively on the temporal dynamics of measured individual characteristics. Individual adaptation of immigrants is occurring in a structural context that is itself subject to temporal change, change which will alter both the selective forces creating migrant cohorts, and the context of adaptation, including the development of supportive communities and transnational institutions.

Migrant health can change simultaneously over several dimensions of time because the factors affecting health alter in each of these dimensions: this multidimensional "rootedness in time" is essential to migration processes. It must be recognised that these methodological problems are created by the

subject itself: migration itself produces complex temporal effects which may be difficult to disentangle even with the best of data. Even when there might be strong theoretical grounds to expect duration of residence effects, arrival-cohort effects, or period effects, establishing their existence and relative strength is far more difficult than the many cross-sectional or even synthetic-cohort analyses have recognised or acknowledged.

The literature on migrant health since Jasso et al. 2004, drawing on the wage assimilation model and a life-course perspective, has broken with the unidimensional environmental transition paradigm. There is a growing awareness of the substantive and methodological interdependence of temporal dimensions, and the possibility that duration effects are confounded by both arrival cohort and period factors – eg. (Ro and Bostean 2015; Teitler et al. 2017; Wallace et al. 2019). Nevertheless, the full methodological and substantive implications and challenges of a multidimensional scheme have not yet been faced: awareness is limited to the need to test for the possibility of cohort effects, when examining duration of stay hypotheses, usually in the context of testing for HME, and often with problematic synthetic cohort methodology. Even when the possibility of period effects is acknowledged they are sometimes assumed to be homogenous for both migrants and natives (Hamilton and Hummer 2011; Hamilton et al. 2015). The risk of this assumption was demonstrated in the Beenstock et al. 2010 study, which shows that period effects can and will differ in intensity and direction for migrants and natives. The same labour market situation that lowered *migrant* wages increased *native* wages (since they possessed more local human capital). For health outcomes period factors operating in opposite directions can also be expected.

## 1.6 Duration of stay and migrant health: has our reach exceeded our grasp?

The approach to migrant health studies advocated here holds that duration of stay is only one of the temporal dimensions which need to be tracked in migrant health studies. Nevertheless, it does have a substantive importance that distinguishes it from other temporal dimensions. When the distinctive health problems of migrants are addressed, the question arises whether accumulated time in the destination country leads to health that is progressively improved, worsened, or is left unaffected, whether health problems and initial difficulties are increasingly solved or deepened. However dynamic and complex the factors that impact migrants' lives, the (over)simple question will remain: has the new life that migration has brought about made an immigrant's health better, worse, or is it unchanged? This puts a policy focus on duration of stay which is not shared by aging or by the period and cohort dimensions of time. Assessment of whether the relative health of migrants in a <u>period</u> is improving or worsening in a country, will inevitably require distinctions to be made on a <u>duration</u> scale: between migrants who are long established and those who have arrived recently, guided by an underlying assumption that the impact of life in a country alters with exposure.

The multidimensional approach holds that this exposure is complex, that duration of stay does not measure a single unitary process, that it is unrealistic and misleading to use it as a simple proxy for acculturation (reflecting the "environmental transition" paradigm) as many studies have continued to do (eg. (Ro 2014)). This insight is not novel. It was recognized (but ignored) nearly four decades ago, in an early review of the findings of migration health studies: "it is readily apparent that length of stay presents a summation of so many discrete and complex processes that a linkage to a time curve of adverse health effects may be impossible, and, in any case, is likely to be unique to each migration phenomenon" (Kasl and Berkman 1983). And they go on to say that duration of stay is "difficult to translate into a conceptual variable, and then fit into a theoretical framework".

The contention that aggregating outcomes over duration of stay can obscure multiple underlying processes anticipates what has been argued here. But the rejection of the use of duration of stay as a "conceptual variable" is only valid if duration of stay is thought of as reflecting a unitary process, and not if it is acknowledged that there is an inescapable interest in the accumulation of changing exposures, behaviours and structural-institutional factors which alter risk (which were summarized in the health field concept, section 1.3.2 and in figure 1.2). Leaving aside the unnecessary assumption that duration of stay must lead to *adverse* (rather than beneficial) health effects (an assumption that has remained all too common (Jasso et al. 2005)), the challenge to the generalizability of findings concerning duration of stay can be met. Indeed, each migration phenomenon is unique: but generalizability arises from the possibility of disaggregating typical temporal patterns which can arise from common circumstances of migration and attempting to ascertain how health outcomes have altered in each temporal dimension in response to changing risk factors. In the case of mortality outcomes, these patterns may differ by cause of death and socio-demographic group, reflecting the changing impact of intervening factors identified by the various domains of the health field concept. Moreover, these patterns need not be linear, especially when vulnerabilities are not continuous over the life course. Some exposures in childhood will remain permanent risk factors, some only emerging in adulthood, others will diminish with time. The potential to modify behaviour and life style will differ by age and age at migration (Kuh and Ben-Shlomo 2004; Spallek et al. 2014). It will remain necessary to untangle duration patterns from cohort and period factors, and duration effects will have to be placed into theoretical frameworks which address each of the domains, and each of the time dimensions.

Dose-response relationships in environmental exposures (as they are presented in the environmental transition perspective) are only one aspect of duration effects. In addition, duration of stay alters risks (including exposure to stress), resources and outlooks in multiple ways. A partial list follows.

Duration of stay can mark the point on the temporal pattern of stress as the variety of challenges which migrants face accumulate, particularly in the early phases of migration where establishment of legal status, un- or underemployment, housing difficulties potential discrimination, family disruption, loss and acquisition of social, cultural and linguistic skills can be acute. Whether or not stress and distress follow a fixed temporal pattern (Ritsner and Ponizovsky 1999), it remains the case that the earlier stage of migration is accompanied by a greater number of potential stressors, although there are some that may appear or reappear in later years (Beiser 2009).

In addition, duration of stay tracks the cumulative degree of success (or failure) of the individual (and his/her household) to adjust to the social, economic, and political environment in the host country. This may involve some degree of adoption of language, behavior, diet, values and beliefs of the destination, and the effect of these will be complex since some behaviours will promote health (for instance, adoption of up-to-date medical advice on diet, screening, pre-natal care, smoking, etc.) and others may be detrimental (such as adoption of unhealthy diets). Knowledge of, and skill in negotiating, the new social environment will rise as duration of stay increases, though perhaps differentially by age of arrival and degree of social inclusion of the migrant group. For immigrants of labour force age, duration of stay is usually associated with rising income, regardless of whether immigrant income ever reaches equivalence to (similarly skilled) natives of the host country. Increasing income, other things being equal, should have a positive effect on health outcomes (Chiswick et al. 2008; Jasso et al. 2004; Jasso et al. 2005). For some immigrants, however, economic success is not achieved. Along the life course there will be an interaction between the determinants and consequences of the socio-economic adjustment trajectory and the life-course health trajectory (Figure 1.2).

Socio-economic adjustment may entail changes in personal orientations, from origin to destination-based membership in social networks, and changes in the intensity and number of social ties. Given that social networks provide both practical and emotional support, and these have health consequences, the temporal pattern of disruption and change in the intensity and extent of social ties will have positive or negative health consequences as well (Berkman et al. 2000; Rottenberg et al. 2014; Tsai and Papachristos 2015).

Finally, duration of stay may be accompanied by a changing focus of orientation for self-assessment: from measurement of achievement and identity with reference to country of origin to reference to the country of destination. This changing framework of reference will be relevant to health relevant psychosocial factors such as satisfaction with income, occupation, and subjective social status. Equally, they may distort changes over time in answers to survey variables such as self-assessed heath (Gong et al. 2012)

These processes, measured at the level of the individual, move along the life course, both through age and calendar time, and are associated with possible cohort effects as illustrated in Figure 1.2. In parallel to them, other factors impacting health will be changing at the social-structural and collective level, providing context for and determinants of individual change. These factors are associated with both period and cohort effects and may confound duration effects. Duration of stay coincides with elapsed periods of historic time (such as periods of economic growth or decline, social and cultural change, medical progress, and changes in health systems) in the destination. Changing contextual conditions may impact migrants differently than natives and long-term residents, and such period factors may create apparent duration effects when this bias is not controlled for (Duleep 2015). Immigrants at differing durations of stay may represent stages of development of a migration stream, who may have been selected differently by measured and unmeasured demographic and social characteristics, area of origin, health status, economic skills, or personality characteristics. Changing historical circumstances in the origin and destination produce cohort effects through changing selection patterns, and the assessment of the impact of duration of stay will need to control for these effects. Thus apparent duration of stay effects may be measuring the impact of the cumulative degree of success of the migrant group as a whole (rather than the individual) to adapt to conditions of life in the destination, collective success which will promote and support individual success (Hatton and Leigh 2011). This may include the development of formal and informal community structures and political organization, all of which may provide health resources on which migrants, at all levels of duration of stay, may draw.

From the perspective of the study of migrant health one can only envy the simplicity of the wage assimilation models, in which shifting monetary rewards to measured and unmeasured skills are the primary engine of change.

Two further fundamental methodological difficulties must be addressed in any attempt to measure duration of stay effects. Since duration of stay proceeds in conjunction with aging, apparent effects of duration may actually represent differences in ages at migration which affect age-specific timing of both origin and host country exposures. Disentangling differences between groups due to average age at migration from those due to duration effects will be difficult in practice because of the age-period-duration-arrival cohort identities. Secondly, change in health levels with increasing duration of residence may be due to increasing frailty through "regression to the mean" of transitory robustness which was selected at migration. This process can occur in parallel to any other process of change by duration of residence, "mimicking" their effects, and making estimation of their strength problematic.

The temporal processes impacting health specified by the life-course approach include birth cohort effects, accumulation of risk, critical or sensitive periods of exposure, varying latency periods, susceptibility due to interacting causes, and more, all playing out through historical time (Kuh et al. 2003). Adopting this model to migrant health studies superimposes it on the particular exposures, risks, depravations, and critical periods that are distinctive of migrants (Spallek et al. 2011). The theoretical approach suggested here is that processes which occur along the "duration of life", must be united with similar and parallel collective socio-economic and institutional processes, superimposed on, and modified along "duration since migration" which create exposures and modify behaviour. The study of migrant health and mortality requires not only awareness of specific risks to migrants along the life course, but a recognition of the inherent dynamic qualities of the context in which these risks are situated and which themselves modify health.

## 1.7 The ideal longitudinal study and ours

In the face of the challenge of confronting a subject that is inherently complex and dynamic, over the last thirty years researchers have described the "ideal" migration study in similar terms (Jasso 2003; Jasso 2014; Kasl and Berkman 1983; Spallek et al. 2011). It would be longitudinal, following up successive equivalent birth cohorts in the origin country, and the destination, or even better, in several destinations (Spallek et al. 2014), distinguishing migrants and non-migrants in the country of origin and native residents in the destination. At regular intervals measurement of health status, diseases, and physiological variables would be collected for all cohorts, as well as legal status, demographic, socio-economic and psychosocial variables. At fixed intervals data on physical and social environmental exposures would be collected along with structural-contextual variables relevant to the origin and destination(s). Clearly such a study would allow for sophisticated comparative multivariate analysis of the health status of migrants and the factors that affect it, relative both to the origin and the destination populations, an analysis that would provide every opportunity to adjust for various temporal confounders.

Merely to describe this ideal is to see how unlikely it is ever to be realised, for logistical and financial reasons alone; and in addition, how long it would take before one could exploit the information it provided. Much less ambitious longitudinal studies, limited to adults, and focussed only on destination countries, are sufficiently difficult to conduct, and are rare and limited in their size and scope.

Given the absence of such complex data, evidently the reach of the 'multidimensional temporal dynamics' rationale exceeds the grasp of the data which are available to realise it fully. Like researchers into income dynamics, one must often make do with retrospective and cross-sectional data, and with thin data concerning exposures, their timing and durations. In this, migration studies are no different than many other observational epidemiological studies, in which it is not possible to investigate a full set of relevant factors and possible confounders (Spallek et al. 2014).

In short, most of the variables that our ideal study would have provided are not available to us. In this respect this review has been like reading a menu for an elaborate meal in a gourmet restaurant before being told that the ingredients are not available today. We will have to make do with something simpler. The present study is observational, retrospective, and limited in the set of factors it can investigate. Nevertheless, the data that are available for it are unusual in providing mortality rates for a very large group of migrants, without sampling, at a fine level of detail, by specific cause of death and by temporal index: age, period, arrival year and duration of stay. Moreover, they fully control for the potential biases of overcount and attrition. Although they do not provide exposures and risk factors in the four

categories of the health field concept, they do allow us to disentangle outcomes by duration, period, cohort, and age dynamics at the level of cause of death. To our knowledge, this has not been attempted before, certainly not in a data set that has this duration or size. Cohorts by period of arrival can be distinguished, the area of the FSU from which immigrants arrived identified, their ethnicity (whether they are Jews or non-Jews), and their educational level, all variables which are likely to reflect selectivity.

By demonstrating that migrant groups have complex temporal patterns in risk of death it is hoped that the realism and potential utility of the "multidimensional temporal dynamics" paradigm will be born out.

# Section 2.0 FSU immigration to Israel in a multidimensional context

This chapter will review literature on the characteristics of the 1990-2003 wave of migration from the FSU to Israel, and its wider social and historical, context providing the setting for calendar period, arrival cohort, and duration effects on relative mortality rates. The characteristics of the population in the dataset will be analysed in chapter 4.

## 2.1 Socio-Demographic Characteristics

Very little information exists on the mortality and health status of the FSU immigrants to Israel prior to their departure, information which could have provided a benchmark against which one can assess how these changed in Israel. Reports are limited to observations of crude mortality rates, life expectancy at birth, and to one study of mortality of Jews in Moscow in the early 1990s. Estimated life expectancy for USSR Jewish males, 70.1 in 1988-1989, was some 6 years higher than that of the average in the USSR, and for females, at 73.7, similar to the average level (Tolts 2001). The Moscow study found that Jews had a large mortality advantage over the local Russian population due to a distinctive pattern of causes of death, a pattern which might be explained by the Jewish population's higher educational level, by cultural and by bio-genetic factors (Shkolnikov et al. 2004b).

Indeed, the small gap in life expectancy at birth between males and females and certain features of the overall pattern by cause suggested that patterns for USSR Jews, in Moscow at least, were "in many ways similar to the mortality patterns observed in Israel and in Jewish communities around the world" (Shkolnikov et al. 2004b). This was explained by common, culturally determined, health-promoting and risk-avoiding behaviours, especially among males. If this is so then the mortality patterns of most FSU immigrants in Israel could be expected to be similar to those of their new hosts and fellow Israelis (potentially, net of the effects due to migration stress or selection processes). The similarity would mean that they would not be a good case for using the "environmental transition" paradigm, since the difference in disease patterns and risk between origin and destination would be small. Yet this claim to similarity in cause of death patterns based on Moscow data cannot be accepted unconditionally, not least because in 1989 life expectancy for Israeli males and females was 4.5 and 4.4 years higher respectively than that of Jews in the USSR, (ICBS 2005) and male Jewish mortality in Russia and the Ukraine generally in the 1980s and 1990s was reported as being 20%-40% higher than in Western countries (Staetsky and Hinde 2015). Moreover, our interest is whether these patterns changed after immigration to Israel, and whether they are associated with the temporal processes of migration: the selection processes and the changing circumstances upon arrival which create arrival cohorts, the duration processes which alter mortality levels and patterns as immigrants adjust to their new circumstances and distance themselves from their country of origin, and the calendar year effects as circumstances for immigrants in Israel relative to the non-immigrant population change over time.

Looked at in retrospect, observers have been struck by two prominent features of this migration wave: its exceptional size both absolutely and relative to the receiving population, and, despite persistent difficulties, by the relative success of its absorption – if success is measured by its collective integration into Israeli economic, cultural, educational and political institutions (Razin 2018; Remennick 2007a; Remennick 2011). But this "relative success" should be assessed against the enormous challenges that the migration wave posed to the immigrants themselves and to the country that received them, challenges which were likely to have health consequences. The retrospective assessment of success fails to capture the experience of the immigrants themselves and of the receiving society as this wave unfolded. At the outset, in 1990, neither the size of the movement, the fate of the USSR nor the

prospects for the immigrants in Israel were known. These uncertainties were resolved over the following decade through varying policy responses as well as political, economic and social developments, all of which had distinct arrival cohort and durational impacts.

The pool of potential immigrants from the USSR to Israel in late 1989 is circumscribed by the definitions of eligibility for migration stated in the Law of Return, which offers Israeli citizenship to Jews (as defined in Israeli law) and to their family members. Israeli population registration regulations, following religious traditions, identify Jews matrilineally or by religious conversion. Eligibility for immigration is defined more widely: it is open to second and third generation direct descendants of Jews, whether or not Israeli law allows them to be registered as Jews in the Population Register (see Section 2.1.1). Consequently, Israeli definitions of the eligible population and the population of Jews by nationality as defined in official USSR statistics overlap but are not identical – eligibility is wider. The overall number of those eligible in 1989 has been estimated as at least 2.5 million persons, when non-Jews who resided in the USSR in a household with Jewish members are included, and even more when third generation descendants of Jews not living in such households are added. Of the eligible, 1.48 million were Jews by "ethnic nationality" enumerated in 1989, in the last census of the USSR. An additional one million were estimated as family members of households with mixed nationality with at least one Jewish member (the "extended" Jewish population (Tolts 1995; Tolts 1997a; Tolts 2001)). Second and third generation descendants of Jews who are not members of such households may add a few hundred thousand more, but their number has never been estimated reliably.

The demographic characteristics of the population with Jewish nationality can be obtained directly from the census and official USSR statistics, but since the number of non-Jewish family members is based on indirect estimates, their characteristics are not known accurately, and this restricts our ability to identify precisely the socio-demographic selection factors of the immigrants to Israel. Identification as "Jewish" in the USSR census was based on self-reports which generally reflected the official "ethnic nationality" as recorded in internal passports. Children of mixed marriages, and especially children of Jewish mothers, tended to be registered with a non-Jewish national affiliation (Tolts 1997a; Tolts 2014b). It may also be the case that some Jewish women who were married to non-Jewish men failed to report their nationality as Jewish in the census, which may help to explain the relatively large surplus of males reported in the census in every age group up to age 55 (Sicron 1998a), although this is disputed (Tolts 2014b). But aside from the observation that potential immigrants who were not Jewish by nationality had a much younger age profile than Jews by nationality, we do not have any detailed demographic information about them (Andreev 1997). Therefore, despite their limitations, the characteristics of the potential immigrant population we will report below are based on data on the core group, persons with Jewish nationality in the official data from the USSR and its successor states.

Over 71% of the Jewish population of the USSR in 1989 lived in either the Russian Federation or the Ukraine, while 13% lived in a variety of Asian and Caucasian republics (Table 1.1), and it can be assumed that the "enlarged" eligible population was distributed similarly.

*Table 2.1 USSR Population with Jewish Nationality, Census 1989*

| Republic | Number | Percent |
|---|---|---|
| Total | 1,480,000 | 100.0 |
| Russian Federation | 570,000 | 38.5 |
| of which: Moscow | 176,000 | 11.9 |
| St. Petersburg (Leningrad) | 107,000 | 7.2 |
| Ukraine | 487,000 | 32.9 |
| Belarus | 112,000 | 7.6 |
| Moldova | 66,000 | 4.5 |
| Baltic States | 40,000 | 2.7 |
| Uzbekistan | 95,000 | 6.4 |
| Azerbaijan | 40,000 | 2.7 |
| Armenia and Georgia | 25,000 | 1.7 |
| Other Asia | 34,000 | 2.3 |

Source: (Tolts 2001; Tolts 2005b)

Over 71% of the Jewish population of the USSR in 1989 lived in either the Russian Federation or the Ukraine, while 13% lived in a variety of Asian and Caucasian republics (Table 1.1), and it can be assumed that the "enlarged" eligible population was distributed similarly. It was a highly urban population, and nearly a fifth of it resided in the cultural and administrative center of the USSR – Moscow and St. Petersburg (Leningrad). Jews were a highly educated and successful and, at the same time, a distrusted ethnic minority; a prominent part of the professional, technological and cultural elite but subject to spoken and unspoken ethnic restrictions (Burg 1979; Remennick 2007a).

It was a population in demographic decline: an estimated 40%-50% of the Jewish population within the post World War II borders of the USSR had been murdered in the holocaust (Gitelman 1990), and the 1.48 million Jews by nationality enumerated in the 1989 census were over a third fewer than the 2.3 million enumerated thirty years earlier, in 1959. The causes of the post-World War II decline were a combination of emigration from the USSR (since 1970) and, primarily, very low birth rates: approximately 1.6 births per Jewish woman in the late 1980s for the USSR overall, rates which appear to have been as low for many decades. And, at least in Russia and the Ukraine, these fertility rates reflected high rates of childlessness, especially among older cohorts which had survived World War II (born before 1933) (Tolts 1997a). Although mortality of Jews was relatively low by USSR standards, due to these low birth rates, as early as 1961 the number of deaths among persons of Jewish nationality exceeded the number of births to endogamous Jewish couples, long before emigration began to affect the population in the early 1970s (Tolts 1993). Marriages by Jews to persons of other nationalities had by 1988 reached over 58% for men and nearly 48% for women (so that in the "enlarged" population of potential immigrants there were more non-Jewish female than male spouses). And since the offspring of mixed marriages were usually registered according to the ethnic nationality of the non-Jewish parent, this led to greater erosion of the Jewish population in official statistics (Tolts 1992). These demographic processes created an extremely old population at the eve of the onset of the immigration wave. Their median age in the 1989 census was 49.7, and it was even higher in Russia (52.3) and the Ukraine (51.6) (Tolts 2005a).

This description of the USSR as a whole conceals geographic heterogeneity in the Jewish population. The Jews of the Asian and Caucasian republics had median ages of 30-37 years, much younger than those of the Slavic Republics, implying higher birth rates in these areas. For example, among the 36 thousand Bukharan Jews living in Uzbekistan and Tajikistan the median age in the 1980s was 27 years, and their total fertility rate was estimated as 3.1, double that of Jews in the rest of the USSR (Tolts 2008). By 1970 Jews were by far the most educated nationality in the USSR (Brym and Ryvkina 1994), but their level of education varied by location. Whereas approximately 17% of employed Russians

aged 15 and over in 1989 held an academic degree, among Jews the proportion was 63% in the Russian Federation, over 70% in Moscow and St. Petersburg, but only 45% in the Ukraine, and 42% in Belarus (Tolts 1997b). In the Asian and Caucasian republics the educational profile of Jews was lower still – only 25% had university degrees (Remennick 2007a). Moreover, the Jewish population of Central Asian republics such as Uzbekistan, Kirgizstan, and Kazakhstan was culturally mixed, due to migration from European areas. In Uzbekistan in 1970, for instance, 77% of the Jewish population was of European origin, having arrived during and after World War II (Burg 1979). The non-European Jewish communities of Uzbekistan, Tajikistan, and Georgia represented ancient communities with their own traditions and genetic heritage, and were far less assimilated to Soviet culture than their European counterparts.

## 2.2 Evolution of the migration wave of the 1990s

Between 1989 and 2003, the period we are studying, the population of Jews by nationality and their family members in the FSU diminished by over 70%. Although the negative balance of births and deaths continued, most of this decline is explained by the massive emigration stream. It comprised approximately 1.5 million Jews and their non-Jewish relatives, approximately 62% of whom headed to Israel, while most of the rest went to the United States and, from 1992 onwards, to Germany (Tolts 2005b). This exodus began in late 1989 amidst political and economic upheaval. Earlier in the year General Secretary Gorbachev had opened the door to the movement by lifting restrictions on emigration, but the key event was in October of that year, when the US government revoked a long-standing policy which had allowed Jewish immigrants from the USSR to enter the US as refugees, without numerical restrictions. The two measures together triggered a flight: the general political instability which threatened the integrity of the USSR and the Soviet Bloc, fear of possible violent consequences of the emerging ethnic tensions which accompanied rising Russian nationalism and anti-Jewish sentiment, economic decline and social turmoil which was precipitated by the liberalising *perestroika* policy of the late 1980s, all led to panic among the Jewish population. Remaining in the USSR in increasingly menacing circumstances was perceived as dangerous, it appeared that the option of reaching the USA was closing, and all opportunities to leave might be removed at any time (Brym and Ryvkina 1994; Gitelman 1997). Israel's policy of allowing unrestricted immigration for Jews and their family members meant that this door to "the West" was still open, and it was widely believed this had to be used while possible. Significantly, the costs of transport to Israel (throughout the period) were born by the Israeli government and its agencies and not by the migrants themselves (Leshem 1998).

During 1990 the immigration wave heading to Israel swelled month by month, from 5,000 persons in January to 36,000 by December of that year (189 thousand in all). The outbreak of "Operation Desert Storm" in the first Gulf War in January 1991, which was followed by the launching of Iraqi missiles on Israel, slowed the flow, but nevertheless 147 thousand entered Israel from the FSU in 1991. After the failure of the anti-Gorbachev putsch of August 1991, the final collapse of the Soviet Union and the communist system in the last quarter of that year, and as the fears of imminent pogroms lessened, the panic subsided. But by then a regular flow of 5-6 thousand emigrants to Israel per month was established and persisted until 1995, steadily declining thereafter to around one thousand per month in 2003, having briefly revived to the 5 thousand per month level only in 1999-2000, in response to a severe economic crisis in Russia (ICBS 2007; ICBS 2009). After 2003 a steady flow of under 1000 per month was maintained – but the mass exodus was over.

What began as a swollen quasi-refugee movement settled down to a stream where weighing of alternatives, incentives and disincentives became routine. The numerical decline went hand in hand with increasing availability of alternative destinations: whereas in 1990-1991 over 90% of the flow headed to Israel, the proportion heading to the USA and Germany gradually increased with the decline in overall numbers: from only 10% in 1990 and 24% in 1991 to over 40% in 1992-2001 (with the exception of 1999-2000 when the proportions heading to non-Israeli destinations was just over 30%) (Tolts 2005b). As we will show below, as the volume and the proportion choosing Israel changed, so did their characteristics.

The consequences of the wave for Israel were dramatic: already by the end of 1990 the FSU immigrants formed 3.8% of the population of Israel, and by the end of 2001 the proportion had grown to 12.4%, nearly 16% of the Israeli population aged 20 and over. The level of education and professional skills of the Jews of the FSU was now a challenge to the Israeli economy: over the same eleven years nearly 100 thousand engineers and architects and nearly 21 thousand doctors and dentists arrived (ICBS 2006), as compared to 27 thousand and 14 thousand in each of these professional groups who were employed in Israel on the eve of the wave, in 1989 (Sicron 1998b). The country was faced with the unexpected objective of finding employment for a large and highly-skilled workforce against the background of a decade of slow economic growth and high unemployment, as high as 9.6% in 1989 (ICBS 2005; Paltiel 2002). In the early 1990s the government and its agencies were caught off guard by the rapid developments. As the pace and the ultimate size of the movement were all unknown, emergency measures had to be taken, not least because it appeared that the incoming immigrants were exhausting the pool of available housing (Borukhov 1998). While attempting to cope with the influx, government assistance programs and subsidies aimed at immigrants had to be changed repeatedly (Leshem 1998). Indeed, the change in national government which brought Yitzhak Rabin to power in the 1992 elections (in which the over 250 thousand FSU immigrants who were eligible to vote formed 7 percent of the electorate), may have been aided by dissatisfaction of the immigrants with existing government programs (Horowitz 2003).

Although the scale of the wave was that of a mass movement, and its early stages consisted of "panicky refugees" (Gitelman 1997), changes in its volume, its composition and the proportion heading for Israel reflect the fact that it was self-selective nonetheless, and that the selection criteria changed over time. When compared to the elderly age profile of the Jewish population of the FSU the wave was composed of a relatively young population, but it was relatively old compared to most migration movements and to the population of Israel. Analysis of the rate of migration as compared to the FSU Jewish population over the first four years of the migration wave showed a pronounced age gradient with migration composed of families with children and elderly relatives. Their median age was approximately 20 years younger, and the proportion of persons age 65 and over among the immigrants was only half that of the USSR Jewish population, and their median age was approximately 20 years younger (Paltiel et al. 1997). Single persons and the childless elderly (as shown above, a relatively large portion of the FSU Jewish population) tended to be left behind. In addition, and unlike most immigration waves, the migrants were disproportionally female, despite the surplus of males in the pool of potential migrants in the "ethnically" Jewish population of the USSR. The higher proportion of females was concentrated at age 45 and over (Sicron 1998a). Geographic selection is apparent – by 2003 emigration had removed almost the whole 1989 census population of Jews in Armenia, Tajikistan, Uzbekistan and Moldova, and around 80% of the Jewish population of the Ukraine and Belarus, Georgia and Azerbaijan, but only 55% of the Jewish population of the Russian Federation (Tolts

2005b). The level of education of the migrants, although always high, changed over time as well, declining from a peak of 59% with 13 or more years of education in 1990 to levels around 43%-45% by 1993 and afterwards (ICBS 2007; Paltiel et al. 1997). Selection by ethnicity was also evident, the proportion of non-Jewish family members increased continuously between 1990 and 2003, from 6% to nearly 60% (temporal changes in the characteristics of the wave by sex, age, geographic origin, ethnicity and education are detailed below in section 4.2).

## 2.3 Impact of the wave on Israel: severe challenge and evolving response

Just as over the decade the socio-demographic profile of arriving immigrants was altering, changing policy and socio-economic conditions in Israel in the 1990s altered the conditions, challenges and incentives confronting these immigrants, and these too may have contributed to health-relevant distinctions by period of arrival.

One of the clearest temporal features of the wave was the discrepancy between its chaotic initial stages and its routinization over time. 1990 and 1991 were years of panic not only for the Jews of the FSU, but for the receiving country as well. In the early 1990s arriving immigrants confronted government agencies and policies in disarray, with officials not knowing where the resources needed to finance absorption and services would come from, not knowing what aid would be required or would be effective. The anxieties which the movement elicited, and the lack of knowledge of its characteristics and impact, are well illustrated by an article published in the *International Journal of Epidemiology* that projected, based on general USSR mortality patterns and the expected size of the population, that the immigration wave would bring about a worrisome increase in total mortality rates in Israel of 6.6% for males and 4.4% for females, mainly from CVD (Rennert 1994) – a prediction that completely failed to materialize.

The agencies which provided services for immigrants were utterly surprised by the scale and pace of the movement and its onset happened to coincide with the initial stages of a plan to reorganize absorption procedures and services for immigrants by adoption of a market-based policy which abolished direct government services while providing direct and indirect financing to the immigrants themselves, to use as they sought fit. This change placed the burden of steering initial adjustment upon private and individual decision-making rather than central government programs and enhanced the lack of coordination. The lack of preparedness together with the market-based policy meant that much of the responsibility for absorption was placed on local authorities and NGOs, as well as on the immigrants themselves and their evolving social networks (Leshem 1998).

Although from the outset concerted efforts were made to adapt national policy as rapidly as possible to the new circumstances, for many years the level of benefits that would be provided and the agencies and mechanisms which would deliver them remained fluid (Alterman 1995). This was evident in all the major spheres of social policy: housing, employment, education and training, and health. Moreover, "Direct Absorption" meant that immigrants received services in the general community and not in "absorption centers" as had been the policy in the 1970s and 1980s. Consequently, in the early 1990s Israel's social welfare services were swamped by the additional burden the immigrants placed on them, and it took years to streamline procedures and provide accessible services in the Russian language. This disorder meant that those arriving in the early stages of the wave were exposed to greater challenges than those who arrived later.

Some examples can illustrate the development of benefits and services over time. From July 1990 immigrants were given an "immigration basket"– a lump sum payment equivalent to approximately

ten thousand dollars, and a monthly stipend for the first year which could be used for any purpose without oversight or restrictions, providing in effect a guaranteed income for the first year in the country. But in the early period financial difficulties, inflation and administrative conflicts meant that stipends fluctuated, and only by 1994 was the "basket" anchored in law, together with responsibilities for its administration and updating. In local terms, the benefits were relatively generous - by 1994 the benefits due to families with two parents and a child were considerably higher than social benefits to natives and long-term residents. But although relatively high, benefits were not always sufficient for one-parent families and the elderly (Leshem 1998; Litwin and Leshem 2008), moreover their restriction to the first year after arrival meant that immigrants had to find employment quickly, on whatever terms were available, whatever their formal qualifications. By 1992 immigrants were made eligible for disability benefits on arrival, and criteria for old age pensions were relaxed to cover immigrants as well. Initially health insurance was provided to immigrants only for their first 6 months free of charge, with special provisions to cover the elderly and immigrants with existing conditions. After 6 months immigrants were expected to insure themselves through existing public Health Funds, as was the case for the rest of the population. But in 1995 a mandatory universal health insurance law was passed covering all the Israeli population as well as immigrants on arrival. These changes in benefit policy meant that immigrants arriving early in the wave arrived *despite* uncertain social and health insurance benefits, whereas prospective immigrants later in the wave could base their decision to migrate on the expectation of relatively generous and stable social and health insurance benefits.

The chaotic initial conditions were especially evident in the field of housing. The period of mass influx in the early 1990s was one of policy improvisation, until eventually housing stocks met demand, and rental and mortgage subsidy policy stabilized. The fear that housing stocks would not meet the demands of immigrants led to a relaxation of planning regulations, large and often severely mis-allocated investments in permanent and temporary public housing, rental and mortgage subsidies and tax relief to renters. By 1993-1994 these investments led to a housing boom, but not before immigrants, especially in the early stage, found themselves sharing crowded and sometimes sub-standard accommodation. Period and durational factors are quite evident. On the one hand, in 1993 about 50 thousand persons still lived in temporary housing. But on the other, by 1995 the number and total area of new housing units had almost tripled their levels in 1989. On the individual level, immigrant families found that achieving a permanent housing solution took four years or more, and in the early years they had to accept crowded accommodation in locations they did not prefer (Borukhov 1998). Although conditions for newly arriving immigrants improved over time, it seems likely that differences in housing conditions and housing resources arouse between period of arrival cohorts, with the earlier arriving immigrants suffering from a longer period of adjustment and harsher initial conditions.

The literature on employment and wages for these immigrants is particularly rich in temporal insights, reflecting the scale of the challenge of absorbing a huge and highly skilled labour force which had arrived in a relatively stagnant economy (Cohen and Haberfeld 2007; Cohen and Kogan 2007; Eckstein and Weiss 2004; Friedberg 2000; Goldner et al. 2014; Gorodzeisky and Semyonov 2011; Sicron 1998b; Weiss et al. 2003). Over the decade a large set of employment programs, financial incentives, and projects to facilitate labour market absorption of immigrants were implemented, focused both on supporting employment itself and on providing accreditation, language and technical skills – all with mixed success (Remennick 2003a; Remennick 2007a). Special programs were created for scientists, physicians, teachers, and engineers (above age 45), especially for the first year or year and a half of stay, and sometimes for longer. Many of these began only in 1991 or later, and by the first quarter of 1991

the immigrant unemployment rate was over 40% (Paltiel et al. 1997; Sicron 1998b). These rates fell rapidly, so that after a duration of three years in Israel, for males at least, unemployment was equivalent to that of the rest of the labour force.

But as these studies have shown, employment levels were achieved at a high cost for many of the immigrants. Unemployment was more pronounced for females and for workers aged 50 and over, and both groups were subject to slow entry to the labour force and high rates of permanent withdrawal. Moreover, despite government programs, there was considerable downward occupational mobility, more so for women, as the Israeli economy failed to find jobs that matched the skills which were offered by the immigrants. In addition, wage growth was slow, and most studies found that even over the long-term FSU immigrants were not rewarded for their pre-migration skills and experience, and never caught up with the wages of Israeli veterans. In part this was because the skills required in a Soviet economic structure did not match up to the language and technical skills required in a Western economy. Paradoxically, the economic boom set off by the immigration wave, although at first unfavourable to wages of veteran Israelis, eventually caused these to rise rapidly, enhancing the gap between immigrants and natives and long-term residents (Cohen-Goldner and Paserman 2011; Gorodzeisky and Semyonov 2011; Razin 2018). Slow immigrant wage growth and rapid wage growth of natives, along with the relatively short time that immigrants had to accumulate local resources, led to the persistence of a relative disadvantage in household income for FSU immigrants in the period of our study.

The pattern of occupational adjustment suggests that it created hardship and stress particularly for those professionals who arrived in the early chaotic years (1990-1991 in particular) who were forced to downgrade their status or to lose their professional identity, and this was especially true for women and for older persons. Immigrants who made their decision later in the decade already knew the limitations of the Israeli labour market, not least when considered against the alternative destinations of the USA or Germany. This appears to have affected comparative self-selection of immigrants to Israel, Germany and the USA. Immigrants with higher educational qualifications and experience tended to head for the USA rather than Israel – unlike the earliest period (Cohen and Haberfeld 2007; Cohen and Kogan 2007). Thus, although immigrants at the outset of the wave were selected for younger age than those who came later, had higher educational capital and came from the more central areas of the USSR, they faced harsher initial challenges navigating the hectic policy changes, substantial hardships in the labour market, and difficulties in finding and paying for housing. On the other hand, they may have been selected for higher motivational factors than those who left later, and they may have benefitted from being "first in line". For instance, data for highly-skilled FSU immigrants in 1999 showed that whereas only about a third had been able to retain their pre-migration occupational category, those who arrived in 1990-91 were more likely to have obtained highly skilled employment than those who arrived later (Paltiel 2002).

## 2.4 Emergence of local FSU community services and institutions

The influx of such large numbers of immigrants facilitated the creation of a social and cultural infrastructure that supported the absorption of future immigrants. An "ethnic enclave economy" was eventually created, as immigrants formed businesses supplying familiar services to their fellows (Remennick 2003d). This process too took time, and in the early years FSU immigrants, perhaps imbued with an anti-entrepreneurial Soviet mentality, were slow to make use of opportunities to create

businesses (Razin and Scheinberg 2001). On the other hand, within a relatively short time the wave of immigrants to Israel created its own, vibrant Russian language cultural services and community institutions in Israel that smoothed the absorption of later arriving immigrants by providing cultural continuity and channels for integration into the new country. These included a wide variety of Russian language newspapers, television and radio channels, bookstores, libraries and entertainment services. These economic and cultural institutions promoted "transnational" economic and social ties to the FSU and lowered the social and cultural costs and risks of movement from the FSU (Elias 2008; Remennick 2007a; Remennick 2013).

One of the most salient consequences of the scale of this migration and the characteristics of the population is that it brought with it its own potential health care personnel. Over 15 thousand physicians, 6 thousand dentists and 25 thousand nurses arrived from the FSU in 1990-2000 to a labour market that was saturated to begin with (Bernstein and Shuval 1998; Remennick 2007a). The processes of achieving Israeli licensing (the precondition for entering their profession even at the most basic level) and obtaining official recognition for medical specializations took many years, and a quarter of those eligible failed to make any attempt to do so. But despite considerable difficulties, by 2004 half of all physicians under the age of 45 in Israel were of FSU origin, and a quarter of those over 45. And after additional training, most nurses of FSU origin retained their profession as well. (Remennick 2007a). Somewhat surprisingly, these numbers did not prevent some FSU immigrants from reporting that they had cultural difficulties accessing the Israeli health system (Remennick 2003b), but there can be no doubt that the presence of so many potential mediators who were able to offer Russian-language services lowered cultural and linguistic barriers to health treatment which are so often present for immigrants in other settings (see, for example (Lebrun 2012)). The barriers did not fall all at once: it took time to lower the resistance of professional organizations and to develop programs to ease the licensing process, and it took as much as five years or more for some medical professionals to acquire Israeli licenses and even longer to have medical specialties recognized (Bernstein and Shuval 1998). Thus in the early years of the immigration wave, barriers to health care for FSU immigrants were higher, and declined over calendar time. Potential FSU immigrants arriving later in the wave could expect to be able to access an understandable health system, and, from 1995 on, they enjoyed universal health insurance.

## 2.5 Previous studies of FSU migrant mortality in an environmental transition framework

The study will build directly on the foundations of previous investigations of mortality of FSU migrants to Israel. Three published studies, which relied on the same dataset as this one[5], documented mortality rates of FSU immigrants to Israel in the 1990s relative to the Israeli population (and compared to a cohort of ethnic German migrants who arrived in Germany in the same period). They explored temporal change within a broad environmental transition framework (Ott et al. 2008; Ott et al. 2009; Ott et al. 2010). They focus on levels of cause-specific mortality risk and changes in them over time and suggest plausible mechanisms for the outcomes. An additional study compared stomach cancer rates in the two settings to local and FSU rates (Ronellenfitsch et al. 2009).

[5] Unlike the present study, the dataset used excluded FSU immigrants to Israel from Central Asian and Caucasian republics (except for Kazakhstan) in order to preserve the study design, which required equivalence with the regions of origin of ethnic German immigrants to Germany in the 1990s.

The point of departure for all these studies was the contrast between health conditions in the origin and the destination environments, the FSU, Israel and Germany. As in the present study, mortality outcomes were documented, but controls for the four categories of factors in the health field concept affecting mortality outcomes are absent, including prevalence and distribution of prominent risk factors such as alcohol and tobacco consumption, diet, living and environmental conditions both in the origin and in the destination, as well as changes in socio-economic conditions between the locations, and utilization of health services.

In the FSU mortality rates had been rising since the mid 1980s, especially for males, widening the gap between mortality rates there and in Western Europe, where mortality was declining. The FSU had higher death rates for noncommunicable diseases than any other industrialised country, elevated deaths from circulatory disease in middle aged adults, and from external causes among young men. The high rates were attributed to a combination of unhealthy behaviors and lifestyle factors (especially alcoholism, binge drinking and an unhealthy diet), as well as poor health care within a failing health-care system (Notzon et al. 1998; Shkolnikov et al. 1996). Israel, on the other hand, had very high and improving life expectancy levels, especially for males, along with relatively low rates of CVD and alcohol consumption, and a modern health care system (Rosen et al. 2015).

Specific features of this migration wave which might impact mortality, beyond the general contrast of origin and destination, are put forward to explain the results: for instance, the comparison between ethnic German migrants to Germany and Jewish migrants to Israel are presented as instances of "diaspora migration". Since entitlement to migration in these cases is based on common ancestry, shared behavioural patterns between the origin and the destination may be present, but also lower levels of positive health selection. Data point to both ethnic groups enjoying higher levels of health before migration than the average in their country of origin. Ethnic behavioural/cultural resemblance between the migrant group and the destination population was suggested as a partial explanation for the overall similarity which was found in their mortality rates.

Over calendar period, mortality rates in FSU migrants showed a mixed picture of rapid convergence with Israeli mortality rates, which was interpreted as assimilation, together with persistent country of origin effects. Age-standardized death rates (ASDRs) for FSU immigrants in Israel were similar to those of other Israelis and much lower than those in the Russian Federation. Compared to other female Israelis, female migrants displayed a similar pattern of levels and change over calendar time in ASDRs and life expectancy at age 15. Mortality rates for male migrants were similar until the mid 1990s but a gap emerged thereafter. By 2000-2003 the gap in male life expectancy at age 15 was two years.

Considering the high mortality rates in the FSU from circulatory diseases, it was especially remarkable that for both male and female FSU migrants in Israel, ASDRs for CVD were similar to those of other Israelis and declined over calendar year in parallel to those of the destination population. This is especially notable given the exclusion of the FSU, until recently, from the cardiovascular mortality revolution which embraced most advanced countries, and the role that medical treatment and technology played in it (Grigoriev et al. 2014), given that such technology was lacking in the FSU. Nevertheless, immigrants from the FSU had considerably higher mortality than other Israelis from external causes and from neoplasms, and especially from cancers associated with infections, and from viral hepatitis. Rising mortality rates for external causes was suggested as explaining the growing gap in mortality between males and females. These patterns were interpreted as showing country of origin effects for diseases with long latency for environmental exposures, as well as the effects of the hardships and stresses of adjustment in a new country.

When mortality rates were investigated by duration for both the German and Israeli cohort (controlling for calendar year time trends) all cause mortality in males but not in females was found to decrease significantly with increasing duration of residence (RR=0.76, 95% CI: 0.73-0.79 for 9+years of residence compared to 0-3 years (Ott et al. 2010)). The effect of duration of stay for males was particularly pronounced for infectious diseases, cancer, and CVD. For females there was a decline in cancer mortality with increased duration of stay, and for both male and female migrants in Israel there was a large reduction in external cause mortality. Although the authors note that these duration effects might be explained by arrival cohort effects (due to earlier arriving migrants, with the longest durations of residence, having lower mortality rates) no attempt was made to investigate this. And although the changes over duration were interpreted as due, possibly, to adaptation to the local environment as well as access to better health care and medical services, it was also noted that these explanations were weaker for certain types of cancer mortality with long latency and relative insensitivity to medical care.

Rates of mortality from infectious diseases and from cancers which are possibly due to infectious agents were investigated in detail (Ott et al. 2008). These included stomach cancer and peptic ulcers (duodenal and gastric) and gastric adenocarcinoma (all associated with H. pylori), cancer of the liver (associated with Hepatitis B and C virus) and cervical cancer (aetiologically associated with human papilloma virus). It was found that FSU migrants in Israel had higher mortality than other Israelis from viral hepatitis, stomach and liver cancer, but not from cervical cancer. For stomach cancer (but not the other causes) mortality decreased with duration of stay. Here too, these results were interpreted as due to exposure to infectious agents in the country of origin. The authors state that the apparent decline in mortality from stomach cancer with duration was not due to arrival cohort effects. However, in this analysis calendar year was not controlled for, nor were rates by arrival cohort reported.

Although these studies found both duration effects and calendar year effects, the framework of analysis is not multidimensional and multifactorial. The possibility of confounding of one temporal dimension by another is not investigated thoroughly. The studies focus on the contrasts between origin and destination but ignore the possible impact of the changing socio-economic context we have just reviewed, and the impacts of developments and changes in the migrant group itself, and in its reception and adjustment in Israel or Germany. The present study will attempt to remedy this.

Moreover, apart from gender differences, the studies treat the migrants as a homogenous group, ignoring the possibility of differential time patterns by age, by area of origin in the FSU, by ethnic group, or by arrival cohort, and how measured effects in one time dimension may be confounded by other time dimensions. Aggregate measures of relative mortality in any time dimension may have been created by (or may conceal) differential patterns in any of the other temporal dimensions. Inconsistencies in the results themselves suggest this might be the case: although for males overall mortality is found to decline with duration, analysis by calendar year showed increasing divergence with mortality from other Israelis. And for females, although there was similarity to Israeli rates when examined by calendar year, when analysed by duration of stay, rates appeared to decline. Here too the findings call for more detailed investigation.

## 2.6 Expected mortality patterns by calendar period, arrival cohort and duration

Our review of the characteristics and course of the 1990s FSU migration wave to Israel demonstrates why a uni-dimensional environmental transition paradigm cannot adequately account for the factors impacting mortality of FSU immigrants in Israel. Yet this paradigm was the guiding interpretation in previous FSU migrant mortality studies. The review shows that the migration wave created its own

"environment". The social, economic and cultural context of the migration wave evolved over calendar time and was a joint product of circumstances in the FSU, of immigrants from the FSU's collective adaptation to life in Israel and the local responses to their entry and presence. These included policy measures by the Israeli government in reaction to the large influx, and the social and cultural responses to the arrival of a massive number of newcomers, as well as changing economic conditions which were in part created by the large influx. The disorder and uncertainty of the early stages of the wave contrasts with the relative order of its later stages. The expected differential duration processes (by gender, origin, ethnic group, age, educational qualifications and other characteristics) which alter mortality risks with cumulative adjustment are superimposed on powerful calendar year processes which transformed the setting in which these processes unfolded. Likewise, the FSU immigration wave is not an unbiased representative sample of the Soviet Union population, nor even of that of the Jewish population there. Changing selective patterns by age, gender, geographical origin, ethnicity, education and occupational profile all mean that arrival cohorts altered as the immigration wave unfolded, with possible impacts on health. Social, economic and cultural processes over the period of observation changed incentives to migrate and migration profiles, creating substantial differences between successive arrival cohorts which expressed themselves in measured socio-demographic characteristics (and possibly in unmeasured ones as well). Relative mortality risks, overall and by cause of death, while potentially changing in each of the three temporal dimensions, may differ not only by age group, gender, geographic origin in the FSU and by ethnic group, but by arrival cohort as well, even net of these cohorts' demographic composition. A principal goal of our analysis is to establish whether, and to what extent, this was the case.

We will now address expected temporal patterns by socio-demographic characteristics in greater detail.

### 2.6.1 Negative self-selection?

The first matter to address is the question of self-selection of relative health (frailty or robustness) and characteristics associated with health since, as we have seen, the literature on changes in relative health and mortality over time has been bound together with the question of selection, particularly in the HME literature. The principal theoretical contentions are that favourable self-selection of the health of migrants is greater the more migration is the result of economic motivations and the greater the costs of voluntary migration: the higher the obstacles, and the greater the differences between origin and destination in returns to economic skills, the greater the selection of positive qualities will be (as measured against the origin, but often against the destination as well). Reflecting the social and economic structure of the countries of origin, economically motivated migrants are often preponderantly relatively young males, who will be the prime beneficiaries of these selective forces (Chiswick 2000; Chiswick et al. 2008; Jasso et al. 2004; Wallace and Wilson 2019). Although a long-term advantage is possible, the effects of this positive selection appear to diminish over duration of residence, whether due to the environmental transition mechanism of (negative) "acculturation" with its accompanying loss of behavioural or early life exposure advantages, or through increasing frailty as temporary advantages are lost through "regression to the mean" (see above, Section 1.2.5.1).

Positive selection implies a negative corollary: non-economically motivated migrants (among them refugees) will be less favourably self-selected, as will be the accompanying spouses, children, or parents of economically motivated migrants. And further, countries which provide a safety net of social services, by lowering the obstacles, will attract immigrants who are less-skilled and frailer, the so-called "welfare magnet" hypothesis of migration flows (Borjas 1988; Borjas 1994). Linked to this is the

hypothesis that the self-selected positive characteristics that are required to motivate migration may decline over consecutive periods of arrival through the processes associated with "cumulative causation" (Fussell 2010; Massey 1999; Massey et al. 1993). The growth of self-sustaining migration networks lowers the monetary and social costs of migration, as the knowledge of the advantages of migration spread in the origin community, as policy and economic relationships alter the economic and social benefits in origin and destination, and as the migration community in the destination evolves (providing its own social and economic services to its members). Lower barriers and positive incentives can be expected to create a negative trend in arrival cohort human capital and an associated negative trend in arrival cohort relative health.

Some of these theoretical propositions have been used to explain patterns found in Israel in the 1990s. They appeared first in the field of wage assimilation. Among FSU immigrants in the 1990s, weak or absent wage assimilation over duration of residence are explained as due to negative self-selection of observed and unobserved characteristics (Cohen and Haberfeld 2007). After 1992, as opportunities to migrate to the USA and Germany emerged, Israel, with its lower barriers to entry, received immigrants who were older and had lower education and skills than those reaching the USA (although higher than those reaching Germany), qualities which are associated with poorer health and higher relative frailty. (Cohen et al. 2011). On the other hand, gender was not associated with migration motivations and type of migration. Since both male and female FSU migrants had been in the labour force before migration and were highly educated, gender differences in selection of human capital characteristics (and by implication of relative health)were not expected and were not found among FSU immigrants to Israel (Cohen et al. 2011).

Recently these theoretical arguments have been put forward as an explanation of patterns found in immigrant health in Israel. It is argued that in Israel the pattern observed in the HME literature is reversed. Relative frailty/ill-health is selected, due to a preferential immigration policy which is not based on employment potential, but rather on the ethnic diaspora-based model. One study (Constant et al. 2018), comparing self-reported health and use of prescription drugs among migrants aged 50 and above to natives in Israel and 16 European countries, found that the migrants had a relative health disadvantage (when controlling for socio-demographic and economic variables) at shortest durations of residence which persists for up to twenty years, unlike immigrants to Europe who are healthier than natives on arrival, but loose their advantage over time. They concluded that this "sick immigrant effect" was due to differences in migration policy between Israel and Europe: Israel's relatively generous immigration regime for Jews and their families attracts relatively sick immigrants, because there are no external controls or self-selection on positive health or health-correlated attributes (such as education or motivation) as in the European countries. Rather, in their view, the motives for immigrants' move to Israel "is mostly dictated by ideological or religious reasons", and Israel's generous provision of subsidized travel, citizenship, economic support, and health insurance on arrival may encourage immigration of the "weak and ailing". And beyond the low economic barriers, "diaspora" migration may involve lower psychological-cultural challenges since the migrant may see himself as (re)joining a group in which she/he will belong to the dominant majority (Constant et al. 2018). Another study reached the same characterization (Pinchas-Mizrachi et al. 2020): FSU immigrants in Israel display a "sick immigrant effect". The authors found that immigrants as a group, and especially males, had a higher cumulative risk of mortality when measuring survival from 1990 to 2016 of FSU immigrants in Israel who arrived in 1990-1995 and were born in 1940-1950 and comparing it to that of Israeli Jews born in Eastern Europe who arrived before 1960 and their offspring (born in the same years) over the

same interval. However, they found that when income was controlled for, the relationship held only for immigrants with low incomes in Israel. FSU immigrants who had achieved high incomes had lower cumulative risk, and there were no differences between immigrants and the control group in the middle-income category. They too explain their findings as being due to the lack of barriers to migration of Jews and family members created by the Law of Return, which may even encourage sick people to make use of their right to free health services in Israel. They suggest that the relatively better health of higher income migrants is explained as due to their lower levels of stress and their adoption of better health behaviour in Israel.

Unlike the present study, neither of these studies tests for cohort or period differences, and both cover restricted age ranges (although Constant et al. test for a "period" effect which is associated with the survey year). Constant et al. interpret longitudinal effects from pooled repeated cross-sectional samples, ignoring the very considerable differences between the cohorts of immigrants who arrived in Israel over its history. Indeed, the history of migration to Israel has unusual consequences for a study comparing immigrants and natives. They do not take into account that in 2010, the midpoint of their data, the study group is larger than the control group! Among Israelis over 50 years of age the majority were born abroad and only 40% were born in Israel, and most of the latter were second generation immigrants (ICBS 2011). Thus comparing "immigrants" to "natives" will have a very different meaning in Israel than it does in most European countries, where the control group is an overwhelming majority in a long established population. The Pinchas-Mizrahi study uses European born immigrants who arrived in Israel before 1960 and their offspring as a control group. But this comparison group is the core of the population with the greatest income and accumulated wealth in Israel, attributes which are clearly associated with health (Lewin-Epstein and Semyonov 2013; Semyonov and Lewin-Epstein 2011). It is all the more surprising, then, that FSU immigrants with middling or high income have equivalent or even lower mortality risks than the control group. Accumulated wealth, not measured directly by income, might also bias comparisons in the low income group. Finally, neither of these studies disaggregates overall mortality/health by specific cause, as will be done in this study.

Beyond these methodological difficulties, these findings are not consistent with our survey of the course of FSU migration to Israel, previous analysis of comparative mortality of this cohort, and the types of demographic selection that have been observed in FSU immigrants to Israel (section 2.2). FSU migrants to Israel were self-selected by demographic characteristics, and some of these characteristics are associated with positive relative health. While the level of education of Jewish FSU migrants reaching Israel declined over the course of the wave and may have been lower than that of FSU migrants reaching the USA, it remained higher than that of the Israeli population overall, a factor which would lead us to expect a mortality advantage. Although the stream of immigrants was relatively old compared to the Israeli population, it was relatively young compared to its origin population, and arrived with younger family members, which should promote the relative health of the elderly (below, section 2.6.3). While previous studies found differences between FSU immigrants and other Israelis by specific cause of death, overall standardised mortality rates of female FSU migrants were equal to those of other Israelis, and for male migrants they were similar initially, although a gap developed over the period of observation (section 2.5). Initial levels of life expectancy of FSU immigrants in Israel were higher than the average in the FSU, but also higher than those reported for Jews in Moscow in the early 1990s. In the oldest age group (over age 65) males enjoyed an initial advantage in life expectancy which only faded by the end of the period of observation, whereas females maintained an advantage throughout (Ott et al. 2009). These findings are not consistent with the expectations of HME theory,

that non-economic migrants do not benefit from favourable self-selection, that older immigrants are expected to be disadvantaged, and females more disadvantaged than males. The evidence does not appear to support uniform negative selection of health for FSU immigrants.

Given these considerations, this study will test whether the negative, "sick immigrant" model is confirmed once a multidimensional temporal model is applied for all-cause mortality and for cause of death groups, and detailed socio-demographic characteristics are controlled for, or whether the HME model is challenged in this case. The HME model argues that initial migrant advantages fade over time, whether due to "acculturation" or regression to the mean. Temporal models will examine whether negative or positive duration effects can be found after adjustment for calendar years effects and/or arrival cohort effects.

### 2.6.2 Arrival cohort creation

We have shown that demographic self-selection varied profoundly over calendar period, and this may have created arrival cohort differences in health, a factor which has not been adequately examined in previous studies. As conditions in Israel and the FSU changed and developed, partly in response to changes induced by the wave, migration incentives and migration composition altered. It began in conditions of widespread distress in the FSU, but while the Jewish population of several FSU republics were transferred completely to Israel, others, and in the Russia Federation especially, a greater proportion was left behind or preferred other destinations. Average education was high but declined as the wave matured. And as the wave continued, an increasing proportion was contributed by non-Jews with family relationships to Jews, whose motivation for migration was far less likely to be cultural, ideological, or religious, who would not necessarily share the positive psychological advantages ascribed to "diaspora" migrants, nor the health benefits credited to Moscow's Jews, deriving from patterns of culturally determined health-related behaviour (section 2.1.1).

The immigrants who arrived in 1990-91 are distinguished not only by their demographic profile, but by their motivations for leaving the USSR, the conditions in which they left their birthplace, and the circumstances they confronted on arrival in Israel. The earlier stages of the migration wave were clearly influenced by the dominance of "push" factors due to harsh conditions in the collapsing USSR (including fears of anti-Semitism and socio-economic and political disruption), which swept through portions of the Jewish population who had not previously considered migration to Israel or elsewhere (Brym and Ryvkina 1994). It is notable that migrants from Moscow and St. Petersburg are more concentrated in this period. The wage assimilation literature found that this arrival cohort was the most positively selected with respect to labour force attributes, although there is no analysis of whether this led to greater success (Cohen and Haberfeld 2007). As the stream stabilized and "institutionalised", "pull" factors based on knowledge of conditions in Israel became more salient. After the initial "panic" migration of 1990-91 there was more opportunity to weigh alternatives. These included the costs and benefits of staying in the FSU, moving to the USA or Germany, or accepting the Israeli "bundle" which included free passage, social welfare benefits, family connections to previous immigrants and the presence of a large and established Russian-speaking culture which could ease adaptation. In addition, the establishment of universal medical insurance in Israel (available on arrival from 1995 onwards while health services in the FSU continued to deteriorate) enhanced the likelihood of migration motivated directly by (ill-) health in vulnerable populations (Findley 1988). If in the early stages of the migration wave fear of antisemitism was a prominent factor, as knowledge of the "immigration offer which Israel extended became widely known it appears to have been sufficient to

motivate non-Jews with formally sufficient family connections to Jews to choose it, given the persistence of social, political and economic difficulties in the FSU. Likewise, in later stages of the wave the portion of migrants from the more peripheral areas of the FSU increased, including migration from the Asian and Caucasian republics. Since, eventually, they were transplanted to Israel almost in their entirety, clearly selectivity was lower in their case. The dominance of "push" considerations emerged again only briefly in 1998-1999, when immigration rates rose as a severe financial crisis in Russia brought about renewed panic (Tolts 2003).

Our analysis will test whether whether the 1990-1991 arrival cohort had distinct mortality characteristics and whether the relative health of FSU migrants who arrived afterwards declined with advancing period of arrival in Israel. One must also ask whether differences in arrival cohort patterns in relative mortality can be accounted for by the observed socio-demographic characteristics (gender, age, geographic origin, education, and ethnic group), or whether, controlling for these observed characteristics, an additional cohort effect of "unobserved" relative health/frailty remains. Such "unobserved" factors will fall in one of the four categories of the health field concept, which are not measured in our dataset: genetic and biological factors, differing behavioural patterns, environmental exposures, and differential impacts of the Israeli health system (given that universal health insurance was available from 1995), which are not completely correlated with the controlled characteristics.

### 2.6.3 Selection and temporal patterns by observed socio-demographic characteristics.

#### *2.6.3.1 Gender differences.*

Higher life expectancy was found among FSU Jews of both sexes as compared to the Russian population, together with a much smaller gender gap in life expectancy. The analysis of the evidence available from Moscow in the early 1990s attributes the advantage (compared to non-Jewish Russian males) as primarily due to favourable behavioural and lifestyle patterns, which promoted relatively low mortality from cardiovascular disease and external causes. The explanation by behavioural/cultural differences followed from the fact that the advantage was not shared by Russians with equivalent high educational qualifications (Shkolnikov et al. 2004b). Lower Jewish female mortality, on the other hand, was matched by that of Russian women with equally high levels of education. While Jewish women had an advantage in CVD mortality relative to Russians, they had a relative disadvantage compared to educated Russian women in mortality from breast cancer and "other" cancers (such as colorectal cancers and leukaemia) – explained as possibly partly genetically-determined and partly exposure-related – and only a small advantage due to accidents, violence and infectious diseases. Whether mortality patterns in Moscow (given its advantages as the center of the USSR) were shared by Jews in more peripheral areas is not known. However, it appears that the primary features found in Moscow were displayed by all FSU migrants to Israel: a relatively small gender gap, similar all-cause and CVD mortality compared to other Israelis, higher external cause mortality and higher neoplasm mortality. Previous analysis of this dataset showed that the disadvantage in neoplasm mortality rates of FSU migrants in Israel was shared by both sexes, a disadvantage which declined over duration of residence (Ott et al. 2010). However, over the period of observation (1990-2003) the gender gap in FSU migrant life expectancy increased, due primarily to higher external cause mortality among males, resulting in a slower rate of improvement among male FSU immigrants compared to other Israelis. (Ott et al. 2009).

Although the wage assimilation literature suggested that differences in selective forces between the genders are less likely in the case of FSU immigrants to Israel (section 2.6.1), the literature on FSU immigrants finds that women faced greater hardship in accessing employment and preserving

occupational status in Israel, and that this generated greater stress in middle-aged FSU women (Ritsner and Ponizovsky 2003; Ritsner et al. 2000b). Gender differences in the association of hardship and stress and their possible mortality outcome would lead one to expect a more rapid increase over duration of residence in mortality from external causes for women rather than men. But the literature also finds that FSU women had greater resilience and ability to adapt to the conditions in their new country, which would imply that despite worse circumstances stress-related mortality may remain low (Remennick 2003a; Remennick 2003b). And given the chaotic conditions in the early 1990s which were later ameliorated, and their differential impact by gender, one can anticipate differential period and cohort impacts on relative mortality. This study will attempt to establish whether the differences by gender in calendar year patterns by cause in FSU migrant mortality which were found in previous studies, along with differences by gender in earlier analysis of duration patterns, are modified when a multidimensional analysis is made and the dimensions disentangled.

#### *2.6.3.2 Age*

The evidence on differential relative mortality and health outcomes for FSU migrants by age is mixed, as are indications of possible temporal patterns. It is generally predicted (by the HME literature in particular) that since migration decisions are taken by young adults it is they who should enjoy the health advantages which are due to self-selection, whereas accompanying elderly would not be positively selected. And since difficulties in socio-economic and cultural adjustment should increase with age, deterioration in health over duration should be greater for the elderly (Chiswick et al. 2008; Jasso et al. 2004). Previous findings for FSU migrants in Israel do not consistently reflect these expectations. On the one hand, previous analysis of this dataset showed that the elderly had an advantage in mortality relative to other Israelis and a negative trend in relative mortality was weaker for them than for younger age groups (Ott et al. 2009). And on the other hand, analysis of self-assessed health showed that elderly migrants to Israel suffered from a distinct disadvantage relative to other Israelis, a disadvantage that diminished only after 20 years of duration of residence, unlike elderly migrants in European countries who enjoyed an advantage in self-assessed health that persisted with duration of residence (Constant et al. 2018).

These contradictory findings combine with equally discordant observations concerning age-disparities in risk factors. Some studies show that for older immigrants the loss of professional identity was particularly acute, since they left behind highly-skilled jobs with which they identified, found it difficult to acquire local skills and tended to remain unemployed (Litwin and Leshem 2008; Remennick 2007a). Their lack of wage income and their loss of USSR pension income was a further disadvantage, and all these contributed to higher levels of stress among the elderly (Ponizovsky et al. 2009; Ritsner and Ponizovsky 2003). Given their contrasting experiences in the Israeli labour market, together with the obstacles to language acquisition and retraining which increase with age, we can expect that older, pre-retirement adults (aged 35-59) will have faced greater and more enduring hardships than younger adults (ages 15-34). On the other hand, the higher educational qualifications of elderly FSU migrants compared to the Israeli population, should serve as a protective factor. Moreover, the evidence we reviewed showed that the elderly who migrated to Israel were a self-selected group of the elderly Jewish population of the FSU: they tended to be members of complete migrating family groups with younger relatives, and continued to live in multigeneration households in Israel (Sicron 1998a). Such family relationships are generally regarded as promoting health and buffering mortality risks (Matthews et al. 2010; Rogers 1996). On the other hand, multi-generational households have also been reported as a potential source of stress for the elderly in some circumstances (Ritsner et al. 2000a), but as housing

conditions for immigrants improved over the decade, these stresses may have alleviated, leading to a positive duration or period effect. As for younger immigrants, a corollary of the positive role of multigenerational households on members of all age groups is that younger or divorced immigrants, who may have arrived alone and without such support, would be more exposed to stress (Mirsky 1998). Finally, migrant community characteristics may have served as buffers. One would expect that the emergence of local Russian language cultural media and institutions, along with the increase in the number of Russian-speaking health professionals which made it easier for FSU immigrants to negotiate the Israeli health system would enhance the relative wellbeing of all FSU immigrants, and in particular of the elderly (aged 60 and above). The temporal expression of these improvements would be difficult to predict. To the extent that these factors are cumulative, they may impact immigrants by duration of residence. But equally, since they emerged over calendar period independently of duration, they might provide a positive impact on the mortality of all older immigrants at all durations of residence.

This study will test whether younger FSU migrants enjoy better health which is sustained to a greater extent than for older immigrants over duration of stay, as the HME model and previous literature predicts, or whether then unusual age profile of this migration wave had unexpected consequences both on levels of self selection and in temporal patterns of relative mortality. Equally, it will explore whether differences by age are modified when examined in a multidimensional context.

#### *2.6.3.3 Ethnicity*

Ethnic differences in mortality in this population have not been investigated previously. Previous analysis of this dataset argued that the lower mortality risks of FSU migrants in Israel compared to those of the Russian Federation were due to country of origin effects: health-promoting characteristics of the Jewish community in the FSU which the migrants brought with them (Ott et al. 2009). However, since the immigration wave encompassed both Jews and non-Jews, and the proportion of non-Jews increased as time went on, it is possible that ethnic differences in levels of mortality and in patterns of causes of death influenced the aggregate trajectory of mortality of the migration wave in Israel. The profound reversals of mortality improvement which the USSR experienced from the 1970s through the 1990s centered on male mortality, and specifically on high rates of CVD and external causes of death. The high level of these have been attributed to a combination of 1. lifestyle and behavioural factors (especially high alcohol consumption and smoking, and possibly nutrition); 2. institutional factors and in particular the failures of the health system; 3. socio-economic factors and especially the greater disadvantage of manual workers and the less educated in the FSU when compared to western countries; and linked to these, 4. psycho-social factors precipitated by the stresses of the economic hardships and social breakdown of the last years of communism and the first decades of the post-Soviet era (Andreev et al. 2003b; Bobak et al. 1998; Shkolnikov et al. 2006; Shkolnikov and Leon 2006; Tillmann et al. 2017). All these factors may have impacted the non-Jewish component of the immigration wave more than the Jewish component.

On the basis of comparative analysis of mortality patterns of Jews and non-Jews in the early 1990s Shkonikov et al. (2004a) found that Moscow's Jews did not share the disadvantages of the general Russian population. Since non-Jewish males who immigrated to Israel as family members of Jews presumably came from similar social milieus to the rest of their family, they may have shared to some extent the risk-averse behavioural patterns of Jewish males or to the patterns which characterised FSU males (Shkolnikov et al. 2004a), but there is no direct evidence for this. Presumably, the higher educational level of migrants to Israel ( Jews and non-Jews alike) should modify and diminish the impact of behavioural factors on mortality patterns in Israel, but not eliminate them entirely. Exposure

to Israel's health system would benefit both ethnic groups, immediately providing more modern and more accessible health care, which might be particularly relevant to avoidable causes of mortality, such as CVD and certain cancers, where early detection might modify mortality. But although immigrants will have distanced themselves from the deleterious socio-economic and psycho-social factors of the FSU, they will be exposed to new challenges of adaptation in Israel, and these may have been differential by ethnic group (see below). Potentially risky behavioural factors may be moderated over duration of residence with adaptation to Israeli social norms, where alcohol and tobacco consumption is much more moderate (Neumark et al. 2007), but ethnic differences in levels and changes over time may remain. Finally, the biogenetic vulnerability to certain diseases, (Shkolnikov et al. refer to diabetes as well as colorectal, breast, and ovarian cancer among Jewish females), would not be shared by non-Jewish migrants, and thus differences in mortality patterns should be present.

Social status may create potential risk factors as well. Israel's immigration law, the Law of Return, was formulated to bolster Israel's existence and status as a Jewish nation-state. The fact that widespread intermarriage in the FSU ensured that the law enabled the entry of large numbers of non-Jewish immigrants was viewed in Israel as paradoxical at least, and not infrequently, as controversial and undesirable (Remennick 2007a). As legitimate immigrants under Israeli law, these non-Jewish immigrants were eligible for the same public support for immigration benefits as Jews, and once in Israel, attended the Jewish education system, and were subject to the same benefits and obligations (including requirements for military service) as the rest of the Jewish public. Socially and economically their adaptation to Israeli society did not outwardly differ from that of Jewish immigrants. Nevertheless, since officially they are not Jews by religion, their personal civil status suffers from handicaps. Since marriage and divorce in Israel are governed by religious law, their lack of official religious status creates barriers and obstacles for family formation and dissolution. And in a nation state that defines itself as Jewish, their official non-Jewish status sets them apart. This difference in civic status may be a potential source of social, economic and psychic hardships which may act as risk factors for poorer health.

Unfortunately, there has been little or no investigation of differences in the socio-economic adaptation to life in Israel between Jewish and non-Jewish FSU immigrants, let alone differences in health status. This may be due in part to public discomfort and reticence: avoidance of a topic which may suggest that Jews and non-Jews differed in their motives for migration and in their social and economic reception in Israel (Remennick 2007a). Indeed it seems that only the degree of their civic inclusion in terms of their national, ethnic and religious identity and the degree to which this has elicited prejudice and discrimination, have received scholarly attention (Cohen and Susser 2009; Prashizky and Remennick 2012; Remennick 2018; Yakobson 2010).Without comparative socio-economic information we cannot anticipate the extent to which differences in patterns of adjustment of Jews and non-Jews to life in Israel had health consequences, nor whether the impact of such factors may have changed with duration of residence in Israel.

Although information on adaptation to life in Israel by non-Jewish immigrants is not available, it has been argued that motivations for migration may have differed by ethnicity. The increase in migration of non-Jews over time has been described as evidence for a gradual shift in the relative dominance of "push" over "pull" considerations in the immigration wave (Remennick 2007a). If such differences in motivation were present, they may have led to negative self-selection in health-related characteristics, even encouraging immigration of individuals in poorer health for whom the provision of health care was a motivating factor.

Given the epidemiological gap between the two ethnic groups in the FSU, comparing their mortality trajectories in Israel is both unavoidable and desirable in the context of this study. It provides us with the opportunity to see whether, and how, a "Russian" mortality pattern is transformed by migration to a Western health system and economy, and a different cultural context. Here an "environmental transition" theme overlaps our interest in multidimensional temporal dynamics, without adopting the simplifying assumptions of the former.

In view of this discussion this study will describe differences in the patterns of relative mortality between Jews and non-Jews, examine whether temporal patterns differ between the groups, and attempt to determine the extent to which such possible differences affect the average patterns found for the population overall.

#### *2.6.3.4 Geography*

FSU migrants to Israel came from a wide variety of regions within the FSU, and the geographic profile of the areas of origin of the migrants changed somewhat over time, reflecting both the dispersion of the Jewish population in the FSU, and the degree to which local conditions encouraged migration to Israel (see below, Section 3.2).

Health conditions in a territory as vast as the FSU were not uniform, either in their levels or in their trends over time, nor in environmental exposures. Although levels of life expectancy at birth in the early 1980s were higher in the European republics than in the Central Asian and Caucasian republics, the mortality crisis of the 1980s and 1990s halted or reversed the improvement of life expectancy at birth in the former regions, while in the later regions the picture was mixed, with some improvements in the Caucuses and relative stagnation in most of Central Asia (but not reversal. perhaps because the Islamic heritage in these areas limits alcohol consumption). In these regions the gender gap in life expectancy was similar to European levels and far smaller than in the European areas of the FSU, although this may be explained by lower levels of female health rather than lower male mortality (Leon and Shkolnikov 1998; McKee and Chenet 2002; McKee et al. 1998; Nolte et al. 2005).

However, it is likely that throughout the FSU, as in Moscow, Jews had a distinct health profile both due to their higher educational profile and cultural-behavioural differences. In areas of Central Asia and the Caucuses, many Jews belonged to distinctive ancient cultural communities (Bukharan Jews in Uzbekistan and Tajikistan, Mountain Jews in Dagestan of the Russian Federation and in Azerbaijan, Georgian and Armenian Jews) but although some information on the distinctive demography of these communities is known, there is no information on their health and mortality patterns (Tolts 2008; Tolts 2014a). In the Ukraine, the Baltic States, Moldova and in the more peripheral areas of Russia, it is possible that Jews shared the advantages they showed in Moscow, but this has not been demonstrated. In the 1980s and early 1990s total life expectancy at birth was higher in the Ukraine, Belarus, Moldova and the Baltic States than it was in Russia (World Bank 2020). It is possible that the relative mortality advantage of Jews in these locations was smaller than in Moscow in the early 1990s, where mortality conditions deteriorated sharply with the collapse of the USSR (Chenet et al. 1998a; Chenet et al. 1998b). Nevertheless, whether relative advantages existed or not, it is likely that since mortality rates in Moscow before the crisis of the late 1980s were lower than in the rest of Russia, Jews from Moscow and St. Petersburg, the administrative and cultural and educational centers of the FSU, had a mortality advantage over Jews from more remote areas, and would have brought this advantage with them to Israel.

When migration involved the transplantation of complete communities (as it did for the non-European republics of the FSU) we cannot expect patterns of positive health self-selection, and possible arrival cohort differences may be moderated. In other areas, where migration was more selective (the Russian Federation, and Moscow and St, Petersburg in particular) arrival cohort patterns will be more likely. Investigations of wage assimilation and labour market success of FSU immigrants in the early years after their arrival found that FSU female immigrants from Asian areas suffered from greater disadvantages than European-born women, and that Asian-born men suffered a disadvantage in wages compared to European-born men (Haberfeld et al. 2000). Lower selectivity combined with evidence for weaker economic adjustment may point to greater health problems for immigrants from Central Asia and the Caucuses.

This study will document the differences in the patterns of relative mortality between immigrants from the different geographic regions of the FSU, examine whether temporal patterns differ between the groups, and attempt to determine the extent to which such possible differences affect the average patterns found for the population overall

### 2.6.4 Conclusion - expected temporal patterns in relative risk

We have reviewed a variety of factors which might have had an impact on individual mortality risks and on the trajectory of mortality rates for the FSU migrant. Our review has shown differences by socio-demographic characteristics in the rates and motivations for migration which may have impacted the health status of arriving immigrants, and some differences in their patterns of adaptation to life in Israel, which may equally have had health consequences. We have shown changes over calendar time in policies, in the nature of the health system, in the social and economic conditions which awaited immigrants in Israel and were engendered by their presence, as well as the gradual emergence of a local FSU-migrant community. All these are environmental developments with potential health consequences. We have seen that changes in self-selective pressures affected the profile of arriving immigrants over time in response to conditions in the FSU, in Israel itself, and with the changing availability of alternative destinations. these are likely to have created changing health profiles by arrival cohort. And in addition, although economic assimilation in Israel progressed with duration of residence, FSU immigrants were left with an enduring relative disadvantage in employment and housing, and their economic absorption was differential by age, gender, period of arrival and occupation. All these factors, taken together, justify a multidimensional temporal approach to the analysis of relative mortality, in which relative mortality trajectories are not only a function of duration of stay and "acculturation" in an "environmental transition" framework, but of factors determined by calendar period and arrival cohort as well. Our task is now to document the changing demographic characteristics of FSU immigrants in Israel and investigate the dynamics of duration, calendar period and arrival cohort differences in relative mortality (as a group, by gender, by age, by geographic origin, and by ethnic group), attempting to weigh the relative impact of each dimension on overall mortality and on specific causes of death.

# Section 3.0 Data sources and statistical methods

## 3.1 Data sources and construction of the analysis file

The data for analysis were assembled from matched records which derive from three administrative data files within Israel's official statistical system:

1. Immigrant records (IR),
2. The Population Register (PR) of Israel,
3. Death records (DR).

### 3.1.1 Immigrant records

The Israel Central Bureau of Statistics (ICBS) receives a monthly data file containing electronic records of the Immigrant Registration Questionnaire for each immigrant or potential immigrant (ICBS 2009). It is this questionnaire which is used to record initial data in the PR, including the official nine-digit Personal Identification Number (PIN) which is used on all official records for Israeli residents, as well as additional fields which are not required by the *Population Registry Law, 5725-1965*. An immigrant in this file is defined as an 'Oleh', a person eligible for permanent residence in Israel under the provisions of the *Law of Return 5710-1950* or a family member of an Oleh who was eligible under the *Law of Entry into Israel 5712-1952*. The Law of Return grants citizenship to any Jew who expresses his desire to settle in Israel, with discretion granted to the authorities on grounds of health or state security. Administrative regulations and legal precedent govern the documentation required to attest whether a person will be considered a Jew under the law. For the purposes of the law, as amended in 1970, this right is extended to "a child and a grandchild of a Jew, the spouse of a Jew, the spouse of a child of a Jew and the spouse of a grandchild of a Jew". This extension was passed into law in order to consciously mirror the German Nuremberg Laws of 1935, effectively offering the right of citizenship in Israel to anyone who would have been denied citizenship of Germany under those laws (Rubenstein 1998). In practice this means that persons who are not Jews by religion or ethnic origin can also receive immigrant status under the Law of Return. And in addition, since these family members may have close relatives or children who are not themselves eligible under the Law of Return, they may be granted immigration status discretionally by the Ministry of Interior, under the provisions of the Law of Entry. The large number of non-Jews in the 1990-2003 immigration cohort entered Israel under these provisions.

The registration questionnaire includes the following information: country of birth, last country of residence, citizenship, date of birth, sex, religion, marital status, occupation abroad, number of persons accompanying head of family, years of schooling, and first address in Israel.

For this study, immigrant records were selected whose country of birth and country of last residence were both recorded as either the USSR or one of its successor states (the Russian Federation, Ukraine, Belarus, Moldova, Lithuania, Latvia, Estonia, Georgia, Armenia Azerbaijan, Turkmenistan, Uzbekistan Tajikistan Kazakhstan, Kyrgyzstan) and who entered Israel in the years 1990-2003. Altogether 926,890 records of FSU immigrants answering these criteria were identified, constituting 83 percent of immigrants who entered Israel in this period.

***Table 3.1 All Immigrants to Israel and from the FSU, by year of entry***

| *Year* | *All Immigrants to Israel* | *Immigrants born and last residence in the FSU* |
|---|---|---|
| **Total** | 1,119,836 | 926,890 |
| 1990 | 199,516 | 184,030 |
| 1991 | 176,100 | 147,068 |
| 1992 | 77,057 | 64,756 |
| 1993 | 76,805 | 66,014 |
| 1994 | 79,844 | 67,489 |
| 1995 | 79,361 | 64,542 |
| 1996 | 70,919 | 58,737 |
| 1997 | 66,221 | 54,274 |
| 1998 | 56,730 | 44,794 |
| 1999 | 76,766 | 64,848 |
| 2000 | 60,201 | 48,800 |
| 2001 | 43,473 | 32,031 |
| 2002 | 33,570 | 17,661 |
| 2003 | 23,273 | 11,846 |

Source: ICBS Israel.

### 3.1.2 Matching immigration records with the Population Register

The immigrant records were matched with the PR (using the unique official PIN which is common to both). The *Population Registry Law* requires that the following items be recorded:

1. Surname, first name and previous names;
2. names of parents;
3. date and place of birth;
4. sex;
5. nationality (Jewish, Arab, or other nationalities);
6. religion;
7. personal status (single, married, divorced or widowed);
8. name of spouse;
9. names, dates of birth, and sex, of children;
10. citizenship (or other legal status of residence);
11. address in Israel;
12. date of entry into Israel;
13. date of acquisition of citizenship or permanent residence.

Religion as recorded in the PR is the religious designation of the person as determined by the Ministry of Interior's regulations, which according to Jewish religious principles is governed strictly by matrilineal descent. In addition, notifications of births, deaths and marriages are maintained by the Chief Registration Officer and are linked to the PR, as are records of departures and arrivals from trips abroad, which are maintained in a Border Control Database. Since the PR is open to revision and correction it is considered more authoritative. Therefore after matching with the PR certain fields were revised: demographic variables entered in the IR were corrected when they did not match the PR, updates to the "religion" field were also retained since this field was frequently provisional in the IR data (ICBS 2009), as were date and place of death, and date of departure abroad for emigrants. Immigrants who had a departure date from Israel and had not returned up until the date when the PR file was updated (March 2005) were designated as emigrants (see below section 3.2.3).

### 3.1.3 Matching with Death Records

The data in this file is based on 'Notifications of Death' forms which are received by the Ministry of Interior. Israeli law requires that these include a medical Death Certificate, signed by a physician. One of the copies of these certificates is forwarded to the ICBS, where it is coded for underlying cause of death and the records are assembled into a national mortality database. This database is the source of statistical data on mortality reported by Israel to the WHO, in accordance with the WHO's classification criteria, the relevant edition of the International Classification of Diseases (ICD). The official coding of cause of death by the ICBS has been assessed as being among the 31 countries of the 191 countries reporting to the WHO with coding of the highest quality (Mahapatra et al. 2007). Until 1997 the causes of death were coded according to the *ICD 9th Revision, Clinical Modification*. From 1998 onwards causes of death were coded according to *the ICD 10th Revision*. Altogether 74,688 deaths of these immigrants were identified up until the end of 2014.

The sources of the variables in the raw datafile are specified in table 3.2

***Table 3.2 Variables and Sources***

| *Description* | *Source* | *Description* | *Source* |
|---|---|---|---|
| Sex | PR | Date of last exit from Israel | PR |
| Type of immigrant visa | IR | Date of last entry to Israel | PR |
| Year of entry to Israel | IR | Emigrated from Israel/all | PR |
| Death in Israel\abroad | DR | 2 digit occupational code | IR |
| ICD 9 cause of death | DR | Date of birth | PR |
| ICD 10 cause of death | DR | Date of immigration | IR |
| Activity Status (Died – living – abroad) | PR | Date of death | DR |
| Marital status | PR | Year of emigration | PR |
| Jews/Other Religion | PR | Exact age at death | Calculated |
| Major city of residence in the FSU | IR | Exact age at immigration | Calculated |
| Country of last permanent residence | IR | Exact age at emigration | Calculated |
| Grouped years of education: 0-8, 9-12, 13+ | IR | Exact age at end of 2004 | Calculated |

## 3.2 Selection of variables for final analysis

### 3.2.1 Age

The data analysis was restricted to immigrants who were aged 15 or over at immigration. There were 744,263 persons aged 15 or over at immigration in the cohort, of whom 54.6% were female. Altogether until 31.12.2004 there were only 579 deaths to immigrants under age 15, and 74,024 deaths at age 15 and over.

### 3.2.2 Marital Status

Although marital status at immigration and in 2004 was available in the source data, these were not used in the analysis, since it was not possible to determine current marital status in each calendar year of the follow-up.

### 3.2.3 Education and Occupation

Education data was available for 96.5% of immigrants aged 15 and over and was used in the analysis. The education variable refers to education received before immigration and does not include subsequent years of education which may have been acquired in Israel – a factor relevant chiefly to the youngest age groups. Moreover, education in this case may have a lower correlation with socio-economic status in Israel than would be the case for a non-immigrant population, since there was substantial downward occupational mobility and non-recognition of educational qualifications by Israeli employers (section 2.4, above). Thus educational level should be regarded as an indicator of life-style in the FSU and health related knowledge rather than of socio-economic status following immigration. Although the immigration file contained information on occupation abroad, this was not used in the analysis due to quality considerations: a. data was available for 68% of the cohort only; b. it was not possible to determine when and for how long an immigrant had been employed in the stated occupation; c. it was not possible to determine how well Soviet occupational categories translated into Israeli occupational codes.

### 3.2.4 Revision of emigration date

Date of exit was derived from border control records accessed through the PR. The raw data file contained two entries from the PR, the latest known date of departure and the latest known date of entry. If an immigrant departed the country and no subsequent date of entry was recorded until March 31 2005, he or she was determined to have emigrated at their date of departure, and to have terminated his exposure-time to death in Israel.

However, in some cases the original date of departure from Israel could not be determined from the data file. Some immigrants left Israel as their permanent location of residence but maintained family or business connections with Israel, visiting the country from time to time. In such cases their last departure abroad constituted a departure after a visit rather than the date of their original emigration (change of permanent residence). These persons were identified in the data file when their latest exit from Israel was preceded by a latest known entry to the country less than 1 month before the final exit recorded. Their years of exposure in Israel terminated earlier than their latest departure, but their original date of emigration was unknown. In order to correct for this, their original date of emigration was imputed. This was done by assigning it randomly from the distribution by duration of stay and year of entry to Israel of all immigrants who emigrated with a known emigration date. In other words, it is assumed that these visiting emigrants had the same average duration of stay in Israel up until emigration as did all other emigrating immigrants who arrived in the same year. Altogether, of the 85,328 emigrants in the cohort, (9.2% of all immigrants) 24,673 (all of whom were not present in Israel in March 2005) had their original dates of exit adjusted in this way.

### 3.2.5 Geographic Origin

The country of last residence for immigrants who arrived in Israel in 1990 and 1991 was recorded in the IR as the USSR, which ceased to exist on December 26th of 1991. However, since city of origin in the USSR was available in the raw data file for most immigrants, they could be assigned to their Republic/State of last residence. For a small remainder (1.5%), country of last residence remained the USSR. Within the Russian Federation, immigrants who originated in the remote and relatively undeveloped area of the Caucuses, who are socially and culturally distinct for European/Ashkenazi Jews (see section 1.X above) can be distinguished in the IR. Equally, immigrants who originated in the cultural political, and economic center of the USSR, Moscow and St. Petersburg (Leningrad) could also

be distinguished. Two broad categories were created, and within them subcategories, plus a residual category:

1. Immigrants from Asian Republics/States (including the Caucasian republics of Georgia, Armenia, Azerbaijan, as well as the central Asian republics of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan; immigrants from the Caucasian republics of the Russian Federation were added to this group and subtracted from the Russian Federation)
2. Immigrants from European Republics/ States (including the Russian Federation, Ukraine, Belarus, Estonia, Latvia, Lithuania, and Moldova). Within this group, 3 subcategories were distinguished: immigrants from Moscow and St. Petersburg, immigrants from the Russian Federation and the Baltic States, and immigrants from the Ukraine, Belarus, and Moldova.
3. USSR unspecified – a small residual category for those whose specific origin could not be identified.

### 3.2.6 Grouping of ICD Codes for cause of death

Preparatory to calculating an aggregate person-years file, the detailed ICD codes for underlying cause of death were grouped into 55 categories used by the ICBS, corresponding to a shortened version of the 80 category Mortality Tabulation List 2 of the WHO for ICD 10. The corresponding ICD 9 categories were determined by the ICBS. Certain minor adjustments were made to the WHO list by the ICBS, in order to correspond with Israeli practice:

- Ischaemic heart disease (Group 53) was divided into myocardial infarction (code I21), and other ischaemic heart diseases (I20, I22-I25).
- Renal disease (Group 65) also includes the remaining codes for renal disease (N17-N29).
- Obstetric deaths (Groups 66-68) also include code O95 (obstetric death of unspecified cause).
- All other diseases (Groups 47+72) do not include the codes included in the groups listed above.
- Other accidents (Groups 75-77) also include the codes for the remaining types of accidents W20-W64, W75-W99, X10-X39, X50-X59.
- Other external causes including assault (Groups 79-80) do not include the codes listed in the group of other accidents.

Appendix Table A3.3 documents the detailed codes corresponding to the 55 groups. These 55 groups were combined into broader categories in the subsequent analysis. These categories will be specified below in the relevant sections.

## 3.3 Person-years calculation

This study is a retrospective cohort study, in which individuals are followed up from the time of their immigration to Israel, until one of three outcomes: death in Israel, loss to follow-up due to emigration, or end of observation. Entry to the study was continuous from 1.1.1990 until 31.12.2003 and end of observation was set at 31.12.2004. An aggregate analysis file was constructed, which calculated exact person-time summed to person-years of exposure and number of deaths based on date of entry to Israel, possible date of death, possible date of emigration, or end of observation, for each of the 55 grouped causes of deaths, by the specific sub-categories of each of the analysis variables, and for each sex separately. This allowed aggregation by year of entry, duration of residence in Israel, calendar year,

and age group. The aggregation was performed with a SAS version 9.1 (SAS 2004) macro, which calculates person-time of exposure in days, correcting for leap year variation. The variables in the aggregate analysis file and their categories are detailed in Table 3.3

***Table 3.3*** *Variables and categories in the analysis file*

| *Variable* | *Categories (levels)* |
|---|---|
| **Time variables** | |
| Age-group | 15 categories: 15-19, 20-24…80-84, 85+ |
| Calendar year | 15 categories: 1990, 1991… 2004 |
| Duration of Residence in Israel | 15 categories: 0, 1, 2…14 years |
| Year of Immigration (Arrival Cohort) | 14 categories: 1990, 1991, 1992…2003 |
| **Other variables** | |
| Sex | Male, Female |
| Geographic Origin | 5 Categories: Russia and the Baltic States; Thereof – Moscow and St. Petersburg; Ukraine, Belarus, Moldova; Caucasian and Asian Republics; USSR – not specified. |
| Education | 3 Categories: 0-8, 9-12, 13+ years. |
| Ethnic Origin/religion | Jews, Non-Jews |

In the specific techniques of analysis used in this thesis (life table analysis, SMRs, multivariate Poisson regression) the time variables were grouped into broader categories. These will be specified below with the description of each form of analysis.

## 3.4 Reference counts and rates for the Israeli population

Examining the time trends of mortality of immigrants from the FSU in Israel requires an appropriate reference population against which changes over time can be measured. Migration studies commonly use comparisons to the destination population, although it has been argued that comparison to the origin population, or both populations, is more appropriate (Jasso et al. 2004; Spallek et al. 2014). Unfortunately, no data is available documenting mortality rates for the Jewish population of the USSR against which we can measure the direction of change over time in Israel. Overall estimates of life expectancy are available for the census years 1979 and 1989 (Andreev et al. 1992), but no information by age and cause of death are available. The only limited but important exception to this is the previously mentioned study which documents mortality conditions for Jews in Moscow at the beginning of the period we are investigating (1993-1995) relative to the rest of the population of Moscow (Shkolnikov et al. 2004b). This study shows clearly that the Jewish population (at least in Moscow, and especially for males) had a large mortality advantage compared with the rest of the Russian population, and that therefore using overall Russian mortality rates for comparison would not be appropriate.

When comparing the FSU immigrant cohort to the Israeli population we are confronted with other difficulties. Although there have been many studies of immigrant mortality in Israel, the common strategy of comparing immigrant with native mortality has seldom been used. Such studies in Israel have tended to focus on differences in subgroups by country of origin and by socioeconomic status (Chernichovsky and Anson 2005; Friedlander et al. 1995; Manor et al. 2004; Manor et al. 2000; Manor et al. 1999). There are obvious reasons for this: the population of Israel was constituted by a series of

immigration waves. The Israel-born are a relatively young group and many are only a generation removed from immigration themselves. In 2004, in the population as a whole 45% of adults over the age of 30 were born abroad, and in the Jewish population specifically – over 50%. Only 15% of the population over age 60 in 2005 were born in Israel (ICBS 2005). If comparisons are made with the population as a whole the reference group contains the distinct Arab population of Israel which has a different mortality profile from the Jewish population, whether for social-behavioral, environmental, or genetic reasons (Na'amnih et al. 2010; Saabneh 2015). However, because of their relatively young age profile, they represented just under 10% of all deaths in 2004 (ICBS 2005). If comparisons are focused only on the Jewish population one is still faced with considerable diversity. This population in 2004 included over 1.1 million immigrants who did not belong to the FSU cohort, including 40 thousand who arrived in Israel from the FSU before 1990 as well as a substantial proportion of Israelis who originated in the Middle East and North Africa, areas with very different environmental risk-factors than the FSU. This heterogeneity in the reference groups cannot be circumvented.

Since by 2004 the FSU cohort represented about 15% of the total population of Israel and 19% of deaths, it was necessary to create reference groups excluding the cohort population. In order to do so a data file was constructed at the ICBS containing records which aggregated counts of deaths and average annual population for all Israelis by calendar year, five-year age group, sex and religion with deaths classified according to the 55 categories defined in section 3.2 above. Reference counts and populations were calculated by subtracting from this file the equivalent counts and populations (person-years lived) from the FSU cohort person-years file (section 2.3). Two reference populations were created:

1. All Israelis who were not included in the FSU immigrant cohort ("other Israelis");
2. Jewish Israelis who were not members of the cohort ("non-FSU Jews").

Mortality rates were calculated for each reference group, based on the resulting counts and populations by calendar year, five-year age group, and sex for each of the 55 categories of cause of death and for all deaths. Given the person-years calculation in the analysis file, with these rates expected deaths by cause, sex, and age group could be calculated for each of the strata in the analysis file. Rates and expected deaths could be calculated for broader groups as well, since these could be derived from the detailed numerators and denominators.

In most cases the comparison group chosen for analysis was Other Israelis. For some life expectancy comparisons the reference group was Other Israeli Jews.

## 3.5 Confidentiality requirements

The resulting files were aggregate files, in which all direct personal identifiers in the raw data files were dropped (names, PINs, addresses in Israel). The files were approved for public release by the data protection committee of the ICBS.

## 3.6 Analytic methods

Our goal in this study is to investigate temporal patterns in the cause-specific mortality of FSU immigrants in Israel relative to the rest of the population of Israel, and to attempt to determine whether these patterns can be attributed to duration of residence, calendar period effects, or arrival cohort

effects. Temporal patterns by calendar year are analysed in cause-specific detail using demographic techniques, calculating life expectancy at age 15 and its decomposition by age and cause. These show overall trends in mortality relative to the Israeli population by sex, age and cause of death over the 15 years of observation. SMR analysis and multivariate Poisson regression models were used to determine whether the patterns found could be best explained by calendar year effects, cohort effects, the impact of duration of residence (or possibly some interaction between these time dimensions) as well as to control for some confounding and background factors.

### 3.6.1 Demographic techniques: Decomposition of life expectancy (at age 15) by sex, age and cause of death

Abridged life tables by sex for age 15 and over were calculated for the cohort as a whole and for sub-groups within it. To explore differences in life expectancy at age 15 ($e_{15}$) by sex between the cohort and Other Israelis were decomposed by age and cause of death. The calculations were done for three sub-periods, 1990-1994, 1995-1999 and 2000-2004, for the following groups:

1. FSU Immigrants; Other Israelis.
2. Jewish FSU immigrants, Jewish Other Israelis
3. Sub-groups of the FSU migrants: Jewish FSU immigrants from European Areas; Jewish FSU Immigrants from Asian Areas; Jewish immigrants from Moscow and St. Petersburg; Non-Jewish FSU Immigrants (from 1995 onwards).

Life tables functions were calculated using Chiang's method for transforming age-specific mortality rates to probabilities of death and for calculating confidence intervals for life expectancy values (Chiang 1984). Life expectancy calculated from age 15 until age 85 and over ($e_{15}$ …$e_{85+}$), by five-year age groups (15-19, 20-24…80-84, 85+). Age 15 was used as a base because, as mentioned in section 2.2.1 above, mortality at earlier ages was very low, and in any case life expectancy at birth will be biased upward in an immigrant population since neo-natal mortality cannot be included because by definition births in Israel are excluded (they are not immigrants), and the immigration of neonates is highly unlikely.

Differences in mortality between the various groups by age and cause of death were analysed using Arriaga's technique for decomposing differences in life expectancy by age and causes of death (Arriaga 1989). Calculation of the life tables as well as age and cause decomposition was performed with a SAS macro (SAS 2004) developed by the author.

We have chosen Arriaga's method of decomposition due to its ease of calculation (Preston et al. 2001). Other techniques are available (Andreev et al. 2002; Pollard 1982). However they have been shown to be mathematically equivalent to Arriaga's method (Pollard 1988), although the approximations used by each method of calculation yield very slightly different results (Beltrán-Sánchez et al. 2008).

No standard statistical significance tests for contributions by age and cause to life expectancy differences have been proposed in the literature (Auger et al. 2012). Although confidence intervals for decomposition contributions were calculated using bootstrap methods through Monte Carlo resampling (Auger et al. 2014), applying this method was not attempted. Since the sample sizes of our study are very large and we have used broad age groups and causes of death categories in order to assure large counts of deaths, it is likely that most differences found are statistically significant.

Arriaga's decomposition method is calculated in two stages: first the relative contribution of differences in mortality by age group are determined, while in the second stage the contribution of causes of death to the differences in each age group are calculated. To present the method we will use the notation proposed in Preston et al. (Preston et al. 2001).

The total age-specific effect (${}_n\Delta_x$) of a difference in age-specific mortality rates on life expectancy at age 15 – $e_{15}$ (or, as in the standard case, at birth- $e_0$) is composed of two factors:

$$ {}_n\Delta_x = \frac{l_x^1}{l_0^1}\cdot\left(\frac{{}_nL_x^2}{l_x^2}-\frac{{}_nL_x^1}{l_x^1}\right)+\frac{T_{x+n}^2}{l_0^1}\cdot\left(\frac{l_x^1}{l_x^2}-\frac{l_{x+n}^1}{l_{x+n}^2}\right) \qquad (3.1) $$

Superscripts 1 and 2 refer to population 1 and 2 (or the same population at different times). The first term in the right side of the equation represents the direct effect of the differences in age-specific mortality rates between populations 1 and 2 at age $x$, the effect on person-years lived between age $x$ and $x+n$ on differences in $e_{15}$, where ${}_nL_x$ is the sum of person-years live in the interval and $l_x$ is the number of survivors to age $x$. The second term represents the sum of indirect and interaction effects. This indirect effect is due to the person years that will be added or subtracted due to the change in survivors at age $x+n$, who will experience the mortality rates of the subsequent age intervals, where $T_{x+n}$ is the cumulative person years lived beyond age $x+n$. In populations with low mortality the interaction effect is very small (Pollard 1988).

For the ultimate age range (${}_\infty\Delta_x$) there is no indirect effect (by definition there are no survivors beyond this interval) and thus the formula for the effect in the final interval is:

$$ {}_\infty\Delta_x = \frac{l_x^1}{l_0^1}\cdot\left(\frac{{}_nT_{x+n}^2}{l_x^2}-\frac{{}_nT_x^1}{l_x^1}\right) \qquad (3.2) $$

The total difference in $e_{15}$ between two populations is the sum of the age specific differences, and thus it is possible to calculate the proportional contribution of each age group to the total difference.

$$ e_0^\circ(2)-e_0^\circ(1)=\sum_0^\infty {}_n\Delta_x \qquad (3.3) $$

The method is extended to decomposition by cause of death as well, under the assumptions that the distribution of deaths by cause is constant within age groups in each population, and that the total age-specific mortality rate at a given age is the sum of mortality rates for each separate cause of death (without interaction between them). The specific contribution of difference in mortality rates from cause $i$ at age $x$ to $x+n$ (${}_n\Delta_x^i$) will be:

$$ \begin{aligned} {}_n\Delta_x^i &= {}_n\Delta_x * \frac{{}_nm_x^i(2)-{}_nm_x^i(1)}{{}_nm_x(2)-{}_nm_x(1)} \\ &= {}_n\Delta_x * \frac{{}_nR_x^i(2)*{}_nm_x(2)-{}_nR_x^i(1)*{}_nm_x(1)}{{}_nm_x(2)-{}_nm_x(1)} \end{aligned} \qquad (3.4) $$

Where

${}_nm_x^i(j)$ = the age specific death rate from cause $i$ at age $x$ to $x+n$;

${}_nR^i_x\ (j)$ = the proportion of deaths from cause *i* at age *x* to *x*+*n* (${}_nD^i_x/{}_nD_x$) in population *j*, and
${}_n\Delta_x$ = is the total contribution of age x to x+n to differences in $e_{15}$, as estimated in equation (2.1).

Thus with this extension, and combining equations (3.1) and (3.4), the total difference in life expectancy between the populations can be apportioned to age and cause:

$$e_0^\circ(2) - e_0^\circ(1) = \sum_0^\infty {}_n\Delta_x = \sum_x \sum_i {}_n\Delta_x^i \qquad (3.5)$$

***Table 3.4*** *Cause of death groups used in Life table analysis*

| *Group* | *ICBS 55 Selected grouped causes of death* |
|---|---|
| **All Causes** | |
| **Cardiovascular Diseases** | 32-38 |
| **All Neoplasms** | 7-26 |
| Selected Tobacco Related | 7-8, 13-14 |
| **All External Causes** | 51-55 |
| **All Other causes (**except infectious diseases**)** | 27-31, 39-41, 50 |
| **Ill-Defined Causes** | 49 |

Net difference in $e_{15}$ between the immigrants and non-FSU immigrant Israelis were analysed by partitioning it into the contributions of age-ranges and groups of causes of death. The age ranges used were 15-34, 35-59, 60-74, 75+. Life tables were calculated for each calendar year and the contribution of groups of causes of death and age groups were analysed by three sub-periods 1990-1994, 1995-1999 and 2000-2004. Causes of death were aggregated into the broad groups listed in Table 3.4. Ill-defined causes were singled out in order to investigate the possible impact of improvement in diagnosis for immigrants over time, and its possible impact on other diagnoses.

### 3.6.2 SMR Analysis and Poisson Regression

Having depicted how differences in mortality rates between FSU immigrants and other Israelis are expressed in life expectancy at age 15 and have changed over calendar period disaggregated by age and cause, we move on to attempt to determine whether and to what extent these changes over calendar time might have been the outcome of the interplay of temporal components, or combinations of them. We will examine whether relative risks of mortality by cause between FSU immigrants and other Israelis, for each sex separately, display:

a. Duration effects. These represent the changing relative mortality rates as residence in Israel lengthens, as immigrants adapt to life in Israel individually and collectively, and distance themselves from conditions in the FSU.

b. Period of arrival effects. The impact on relative mortality rates over time of differences in the overall composition of the FSU immigrant population due to changes in the (unmeasured) characteristics of immigrants who arrived in Israel at different times. Period of arrival (sub-cohort) effects include the differential impact of selection on arrival cohorts. These effects are

"unmeasured", because the impact of variables which are present in our dataset (age composition, differences in education level, area of origin, or ethnic origin) were controlled for.

c. Calendar year effects. Since we are analyzing relative mortality, the impact on mortality rates of changing available therapies, trends in economic conditions, changes in health services organization or other temporal factors are already captured by the reference rates for Other Israelis. Therefore, calendar year effects on rate ratios in this analysis represent factors which have a *differential* period effect on migrants. These might include, for instance, changes (improvement or deterioration) in the health services delivered to FSU migrants (including screening programs or services in the Russian language), or changes in the economic and social conditions of migrants relative to other Israelis, irrespective of duration of stay.

These three temporal components may all act together (ignoring for the moment the methodological difficulty of identification by any two of the third, which will be discussed in section 2.6.7), any combination of two may be acting, only one may be present, or none. And in addition, they may interact, for example duration effects may be modified by cohort. Our regression models are designed to try to help determine which of these temporal dimensions, if any, is modifying the relative mortality risks by cause of death of FSU immigrants, while controlling for confounders and other background variables.

Causes of death were aggregated into the groups indicated in Table 2.4, without the "selected tobacco-related" group.

### 3.6.3 SMR analysis by temporal dimension

The mortality risks relative to the Israeli population and their pattern of change over time were measured by the Standardized Mortality Ratio (SMR), the ratio of observed to expected deaths, which indicates how FSU migrants' death rates by cause compare to the relevant Israeli population by duration, cohort, or calendar year, controlling for sex. The SMR for a particular sex for the cohort as a whole with reference to other Israelis, for all causes of death and for all temporal intervals is the ratio of the sum of observed deaths in the cohort (D) over all ages, all causes of death all calendar years to expected deaths in the reference (E) population for all ages, causes and calendar years. This overall SMR can be represented as the ratio of the sum of observed deaths to the sum of the deaths expected given the product of the person years at risk (PY) in the cohort over all ages, causes and calendar years of observation and the age specific death rates for each age, cause group, and calendar year (with the index for sex omitted for sake of simplicity):

$$SMR = \frac{D}{E} = \frac{\sum_{i=1}^{I}\sum_{j=1}^{J}\sum_{k=1}^{K} d_{ijk}}{\sum_{i=1}^{I}\sum_{j=1}^{J}\sum_{k=1}^{K} n_{ijk}\lambda_{ijk}} \quad (3.6)$$

where j is the age group, i the cause of death group, k the calendar year, $n_{jk}$ is the person years in age group j and calendar year k, and $\lambda_{ijk}$ is the age specific death rate in the reference population in calendar year k for cause i. An SMR for a particular cause can be calculated by holding *j* constant for that cause. An SMR for a particular calendar year can be calculated holding the value of *k* constant in both the numerator and the denominator for that particular year.

When the aggregated elements in the numerator are presented as in equation 3.6, it appears that both calendar year time and age in the cohort population are explicit elements in both the numerator and denominator of the measure. However, in practice the numerator is an undifferentiated total count of observed deaths (overall, by cause, or by temporal component). Only if the proportionality assumption for the SMR is maintained can this measure be used to reflect accurately differences in rate ratios of its components over time. This assumption specifies that the stratum-specific death rates are proportional to the equivalent rates in the standard population, i.e. that the ratio of rates between the cohort and the reference population are constant across age and temporal component (Clayton and Hills, 1993). When the proportionality assumption is satisfied, the ratio of SMRs reflects the underlying rate ratios. Any departure from this assumption will result in bias. Fortunately, multivariate techniques allow us to control for the heterogeneity of risk, by age for example (Breslow and Day, 1987). Such controls were made in this study.

We have calculated SMRs for each calendar year, year of duration of residence, and year of arrival for each of the grouped causes of death used in our multivariate analysis (see below). Graphical representation of SMRs are given below with alternative representations of the time dimensions on the x and y axis. Both the SMRs and 95% confidence intervals were calculated with SAS 9.3 GENMOD procedure.

### **3.6.4** Multivariate Poisson regression

Multivariate Poisson regression was used to investigate the relative contribution of each temporal component. Poisson regression depends on the assumption that observed deaths have the properties of a Poisson distributed random variable. Our analysis file (section 3.2) is essentially a multidimensional table in which counts of deaths in the FSU cohort by grouped cause of death are classified by sex, age group, educational level, ethnic group (Jews/Non-Jews), region of origin) and time component (calendar year, period of arrival, duration of stay). For each cell in this table person-years at risk and observed and expected deaths in the relevant reference populations are recorded. The latter were calculated based on the sex, age and cause specific death rate for the equivalent calendar year. Given the small number of events in each cell measured in small units of time it can be assumed that these are Poisson-distributed (Breslow and Day, 1987).

The Poisson assumption is that the number of observed deaths (d) in each of our age-time-covariate cells is a random variable with positive integer values following a Poisson distribution

$$pr(d = x) = \frac{\lambda n^x \mathrm{e}^{-\lambda n}}{x!} \quad (3.7)$$

where $\lambda$ is the unknown death rate and $n$ is the person years denominator of the rate. Ascribing this functional form entails several assumptions. First and foremost, in the Poisson model the mean and variance of expected deaths are equal, and a violation of this assumption is referred to as overdispersion. It is further assumed that the numbers of deaths in each cell are statistically independent (i.e. a person can die of one and only one cause of death, there is no interaction between causes of death, and deaths in one temporal period do not affect deaths in another period). In addition, the rate $\lambda$ remains constant within every interval of time specified in our analysis, an assumption that is nearer to the truth the shorter the time period under observation. It is also clear from equation 3.7 that according to the Poisson distribution deaths take an exponential form.

According to the assumptions of Poisson regression, in our multivariate analysis the log SMR for cause *i* is modeled as a linear function of a series of covariates, including the temporal components, as expressed in the β parameters in the following equations:

$$\log(\mathrm{SMR_i}) = \alpha_i + \beta_i x_i \qquad (3.8)$$

$$\mathrm{SMR_i} = e^{\alpha_i} e^{\beta_i x_i} = e^{\alpha_i + \beta_i x_i} \quad (3.9)$$

$\beta x_i$ are a series of covariates and their parameters. $\alpha_i$, the intercept, is the overall baseline effect, and it is equal to the log SMR when all $\beta_i = 0$. The transformation of model 3.8 to the form in equation 3.9 makes clear that the additive form of the loglinear model expresses a multiplicative model, in which the value of the SMR is proportional to the covariates, the exponentialized values of β indicating the estimated factor by which the SMR changes in the presence of a particular covariate.

The model as stated in equation 3.8 is an extension of the Poisson loglinear model for rates. In the conventional Poisson model for rates log person years serves as an offset (expressing the fact that counts of deaths are proportional to duration of exposure). If the log of the age specific rate for cause *i* in calendar year *k* is $\lambda_{ijk} = d_{ijk}/n_{ijk}$, where *d* is the number of deaths and *n* the person-years denominator for cause *i* and age group *j*, then the model is:

$$\log(\lambda_{ijk}) = \alpha_{ij} + \beta x_{ijk} \quad (3.10)$$

The logarithm of death rates is modeled as an additive model with an intercept corresponding to the effects of age (and other the stratification variables), and a vector of regression coefficients β modifying the covariates of interest, x. Since the rate numerator, the number of deaths from cause *i* at age *j* $d_{ijk}$ is regarded as a Poisson variable resulting from the age specific death rates and the person years lived at age j and calendar year k then the following model derives from 3.10:

$$\log(d_{ijk}) - \log(n_{ijk}) = \alpha_{ijk} + \beta x_{ijk} \quad (3.11)$$

$$\log(d_{ijk}) = \log(n_{ijk}) + \alpha_{ijk} + \beta x_{ijk} \quad (3.12)$$

Person-years in this model are regarded as constants and are not parameters of the model, and the form of equation 3.11 makes clear why log person-years is designated as an *offset*. Since the SMR is simply the ratio of deaths to expected deaths given the rates of the standard population, then

$$\log SMR = \log\left(\frac{d_{ijk}}{\lambda^S_{ijk} \cdot n_{ijk}}\right) = log\left(d_{ijk}\right) - log\left(\lambda^S_{ijk} \cdot n_{ijk}\right) \quad (3.13)$$

And thus when log expected deaths replace log person years as the offset in equation 3.12, then we obtain the final form of our model:

$$log\left(d_{ijk}\right) = log\left(\lambda^S_{ijk} \cdot n_{ijk}\right) + \alpha_{ij} + \beta x_{ijk} \quad (3.14)$$

where $\alpha_{ij}$ represents the log SMR when the values of $\beta$ are zero, and otherwise the values of $\beta$ represent how the log SMR varies proportionally to each covariate. In this model the log expected deaths are regarded as fixed, with the justification that the standard death rates on which they are based are drawn from a very much larger population than the investigated deaths (Breslow and Day 1987). As stated earlier, the proportionality assumption of SMR can be investigated with this model and need not be accepted uncritically, for example, by testing whether the $\beta$ parameters for age are significant. Equally, when the proportionality assumption holds, the parameter estimates in our multivariate models can be considered to be equivalent to rate ratios. Since Poisson regression is sensitive to violation of the assumption that the mean and variance are equal, attention must be given to possible overdispersion.

### 3.6.5 Specific multivariate Poisson Models

The SMR for all causes of death and each of our selected causes was analysed with twenty-two models, for each sex separately. Extending the logic proposed by (Kaldor et al. 1990) the models are nested with increasing complexity. They are designed to control for the background socio-demographic variables and to test for exhaustive alternative combinations of the time variables, attempting to see which of the temporal components, if any, provides the best explanation for change in the SMR for a particular group of causes of death. In addition to the main effects of the time variables alone and in combination, the models check for interaction between duration of stay and calendar year, duration of stay and period of arrival, period of arrival and calendar year. The models are ordered ("nested") by complexity, so that the contribution of an additional variable to the goodness of fit of the model can be assessed, the implication of a better fit being a test of the hypothesis that the additional variable contributes to a better explanation of the SMR.

The fit of the model (actually, the "ill-fit" of the model) is measured by the deviance. The log-likelihood of the model is a measure of the goodness of fit, whereas the deviance is minus twice the log likelihood ratio between a given model and the saturated model, the model with the maximum possible number of parameters. It thus represents the discrepancy between the observed and predicted counts of deaths, given the model. Two models can be compared by the difference in their deviances, this being −2log likelihood ratio for the two models, since the log likelihood for the saturated model cancels out. The difference in deviance is distributed as a chi-square random variable, with degrees of freedom equal to the difference in degrees of freedom between the two models contributed by the additional variable (Clayton and Hills 1993; Kaldor et al. 1990).

This test is possible when the models are nested. However, comparison between competing models that are not nested cannot be achieved with likelihood ratio tests, and such is the case when we have to choose between alternative temporal components. Therefore another method of model selection is necessary. The Akaike Information criterion (AIC), which is defined as −2log-likelihood + 2p, where p is the number of parameters in the model, is a standard model selection criterion in such cases (Lindsey and Jones 1998). As in the case of deviance, the model with the smaller AIC is to be preferred. When the number of parameters is the same, it compares log-likelihoods, but in addition, the measure penalizes the deviance for the additional complexity of added parameters. This is especially valuable in our study since the size of our data matrix tends to make all parameters to be statistically significant. In addition, the measure will help us to choose between different temporal interpretations of equal complexity. However, as we will discuss in section 3.6.6, this must be done with caution.

Table 3.5 presents the models and the degrees of freedom of each. Models 1-4 progressively introduce socio-demographic characteristics, testing the null hypothesis that the addition of a particular variable has no influence on SMR. By testing age we are explicitly testing whether the SMR is proportional by age.

Models 5-7 test the null hypothesis that each of the three temporal variables does not alter the SMR, controlling for background variables. For discrete analysis, duration of residence, arrival period, and calendar year were grouped into 6 categories of 2-year bands, with the exception of the last period of duration (14-16 years) and the last calendar year period (2002-2004). For continuous analysis each temporal dimension was represented by the midpoint of the six categories.

Models 8-10 present pairs of two temporal factors, and the null hypothesis that is tested is that the additional temporal variable does not alter the SMR estimated in the equivalent model 5-7. Since models 8-22 are not nested, the best fit among them is decided by the AIC criterion.

Models 11-14 test the null hypothesis that the temporal variables of model 8 (duration and calendar year) are not modified by interaction with ethnicity or elderly age (age 60 and over).

Models 15-18 test the null hypothesis that the temporal variables of model 9 (duration and arrival period) are not modified by interaction with ethnicity or elderly age.

Models 19-22 test the null hypothesis that the temporal variables of model 10 (calendar year and arrival period) are not modified by interaction with ethnicity or elderly age.

### *Table 3.5 Multivariate Models and degrees of freedom*

| Model Number | Variables (temporal variables in 6 discrete categories) | Degrees of Freedom |
|---|---|---|
| 0 | **SMR** | **1** |
| 1 | age | 15 |
| | **Background variables** | |
| 2 | age+education | 16 |
| 3 | age+education+nonjews | 17 |
| 4 | age+education+nonjews+origin | 21 |
| | **Background variables and Temporal variables** | |
| 5 | age+Background variables+duration | 27 |
| 6 | age+ Background variables +calendar year | 27 |
| 7 | age+ Background variables +arrival cohort | 27 |
| | **Background variables and combinations of temporal variables** | |
| 8 | age+ Background variables +calendar year+duration | 33 |
| 9 | age+ Background variables +duration+arrival cohort | 33 |
| 10 | age+ Background variables +calendar year+arrival cohort | 33 |
| | **Interactions with duration and calendar year** | |
| 11 | age+ Background variables +calendar year+duration+ calendar year*age60 | 38 |
| 12 | age+ Background variables +calendar year+duration+duration*age60 | 38 |
| 13 | age+ Background variables +calendar year+duration+calendar year*nonjews | 39 |
| 14 | age+ Background variables +calendar year+duration+duration*nonjews | 39 |
| | **Interactions with arrival cohort and duration** | |
| 15 | age+ Background variables +arrival cohort+duration+arrival cohort*age60 | 38 |
| 16 | age+ Background variables +arrival cohort+duration+duration*age60 | 38 |
| 17 | age+ Background variables +arrival cohort+duration+arrival cohort*nonjews | 39 |
| 18 | age+ Background variables +arrival cohort+duration+duration*nonjews | 39 |
| | **Interactions with calendar year and arrival cohort** | |
| 19 | age+ Background variables +arrival cohort+calendar year+ arrival cohort*age60 | 38 |
| 20 | age+ Background variables +arrival cohort+calendar year+ calendar year*age60 | 38 |
| 21 | age+ Background variables +arrival cohort+calendar year+ arrival cohort*nonjews | 39 |
| 22 | age+ Background variables +arrival cohort+calendar year+ calendar year*nonjews | 39 |

## **3.7** Methodological difficulties in statistical estimation of time factors

We have presented the test for temporal components as a straightforward exercise in model selection, but it must be acknowledged there are potential biases and pitfalls in this strategy. The linear relationship between the components, which we have already raised in section 1.4.4 above, complicates statistical estimation considerably. When the dimensions are specified as continuous variables, then duration = year – cohort. Although we have referred to time as having several components or dimensions, these are essentially inseparable: an individual immigrant cannot increase his duration of residence without calendar time changing as well, and unlike spatial dimensions one cannot, at the individual level, fix one coordinate while changing the other two. Due to this linear relationship, it is not possible to estimate parameters for all three factors simultaneously in a simple regression model. In the parallel context of age-period-cohort investigations, this is referred to as the "identification" or "non-identifiability" problem.

However, given the theoretical importance of investigating simultaneously effects which alter through age, cohort and period, sophisticated attempts have been made to overcome or circumvent the difficulty (generally referred to as APC models) and these usually belong to the class of generalized linear models, as do the Poisson regressions we have used.

This can be demonstrated with a representation of the generalized linear APC model for rates, adapted to our migration context (Robertson et al. 1999). Here the logarithm of the SMR is a linear function of duration (*i*), year (*j*), and arrival cohort (*k*), where $i = 1, \ldots, m$ and $j = 1, \ldots, n$. Thus the number of duration groups is *m* and the number of year groups is *n* :

$$\log(SMR_{ij}) = \alpha + duration_i + year_j + cohort_k + v(j - 1 + m - k) \quad (3.15)$$

The mean effect is represented by α, the three following terms represent the effects of duration *i*, year, *j* and arrival cohort *k*. Because of the linear dependencies between the components, only one cohort is associated with each combination of duration and year. Thus $k = j - i + m$, $k = 1, 2, \ldots, m + n - 1$. The final term, $v$, represents the unidentifiable parameter. It can take any value and the fit of the model will be the same, since $(j - i + m - k) = 0$.

Attempts to overcome the identifiability problem have included breaking the linear dependency by imposing arbitrary linear constraints, imposing a penalty function that is minimized, or concentrating on the so-called estimable functions thereby abandoning the attempt to estimate the linear slope of each component separately, concentrating instead on factors which are not identified, namely the curvatures or the departures from linearity in each component (Robertson et al. 1999). The last approach is based on the finding that it is only the linear components of age, period, and cohort that are not individually identifiable, and higher order relationships remain estimable. Each of these approaches takes a different form and some have been found to be inherently biased. Moreover all impose assumptions and limitations which complicate the interpretation of the results (see also (Holford 1991; Kupper et al. 1985; Robertson and Boyle 1998)). Given these limitations we have not tried to employ an APC model in our analysis.

However, the detailed assessment of APC models has shown that resorting to models with only two time factors, as we are proposing to do, does not escape some of the difficulties involved, among them cohort overlap and truncated observation periods, problems with interaction terms, and exposure to linear bias.

**Overlap.** Figure 3.1 shows how the sub-cohorts by arrival period in our multivariate models move through a lexis diagram by groupings of calendar year and duration of residence. Although there is a linear dependency between the temporal components, when these components are aggregated into discrete groups they do not behave like the underlying equation. Figure 3.1 shows, for instance that in the calendar years 1992-1993 the 1990-1991 sub-cohort passes through two different grouping of duration (0-1, 2-3). But in both these categories of duration the exposure of this sub-cohort is censored: only for part of the sub-cohort is duration 0-1 and 2-3 experienced in 1992-93. Moreover, the 1990-91 sub cohort experiences duration 0-1 in two different calendar year categories. At the other end of duration and calendar year, the broader width of the last category creates more asymmetries. The 2002-03 arrival sub-cohort reaches duration 0-1 and 2-3 in the calendar years 2002-04. But in fact the fraction

of the cohort that reaches 2-3 years in practice reaches a shorter duration of 2 years only. Parallel censoring occurs for earlier sub-cohorts at higher durations of residence. Three arrival cohorts are represented in the final calendar year period (2002-04) in all levels of duration except the longest one (12-14 years of residence). These overlaps and censorings create difficulties of interpretation, "misleading" computer software into failing to recognize the underlying linear dependence between the variables (Clayton and Hills 1993; Robertson and Boyle 1998). Moreover they may make it more difficult for statistical models to confirm the existence of cohort effects (Holford 1991). And beyond the difficulties of interpretation they may affect the fit of alternative models. In addition, figure 3.1 shows that earlier cohorts are represented by longer periods of observation (duration), more cohorts are observed at shorter durations, and equally, later calendar years are associated with both longer durations and a larger number of cohorts. The fact that observations are restricted in this manner may have implications for the fit of alternative statistical models to the data, and will also mean that generalizations concerning the effects of a particular time component will be effected by these limitations (Kupper et al. 1985).

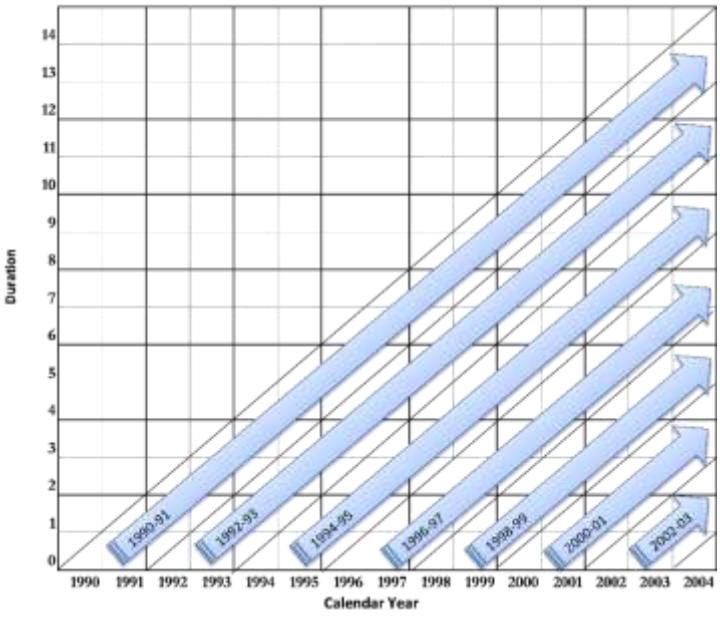



*Figure 3.1 Arrival cohorts through calendar years and duration*

**Linear bias.** The severest challenge to the approach we have adopted is the finding that the selection of a two-factor model based entirely on standard goodness-of-fit criteria can be misleading if the omitted component follows a true linear trend. In such cases the coefficients of the included components will be seriously biased, even though there is relatively good agreement between observed and predicted responses (Kupper et al. 1985). When trying to test for the effect of a given factor by comparing the fit of a three factor to a two factor model, because the linear parameter (the slope) of each component is entangled with the other two, there is a loss of one degree of freedom for the test of that components effect in the presence of the other two. Thus the test becomes one of curvature rather than of slope (for a mathematical exposition of this see (Holford 1991)). This finding is an expression of a more general problem with using model selection to choose among the three components. Although we are selecting two factors only, since we cannot determine on statistical grounds alone that the eliminated component has no linear effect, the problem of identifiability remains implicit in the model, and omission of a time component does not eliminate the $\upsilon$ term in equation 2.14. Any selection of a two factor model is based on an unverifiable assumption that the linear trend of the excluded factor is zero (Holford 1992). But although this assumption is unverifiable, fortunately causal agents that change over time frequently show curvature. In the case of duration of residence, it is usually the case that short-term effects are different in intensity than long term effects. Cohort effects are discrete, and even when earlier arriving cohorts may have different characteristics than ones that

arrived latter, the differences between them are unlikely to be linear. When there are long term trends calendar year effects may display a long term trend with little curvature: but in our case calendar year effects represent *differential* effects on the immigrant cohort, and these too are unlikely to follow a purely linear trend. Finally, a discrete specification of the time dimensions allows us to examine the linearity of the factors.

Despite this significant methodological problem, the epidemiological literature contains innumerable examples of two factor models: models with age and period, or birth cohort and period, or in the context of migration studies, models with cohort and duration. Research often uses more than one time scale simultaneously: two factor analysis has not halted although the problems we have outlined will be encountered whenever two temporal factors are involved (Clayton and Hills 1993). The considerations we have outlined merely strengthen the conclusion that statistical considerations alone cannot provide us with the sole criteria for model selection, and these must be supplanted with external information, theoretical considerations and judgement. In the following analysis the best-fitting model has been chosen for interpretation, but in each case an attempt has been made to determine why the omitted factor(s) was a weaker contributor to the temporal trends which were found, without implying that it had no influence at all.

# Section 4.0 Results

## 4.1 Introduction

Analysis of changes in the mortality patterns of the immigration wave from the FSU through each temporal dimension (calendar year, period of arrival cohort and duration of residence) must take account of the changes in its socio-demographic characteristics in each of these dimensions, through the addition of new arrivals and attrition by death and emigration. The chapter begins with a description of these changes. Analysis of mortality patterns over the time dimensions will begin with a depiction of the changes in life expectancy at age 15 for FSU immigrants compared to that of other Israelis between 1990 and 2004, decomposed by calendar year, sex, period, age, cause of death group, geographic origin and ethnicity. This calendar period-based analysis will be followed by an analysis of changes in SMRs through the other two temporal dimensions, arrival cohort and duration of residence, controlling for sex and cause of death group. Having presented competing descriptions of changing mortality patterns over calendar period, arrival cohort and duration dimensions, a multivariate analysis will attempt to determine which of the temporal dimensions, singly or in combination, provides the best statistical account of temporal change. The models are stratified by sex, and outcomes include all-cause mortality, and specific cause of death groups.

## 4.2 Socio-demographic characteristics of the FSU population in Israel

### 4.2.1 Characteristics by arrival cohort.

Table 3.1 presents the characteristics of the FSU population by sex, aggregated into two-year arrival cohorts. Major differences between the cohorts are evident, in region of origin within the FSU, in educational qualifications, in ethnic composition and in their age profile. The most notable distinction is in volume, with the distribution heavily skewed to the earliest period: 35% of the immigrants from the FSU in 1990-2003 arrived in the first two years, 1990-1991. In the subsequent 8 years, 1992-1999, a further 52% arrived at a relatively constant rate, whereas in the following four years volumes declined sharply and only 13% of the immigrants arrived after 1999.

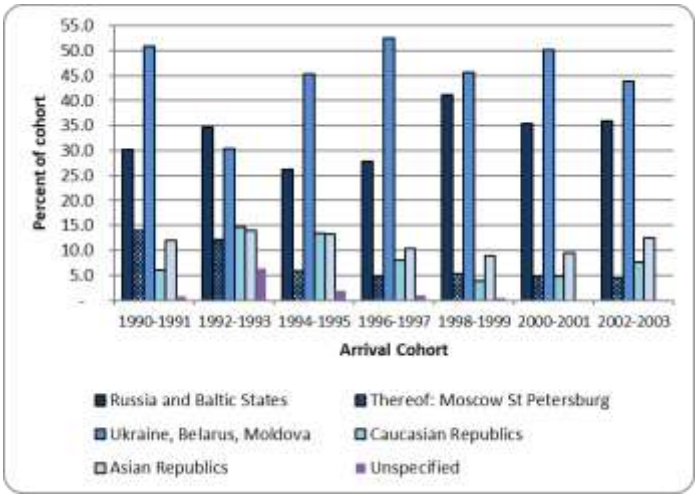



*Figure 4.1Region of origin in the FSU, by arrival cohort*

The changes in volume by arrival cohort are accompanied by changes in composition by region of origin, as displayed in figure 3.1. Immigration from the cities of Moscow and St. Petersburg, the administrative and cultural center of the USSR was 9% overall. It peaked at 14% in 1990-1991 at the onset of mass-migration, declined somewhat to 12% in 1992-1993 and fell to less than 6% by 1994-1995, and declined continuously thereafter. This was the case although the proportion of the Jewish population of the FSU residing in these two cities (the pool of potential migrants) was very high at the outset of the migration wave (approximately 20% in 1989) and retained a similar or higher proportion throughout the period.

***Table 4.1 FSU immigration to Israel 1990-2003, deaths and emigration. Characteristics by sex, age, geographic origin and ethnicity***

| | **Period of Arrival** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **1990-2003** | 1990-1991 | 1992-1993 | 1994-1995 | 1996-1997 | 1998-1999 | 2000-2001 | 2002-2003 |
| **All immigrants aged 15+** | 744,263 | 258,060 | 104,004 | 106,258 | 91,945 | 90,255 | 68,169 | 25,572 |
| **Deaths** | 74,109 | 36,134 | 13,465 | 11,175 | 6,570 | 4,215 | 2,125 | 425 |
| **Emigrants** | 66,787 | 25,352 | 10,363 | 9,349 | 7,426 | 8,083 | 5,105 | 1,109 |
| | **Males** | | | | | | | |
| **Total** | 338,217 | 117,958 | 47,806 | 47,495 | 41,216 | 40,981 | 31,137 | 11,624 |
| **Age** | | | | *Percentages* | | | | |
| 15-34 | 43.5 | 39.7 | 44.3 | 43.8 | 45.5 | 46.9 | 47.5 | 48.5 |
| 35-59 | 36.8 | 40.6 | 34.4 | 34.9 | 35.3 | 35.0 | 34.7 | 34.5 |
| 60-74 | 15.9 | 15.2 | 17.0 | 17.5 | 16.2 | 15.5 | 15.4 | 14.8 |
| 75+ | 3.7 | 4.5 | 4.3 | 3.8 | 3.0 | 2.6 | 2.4 | 2.2 |
| **Region of FSU** | | | | | | | | |
| Russia and European Republics | 78.4 | 81.1 | 64.3 | 71.6 | 80.3 | 86.8 | 85.9 | 79.6 |
| *Thereof*: Moscow, St. Petersburg | 9.2 | 14.1 | 12.0 | 5.9 | 4.6 | 5.2 | 4.7 | 4.3 |
| Caucasian and Asian Republics | 19.9 | 18.1 | 28.9 | 26.4 | 18.5 | 12.8 | 14.1 | 20.4 |
| USSR Unspecified | 1.7 | 0.8 | 6.8 | 2.1 | 1.2 | 0.4 | - | - |
| **Education: 13 years and over** | 47.1 | 55.1 | 44.6 | 41.4 | 40.3 | 43.3 | 44.6 | 44.4 |
| **Ethnic Group** | | | | | | | | |
| Jews | 75.3 | 93.7 | 84.1 | 75.9 | 64.5 | 52.9 | 46.9 | 43.1 |
| Non-Jews | 24.7 | 6.3 | 15.9 | 24.1 | 35.5 | 47.1 | 53.1 | 56.9 |
| | **Females** | | | | | | | |
| **Total** | 406,046 | 140,102 | 56,198 | 58,763 | 50,729 | 49,274 | 37,032 | 13,948 |
| **Age** | | | | *Percentages* | | | | |
| 15-34 | 37.8 | 35.4 | 36.4 | 36.4 | 39.1 | 41.4 | 42.3 | 43.7 |
| 35-59 | 37.4 | 38.1 | 35.7 | 37.2 | 38.0 | 37.1 | 37.0 | 37.5 |
| 60-74 | 18.5 | 19.7 | 20.3 | 19.4 | 17.1 | 16.3 | 15.8 | 14.5 |
| 75+ | 6.3 | 6.8 | 7.6 | 7.0 | 5.8 | 5.1 | 4.9 | 4.3 |
| **Region of FSU** | | | | | | | | |
| Russia and European Republics | 78.6 | 81.2 | 65.6 | 71.6 | 80.5 | 86.8 | 85.5 | 80.0 |
| *Thereof*: Moscow, St. Petersburg | 9.2 | 14.0 | 12.4 | 5.9 | 4.8 | 5.3 | 4.7 | 4.6 |
| Caucasian and Asian Republics | 19.9 | 18.0 | 28.5 | 26.8 | 18.5 | 12.7 | 14.5 | 20.0 |
| USSR Unspecified | 1.5 | 0.8 | 5.9 | 1.6 | 1.0 | 0.4 | - | - |
| **Education: 13 years and over** | 48.7 | 54.8 | 45.8 | 43.0 | 43.0 | 46.9 | 48.8 | 49.1 |
| **Ethnic Group** | | | | | | | | |
| Jews | 76.0 | 93.7 | 83.7 | 77.2 | 66.8 | 54.7 | 47.9 | 45.0 |
| Non-Jews | 24.0 | 6.3 | 16.3 | 22.8 | 33.2 | 45.3 | 52.1 | 55.0 |

Immigration from the far more peripheral Asian and Caucasian Republics (12% and 8% overall) peaked soon after the wave began, in 1992-1993 and 1994-1995, reaching 27%-29% of all immigrants in those arrival cohorts, whereas earlier and later their share varied between 14% and 20%, with differing

relative contributions of the Asian regions and the Caucasian regions. The latter were especially concentrated in 1992-1995. By 2003 the Jewish communities of these regions were transplanted to Israel almost entirely (above Section 1.7.1). The contribution of the largest regional groupings, the Russian Federation and the Baltic States (32% overall), on the one hand, and Ukraine, Belarus, and Moldova (47% overall) on the other, were also variable. The latter group was usually the largest component, contributing 44%-55% of the total, but in 1992-1993 its share fell to as low as 30%. The contribution of the Russian Federation and the Baltic States varied from as low as 26% in 1994-1995 to a high of 41% in 1998-1999 (the years around the severe financial crash in Russia of August 1998). Since the proportion from Moscow and St. Petersburg remained low after 1990-1991, it follows that these arrivals were from the more peripheral areas of the Russian Federation. In summary, the shifts in geographical composition are not continuous, they create arrival cohorts with distinct geographic compositions, reflecting differences in both the physical and the social environment from which the immigrants originated, favouring more peripheral areas over time.

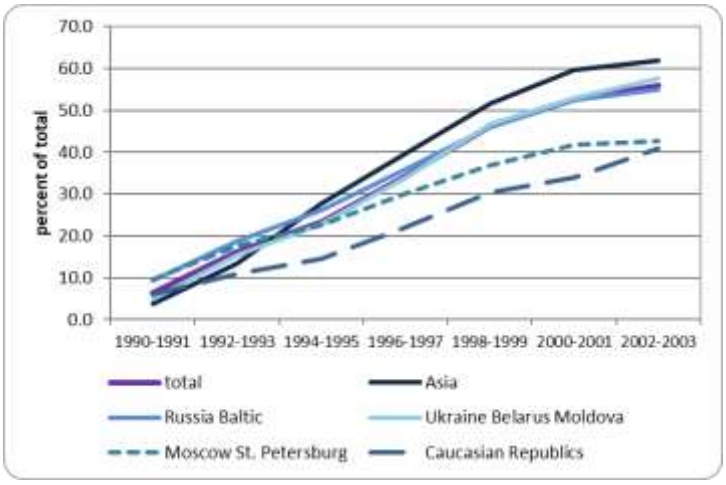



*Figure 4.2 Proportion of non-Jews in arrival cohort, by region of origin.*

Whereas the geographic distribution is discontinuous across arrival cohorts, the change in ethnic composition is continuous, with the proportion of non-Jews rising from 6 percent in the 1990-1991 cohort to nearly 56% in the 2002-2003 cohort. However, as figure 4.2 shows, both the rate of change and the final proportion differs between the regional groupings, with the Asian republics ultimately reaching the highest proportion of non-Jews at over 60%, and the Caucasian Republics and Moscow and St. Petersburg with much lower proportions – around 40%.

**Age, sex and ethnic group**: the movement of FSU migrants to Israel is not typical of migratory populations, where economic and social selection often favours young males. Table 4.1 indicates that women are 54.6% of the population overall, with little difference between the arrival cohorts. Nor is the population concentrated at younger working ages: mean age of immigrants aged 15 and above is 40.8 years for men, and 43.9 years for women. However, the age profile is not fixed, and arrival cohorts become younger over time, while the female population remains older across cohorts. The proportion aged 15-34 rises continuously from 35% among women

and 40% among men in the earliest cohort to 44% among women and 49% among men in the latest cohort. The proportion aged 60 and above falls from 29% for women and 20% for men to 19% for women and 17% for men, respectively. Disaggregation of mean age by sex and ethnic group shows a more complex pattern. Figure 4.3 shows that overall mean age remained stable until the 1994-1996 arrival cohorts, declining thereafter. However, when the data is broken down by ethnic group mean age rises moderately for all but female Jews, for whom there is a modest decline after 1995. The overall fall in mean age is due to confounding by ethnic group: as the figure shows, there is a ten-year difference in mean age between the Jewish and non-Jewish population, and the mean age fell overall with the rising proportion of non-Jews.

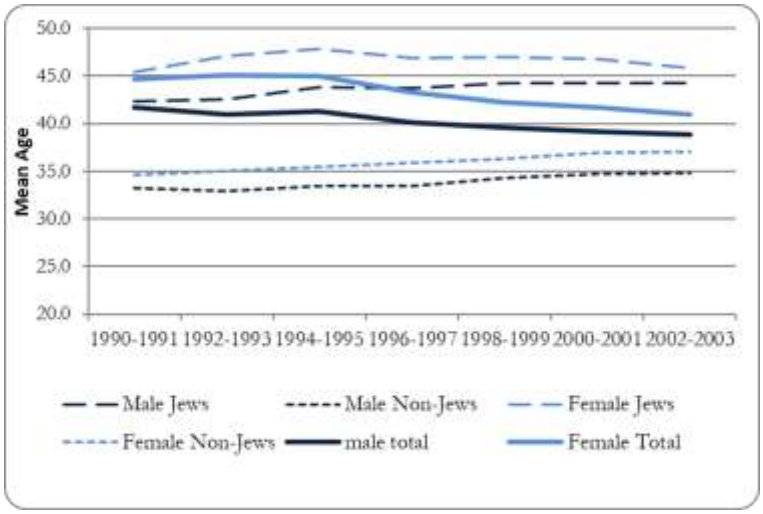



*Figure 4.3 Mean age at arrival (age 15 and over),by cohort, sex and ethnicity*

**Educational Achievement.** Educational achievement of the population is high, overall: 49% of the women and 47% of the men have 13 or more years of education. In parallel to the pattern found for mean age, differences in educational achievement between the Jewish and non-Jewish group result in an aggregate pattern of change in achievement across cohorts which contrasts with the pattern of change within each ethnic group. Table 3.1 shows that the proportion of immigrants with 13 or more years of education falls continuously, but more steeply for men: from 55% in the 1990-1991 arrival cohort for both men and women, to 44% for men and 49% for women by the 2002-2003 arrival cohort. However, as shown in Figure 4.4, when disaggregated by ethnic group one does not see a continuous decline but a U-shaped pattern. There is a fall in education qualifications from the onset of immigration and until the 1996-1997 arrival cohort and a rise thereafter, for both genders and ethnic groups. In all cohorts there is no difference in educational qualifications between men and women for the Jewish ethnic group, whereas the proportion of non-Jewish women with 13 or more years of education is consistently 6% - 8% higher than for non-Jewish men. The latter group consistently has the lowest education qualifications.

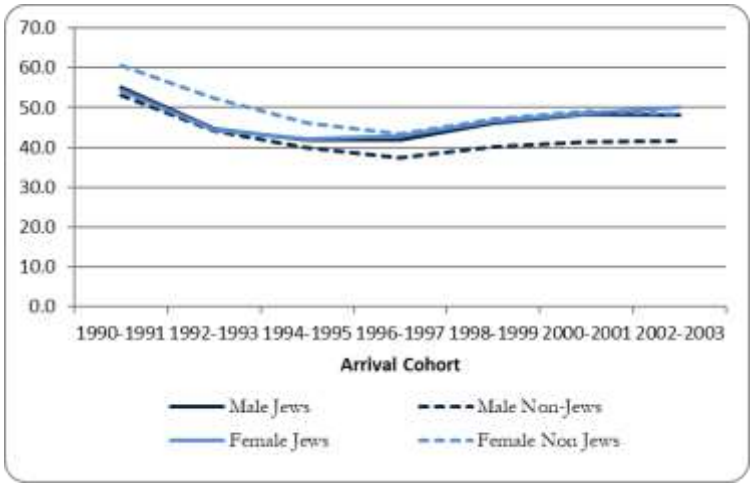



*Figure 4.4 Percentage with 13+ years of education, by cohort, sex and ethnicity*

Hence the fall in mean age, the steady decline in educational qualifications and the growing gap between men and women are associated with the rising proportion of male non-Jews among all immigrants. They are also associated with the apparent shift in self-selection favouring migration sources in the periphery to those in the centre. Logistic regression modeling of the odds of having 13 or more years of education by sex, age, geographical origin, ethnicity and emigration (Appendix Table A3.1) shows that for both sexes non-Jewish ethnicity is associated with lower odds of higher qualification levels, 0.792 (0.779-0.805) and 0.914 (0.900-0.929) for men and women respectively. Among the areas of origin there are large differences in the odds of higher education. Relative to origin in Russia and the Baltic States, origin in Moscow and St Petersburg raises the odds nearly two-fold, whereas origin in the Caucasian Republics lowers the odds by nearly half. Clearly the shift in geographic selection from center to periphery also lowered the educational qualification of migrants between the arrival cohorts. In addition, higher educational qualifications are clearly associated with re-migration (emigration from Israel). The odds ratios are 1.271 (1.250-1.292) as compared to lower education, indicating attrition over time of the positive education self-selection of earlier arrival cohorts. In earlier arrival cohorts education was higher but exposure to emigration longest. Thus the positive potential health benefits of higher education are eroded over time through attrition, creating a potential negative duration effect.

### 4.2.2 Contribution of arrival cohorts to composition of calendar period and duration

The socio-demographic characteristics of the arrival cohorts accumulate successively to create overall cross-sectional characteristics by calendar periods and duration of residence intervals. As calendar time moves forward the number of arrival cohorts participating grows, and vice versa – as duration periods increase in length the number of participating arrival cohorts decreases. Consequently the particular characteristics of the earliest arrival cohorts dominate in the earliest calendar periods and the longest duration periods.

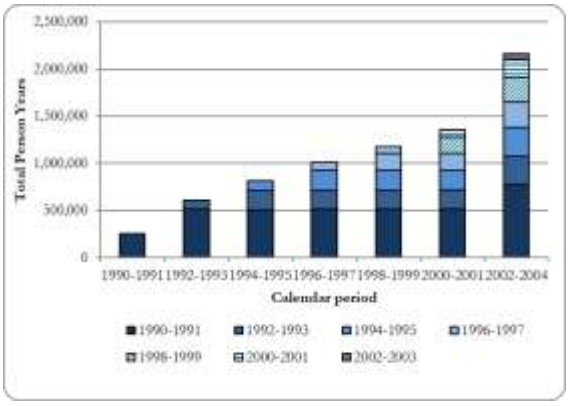



*Figure 4.5 Person-years composition of calendar period by arr ival cohort*

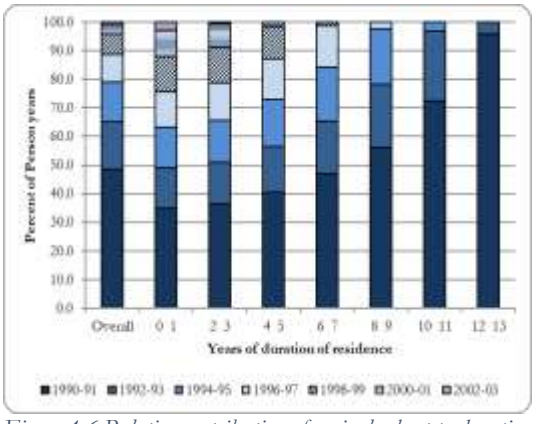



*Figure 4.6 Relative contribution of arrival cohort to duration of residence intervals*

### 4.2.3 Characteristics by calendar period

The greater volume of migration in the earliest period moderated the impact of the discontinuity in the characteristics of successive immigration cohorts on the transformation of the population overall through calendar time (these characteristics are documented in Appendix table A3.4). There is a moderate change in the distribution by region of origin, with a the relative decline of the proportion from Moscow and St. Petersburg, from 14% to 8%, and a rise in the proportion from the Asian and Caucasian areas form 18% to nearly 22%, and a moderate decline of the Ukraine Belarus and Moldova region from 52% to 46%. Similarly, the age profile of the population as a whole changes little, although, within the 60 and above age group, the proportion aged 75 and over increases from 9% to 13% and the proportion aged 60-74 declines. The most prominent changes are those in ethnicity and education. As the proportion of non-Jews in each arrival cohort eventually reaches over 50%, the ethnic composition of the population as a whole changes, with the proportion of non-Jews rising from 5% in the initial period to 24% by 2002-2004. And as educational qualifications decline across arrival cohorts, the proportion of the population with 13 or more years of education declines continuously, a process that is enhanced by the higher emigration rates of persons with the highest educational qualifications.

As Figure 4.7 shows, emigration was higher in the earliest arrival cohorts, consistently higher for males than for females, and twice as high for non-Jews than for Jews. Logistic regression (Appendix Table A3.2) shows that the selective effect of emigration was to decrease the proportion from the centre of the FSU, of the higher education groups and of the non-Jewish population.

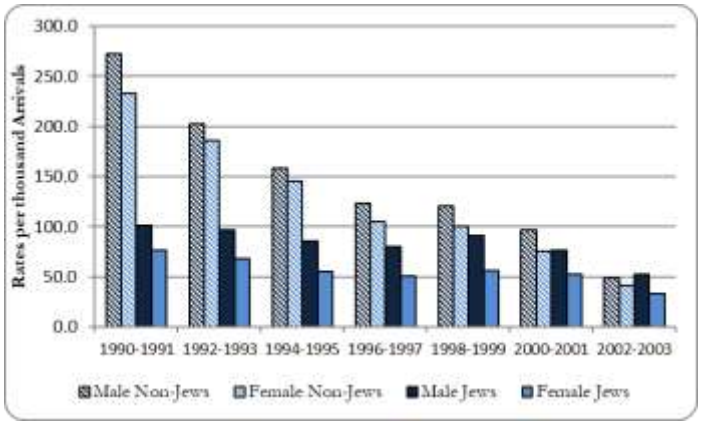



*Figure 4.7 Cumulative emigration rates by arrival cohort*

The odds of emigration are highest for the youngest age group and decline sharply with age, are much higher for those originating in the urban centres of the FSU, Moscow and St Petersburg 1.966(1.916-2.017) nearly 30% higher for the highest education group 1.291 (1.270-1.313), and 45% higher for Non-Jews 1.451 (1.426-1.477).

### 4.2.4 Characteristics by duration

Table 4.2 shows composition of characteristics of the migrant population in each of the two-year duration periods. These are determined both by the compositions of these periods by arrival cohort, and the changes due to aging and attrition through death and emigration. The population ages

***Table 4.2 Person-years by duration of residence, age, geographic origin, education and ethnicity***

| | Duration of Residence | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0-1 | 2-3 | 4-5 | 6-7 | 8-9 | 10-11 | 12-13 |
| **All immigrants** | 1,471,449 | 1,401,849 | 1,259,617 | 1,087,956 | 914,642 | 712,769 | 535,047 |
| | | | *Percentages* | | | | |
| **Age** | | | | | | | |
| 15-34 | 39.6 | 37.8 | 36.1 | 34.6 | 33.7 | 33.0 | 32.8 |
| 35-59 | 37.3 | 37.9 | 38.7 | 39.3 | 39.9 | 41.0 | 42.5 |
| 60-74 | 13.6 | 13.4 | 12.7 | 12.2 | 11.6 | 10.9 | 10.1 |
| 75+ | 9.5 | 10.9 | 12.4 | 13.9 | 14.8 | 15.1 | 14.7 |
| **Region of FSU** | | | | | | | |
| Russia and Baltic Republics | 31.7 | 31.2 | 30.4 | 29.1 | 29.4 | 30.2 | 28.8 |
| *Thereof*: | | | | | | | |
| Moscow, St. Petersburg | 9.1 | 8.9 | 9.2 | 9.7 | 10.6 | 12.0 | 12.7 |
| Ukraine, Belarus Moldova | 46.6 | 46.6 | 46.2 | 45.8 | 44.3 | 44.5 | 49.4 |
| Caucasian and Asian Republics | 20.1 | 20.6 | 21.7 | 23.3 | 24.3 | 23.4 | 20.8 |
| Unspecified | 1.6 | 1.6 | 1.7 | 1.9 | 2.0 | 1.9 | 1.0 |
| **Education: 13 years and over** | 47.3 | 45.8 | 44.5 | 43.5 | 43.2 | 43.6 | 44.5 |
| **Ethnic Group** | | | | | | | |
| Jews | 75.7 | 77.0 | 80.1 | 84.0 | 87.4 | 90.6 | 93.9 |
| Non-Jews | 24.3 | 23.0 | 19.9 | 16.0 | 12.6 | 9.4 | 6.1 |

significantly along with increasing duration of residence: the proportion aged 15-34 declines from nearly 40% at duration 0-1 years to 33% at durations 12-13 years, and the proportion age 60 and over rises from 23% to 25% over the equivalent duration. The proportion from Russia and the Baltic States decreases slowly with increasing duration, whereas the proportion from Moscow and St. Petersburg rises from 9% at 0-1 years to nearly 13% at the longest duration interval. The pattern for the proportion for the Asian and Caucasian Republics is not monotonic: it rises from 20% at the shortest duration to a peak of 24% at 8-9 years of residence, falling back to 21% at the longest duration. There is a mirror-image pattern for the proportion in the highest education group. It is highest at the shortest duration, 47%, falling to a low of 43% at 8-9 years of residence, and then rising back to 44.5% at 12-13 years of residence. The proportion of non-Jews is highest at the shortest duration, 24%, and falls to 6% at the highest duration.

## 4.3 Calendar change in FSU immigrant life expectancy at age 15, 1991-2004

At the outset of the immigration wave in 1991[6], life expectancy at age 15 ($e_{15}$) was higher for female FSU immigrants than for female Other Israelis (65.4 vs. 64.3 respectively) and similar for males in both populations (60.7 vs 61.0 respectively) (figure 4.8). By 1994 $e_{15}$ for female FSU immigrants had fallen to the level for Other Israelis, and thereafter both groups improved in tandem, reaching 67.6 for FSU immigrants and 67.5 for Other Israelis by 2004, an improvement of 2.2 years for female FSU immigrants, and 3.2 years for female Other Israelis (figure 4.9). For FSU males, however, there is no improvement until 2002 and an improvement of only 0.8 years by 2004 (61.5), whereas $e_{15}$ for Other Israeli males improved continuously, reaching 63.7 years by 2004, an improvement of 2.8 years. As a result, the gap between male and female $e_{15}$, which in 1992 was 3.7 years for Other Israelis and 4.4 years for FSU immigrants, increased for the latter to 6.6 years in 2000, declining somewhat to 6.3 years in 2004. For Other Israelis the gap was virtually constant throughout the period at the very low level that is typical of Israel. In summary, FSU females as a group quickly lost a slight initial advantage in $e_{15}$ over Other Israelis, but thereafter the immigrant population matched the Israeli population both in level and pace of improvement. For males initial equivalence was lost and the gap between male FSU immigrants and Other Israelis increased to 2.2 years by 2004, since $e_{15}$ remained stagnant until 2002.

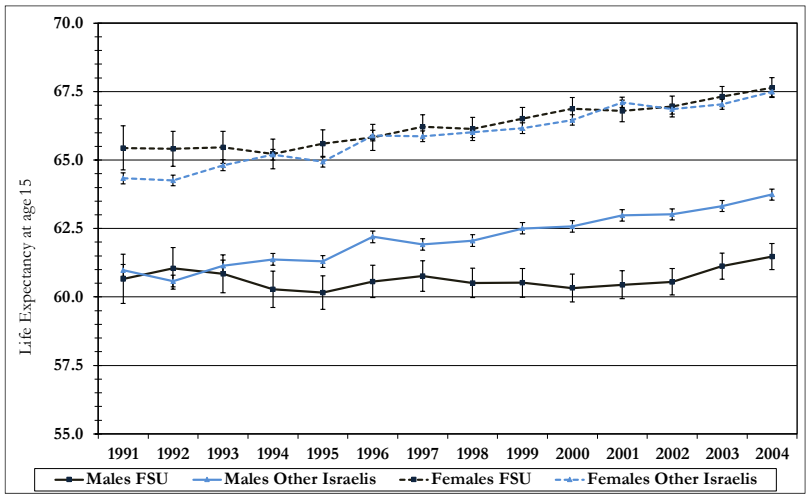



*Figure 4.8 Life Expectancy at age 15, FSU immigrants and Other Israelis, 1991-2004*

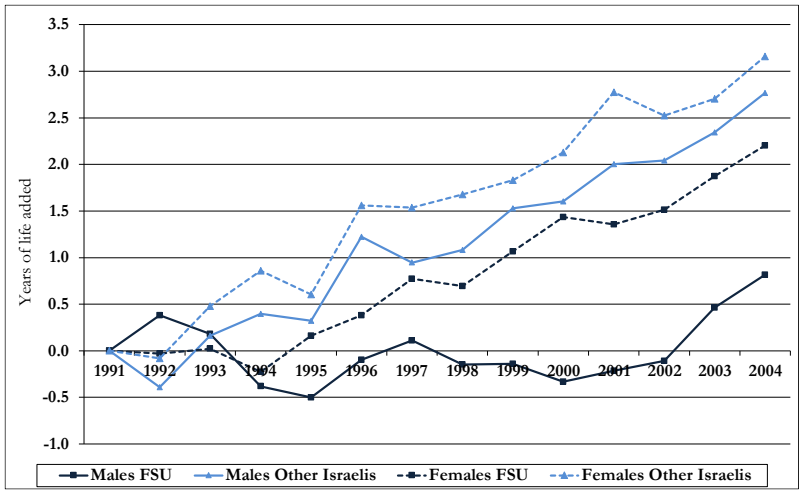



*Figure 4.9 Trend in added life expectancy at age 15, 1991-2004 1991=0*

[6] Life expectancy for 1990 was not calculated since the arrival of immigrants accelerated rapidly from low to very high levels over the year, complicating the calculation of exposure and the person-year denominator for rates.

### 4.3.1 Change in $e_{15}$ by period and by geographical origin and ethnic group

Disaggregation of the FSU immigrant population by sex, geographic origin and ethnic group reveals that these overall patterns were not homogenous: there are differences in initial comparative levels of $e_{15}$ and some important differences in trends as well, as shown over three calendar year groupings, 1990-1994, 1995-1999, 2000-2004 (table 4.4).

***Table 4.3 $e_{15}$ for FSU immigrants and non-FSU immigrants***

| | Males | | | | Females | | | |
|---|---|---|---|---|---|---|---|---|
| | 1990-1994 | 1995-1999 | 2000-2004 | Δ | 1990 - 1994 | 1995-1999 | 2000-2004 | Δ |
| **Other Israelis** | 61.0 (60.9-61.1) | 62.0 (61.9-62.1) | 63.1 (63.0-63.2) | 2.1 | 64.6 (64.5-64.7) | 65.8 (65.7-65.9) | 67.0 (66.9-67.1) | 2.4 |
| **All FSU Immigrants** | 60.7 (60.4-61.1) | 60.6 (60.3-60.8) | 60.8 (60.6-61.0) | 0.1 | 65.4 (65.1-65.7) | 66.1 (65.9-66.3) | 67.1 (67.0-67.3) | 1.8 |
| FSU Jews | 60.8 (60.4-61.1) | 60.8 (60.6-61.1) | 61.7 (61.4-61.9) | 0.9 | 65.2 (64.9-65.5) | 65.9 (65.7-66.1) | 67.1 (66.9-67.3) | 1.9 |
| FSU Non-Jews | | 58.9 (57.9-60.0) | 58.1 (57.4-58.8) | -0.8 | | 69.8 (68.9-70.8) | 69.0 (68.5-69.6) | -0.8 |
| FSU European Republics | 61.2 (60.8-61.6) | 61.3 (61.0-61.6) | 62.0 (61.7-62.3) | 0.8 | 65.4 (65.1-65.8) | 66.3 (66.1-66.6) | 67.4 (67.2-67.6) | 2.0 |
| Moscow-St Petersburg | 62.5 (61.4-63.6) | 62.2 (61.4-63.1) | 63.4 (62.6-64.1) | 0.9 | 67.1 (66.1-68.0) | 68.0 (67.3-68.6) | 69.5 (68.9-70.0) | 2.4 |
| FSU Caucasian and Central Asian Republics | 58.8 (58.0-59.7) | 58.9 (58.4-59.5) | 60.2 (59.7-60.7) | 1.4 | 64.1 (63.4-64.8) | 64.3 (63.9-64.8) | 65.9 (65.5-66.3) | 1.8 |

In general, the ranking of the sub-groups by level of $e_{15}$ corresponds to their ranking by educational qualifications (4.2.1 above). For both sexes immigrants originating in the more central areas of the FSU have higher levels of $e_{15}$ than those from the more peripheral areas. The pace of change differs among the subgroups as well, but it does not necessarily correspond to the degree of disadvantage. Among males, immigrants for Moscow-St. Petersburg had a slower rate of improvement in $e_{15}$ then Other Israelis, loosing an advantage of 1.5 years. Immigrants from the European Republics (excluding Moscow and St. Petersburg), who enjoyed near equivalence with Other Israelis in 1990-1995, experienced a growing disadvantage thereafter. Males from the Asia-Caucasus region, beginning with an initial disadvantage of 2.5 years, enjoyed the most rapid improvement while not loosing their disadvantage. Among females the advantage over Other Israelis was shared by all groups except immigrants from the Asia-Caucasus region. The aggregate trend, convergence with Other Israelis for females from an initial advantage, is not true of the sub-groups. Among female immigrants from the European Republics in general and Moscow-St. Petersburg in particular $e_{15}$ improved and their advantage was maintained. Those from the Asia-Caucasus region suffered a disadvantage, and slower improvement.

The non-Jewish group has the most distinct mortality pattern: they have the lowest life expectancy among males but one of the highest for females, resulting in a much larger female/male advantage: 10.9 years in 1995-2004, double the advantage for Jewish FSU immigrants from the European region. As the proportion of non-Jews in the FSU immigrant population rises over the course of the immigration wave, they contribute increasingly to the aggregate pattern for FSU immigrants, widening the gender gap in $e_{15}$ for all FSU immigrants. Unlike the other groups, among non-Jews levels of $e_{15}$

deteriorate over time both for males and females. Of the 2.3 year difference in $e_{15}$ between FSU immigrants and Other Israelis in 2000-2004, 0.9 years are due to higher male non-Jew mortality.

### 4.3.2 Decomposition of changes in $e_{15}$ of FSU immigrants and Other Israelis by sex, age and cause of death group 1990-1994 to 2000-2004

Just as overall trends in the gap in $e_{15}$ between Other Israelis and FSU immigrants differed by geographic and ethnic group they did so by age and cause of death group.

#### *4.3.2.1 Decomposition of contribution of age-groups to gaps in $e_{15}$ within periods, and to changes over calendar time*

For Other Israelis the increase in $e_{15}$ between 1990-1994 and 2000-2004 was 2.12 years for males and 2.40 for females (table 4.5, left panel). For both sexes virtually all the increase can be attributed to improvements in mortality above age 60, and approximately a year of the improvement is contributed by the 60-74 age range. By contrast, for male FSU immigrants $e_{15}$ remained stagnant because improvements in mortality above age 60, which contributed 0.8 years to $e_{15}$ (albeit less than for Other Israelis, 1.7 years), were counterbalanced by deterioration in mortality below age 60 (–0.7 years). For female FSU immigrants we find a contrasting pattern. There are mortality improvements in all age ranges, but below age 60 these gains contribute more to the gains in $e_{15}$ than those for Other Israelis. The lag in improvement for FSU females, as compared to Other Israelis (from an initial advantage), is due to slower improvement above age 60, and especially at age 75 and over.

***Table 4.4 Decomposition by age groups of change over time in $e_{15}$, and contribution within periods, FSU immigrants and Non-FSU Immigrants***

| Age | Years of expected life contributed by age to change in $e_{15}$ between 1990-94 and 2000-04 | | Composition by age of differences in $e_{15}$ between FSU immigrants and Other Israelis | | |
|---|---|---|---|---|---|
| | Other Israelis | FSU Immigrants | 1990-1994 | 1995-1999 | 2000-2004 |
| Males | | | | | |
| Total | **2.12** | **0.09** | **-0.27** | **-1.45** | **-2.31** |
| 15-34 | 0.04 | -0.53 | -0.27 | -0.45 | -0.84 |
| 35-59 | 0.42 | -0.18 | -0.48 | -0.96 | -1.09 |
| 60-74 | 0.98 | 0.64 | -0.06 | -0.20 | -0.39 |
| 75+ | 0.68 | 0.16 | 0.54 | 0.16 | 0.02 |
| Females | | | | | |
| Total | **2.40** | **1.78** | **0.76** | **0.32** | **0.14** |
| 15-34 | 0.05 | 0.07 | -0.09 | -0.01 | -0.07 |
| 35-59 | 0.42 | 0.50 | -0.25 | -0.18 | -0.18 |
| 60-74 | 1.02 | 0.87 | 0.20 | -0.01 | 0.04 |
| 75+ | 0.91 | 0.34 | 0.91 | 0.52 | 0.35 |

When the contribution by age to disparities in $e_{15}$ between Other Israelis and FSU immigrants are considered in each period separately (table 4.5, right panel), we again see differences and similarities between the sexes. For FSU males we see that all age groups contribute to the negative trend: below age 75 disadvantages progressively deepen, whereas above age 75 an initial advantage is eroded. In all periods age 35-59 contributes most to the disparity in $e_{15}$, in 1990-1994 almost half a year of the gap in $e_{15}$ is contributed by this age-group, but by 2000-2004 this has increased to over one year. For female

FSU immigrants, the advantage over Other Israelis in all periods was contributed wholly at elderly ages above 60, and in 1990-1994 nearly a year of $e_{15}$ difference is contributed at age 75+. However, the trend in relative mortality over calendar time in this age group is negative, and the initial advantage of 1.1 years in $e_{15}$ over other Israelis above age 60 diminishes to less than 0.4 years by 2000-2004. Below age 60, although female FSU immigrant's mortality improved more rapidly than Other Israelis, this was from an initial disadvantage which, despite convergence, was not eliminated.

The patterns of change over calendar time differ by age and by sex. Above age 60 for both sexes the calendar year trajectory of $e_{15}$ for FSU immigrants was positive, although slower than for Other Israelis. The slower improvement for females was due to a loss of an initial advantage above age 60, and for males it is due to a loss of an advantage above age 75. For both sexes at adult ages (below age 60) the trend begins from an initial disadvantage for FSU immigrants in 1990-1994, which for males deepens considerably while for females improves somewhat. FSU females experience greater improvements at these ages than Other Israelis. For FSU males at adult ages the path is slightly negative, contrasting with the improvements for Other Israelis. It remains to be seen which causes of death contributed to these patterns.

#### *4.3.2.2 Decomposition of differences in $e_{15}$ by cause of death group*

Figure 4.10 shows that for Other Israelis virtually all the improvement in $e_{15}$ for both sexes in the decade between 1990-1994 and 2000-2004 was due to improvement in cardiovascular (CVD) mortality above age 60, with minor contributions from "other neoplasms". For all age groups combined and for both sexes, 2.2 additional years of expected life were due to reduction in mortality from these groups alone. Counterbalancing this, -0.3 years of $e_{15}$ were lost for each sex by rising mortality from diabetes[7] (which is included in "all other causes" in the figure).

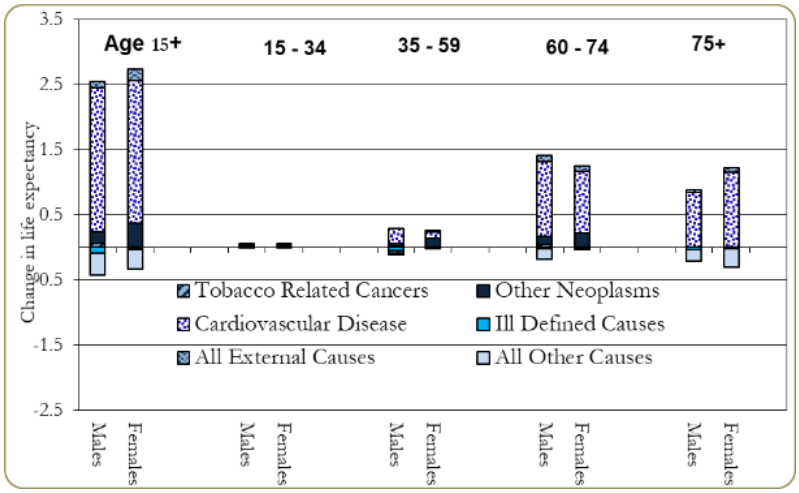



*Figure 4.10 Contribution of causes of death, by age, to change in e15 for Other Israelis between 1990-94 and 2000-04*

[7] The coding of diabetes as the underlying cause of death is variable because of inconsistency between doctors in filling out death certificates: this cause may be omitted altogether and/or there may be variation in its placing in the causal chain when entered together with CVD . An unknown portion of the improvement from CVD may be due to changing practices by doctors in attributing causes of death on death certificates. Stokes, A. and Preston, S. H. (2017). **Deaths Attributable to Diabetes in the United States: Comparison of Data Sources and Estimation Approaches**. PLoS One *12*, e0170219, doi: 10.1371/journal.pone.0170219..

Net differences between FSU immigrants and other Israelis in $e_{15}$ and the pace of improvement are due both to differences between the groups in the rate of positive gains from particular causes of death, as well as some reversals. Over the decade male FSU immigrants gained 1.6 years and females 1.9 years of $e_{15}$ due to reductions in mortality from CVD, 0.6 and 0.3 years less than the gains for Other Israelis, respectively (Figure 4.11). However, the lack of improvement overall in $e_{15}$ for males is not due only, or even primarily, to slower improvement from this cause. Rising mortality due to external causes of death below age 60 (-0.7 years), and all other causes above age 60 (-0.9 years), explain the increasing gap. -0.4 years of all other causes above age 60 is explained by diabetes and respiratory diseases, in equal measure. The slower rate of improvement for female FSU immigrants above age 60 is not due to the major cause of death groups, CVD or all neoplasms combined. These together contributed positively 2.3 years to improved $e_{15}$, only 0.2 years less than for Other Israelis. Improvement was curtailed by deterioration in mortality from all other causes (40% of which is due to diabetes and respiratory diseases), which reduced $e_{15}$ by -1.1 years, -0.8 of them above age 75.

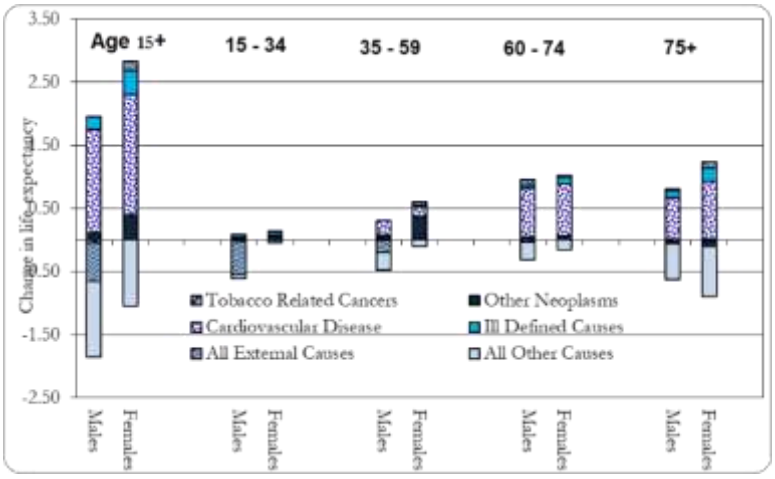



*Figure 4.11 Contribution of causes of death, by age, to change in e15 for FSU immigrants between 1990-94 and 2000-04*

**Ill-defined Causes.** For both males and females from the FSU attribution of change to specific causes of death is somewhat complicated by the reduction of death from the ill-defined causes group, which contributes 0.4 years of life expectancy for females and 0.2 for males, almost all in the elderly age range. As with immigrant groups in other countries (Albin et al. 2005; Bos et al. 2004), "Signs, Symptoms and Ill-defined conditions" as a cause of death is more prevalent among FSU immigrants than among Other Israelis, but its proportion diminishes over the years, as language skills, and familiarity and experience with the medical system reduce the proportion of incomplete medical records which would result in incomplete death certification. Better documentation is therefore a partial explanation of the increase in mortality in the all other causes group, but only to the upper limit of counterbalancing improvements in other causes, 0.4 years of life expectancy for females, and 0.2 for males, overall.

### 4.3.3 Decomposition of differences of calendar year differences in $e_{15}$ with Other Israelis, by age and cause of death group, by geographical origin and by ethnicity

Decomposition has shown that the deterioration in relative mortality and stagnation in calendar year trends in $e_{15}$ for males and the convergence for females is composed of differences both within the FSU population and between them and Other Israelis in the trends by age group, and in the contribution of changes in mortality by particular cause of death groups. Differences in levels and trends were found by geographic origin and ethnic group as well. We will now increase the resolution

of our analysis by decomposing the differences between the populations by age and cause of death group over calendar year periods for each of the geographic origin and ethnic groups. This allows examination of the extent to which the differences between these groups contributed to the overall calendar year patterns. Differences by ethnicity, Jewish and non-Jewish FSU immigrants, will be presented first of all, since these were the largest differences found so far. Comparison with Jewish Other Israelis (rather than all Other Israelis) specifically removes the possible influence of the distinct mortality patterns of Arab Israelis on the comparison (see section 2.4). This will be followed by consideration of the differences between the geographic regions.

#### *4.3.3.1 Decomposition by Ethnicity: Jewish FSU immigrants and Jewish Other Israelis (figures 4.12, 4.13)*

**Males**. At the outset of the immigration wave, in 1990-1994, Jewish FSU males had a small net disadvantage in $e_{15}$ of -0.4 years compared to Jewish Other Israelis. An advantage of 0.2 years for CVD and 0.6 years for all other causes, all of which was contributed above age 60 and especially above age 75, was counterbalanced by disadvantages at younger ages, of -0.6 years contributed by all neoplasm mortality (tobacco related and other neoplasms combined), chiefly at ages 35-74, -0.3 years by external causes of death (concentrated at ages 15-59), and -0.3 by ill-defined causes. This net imbalance of worsened over time. Over the next two periods the deterioration of comparative mortality was common to all age groups, reaching a net disadvantage of -1.9 years by 2000-2004. The initial advantage due to CVD became a disadvantage of -0.3 years by 2000-2004. Combined neoplasms contributed -0.9 years, and external causes -0.7 years to the deficit. Over 35% of the total net disadvantage in 2000-2004 was due to higher mortality from external causes, most of which was contributed at ages 15-34 alone (20% of the total disadvantage). A further 48% of the disadvantage was contributed by all neoplasms, 15% of this difference contributed at ages 35-59. Altogether 75% of the net disadvantage was contributed by adult mortality (<60), and over half of the disadvantage can be regarded as directly behaviour-related (included the tobacco-related respiratory cancers, external causes and alcohol-related causes which are included in "other diseases").

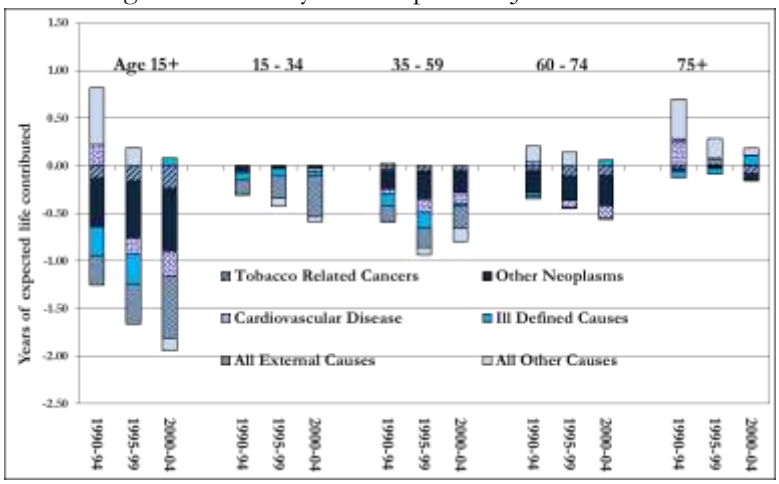



*Figure 4.12 Age and cause-specific contributions to differences in $e_{15}$ between Jewish FSU immigrants and Jewish Other Israelis; Males*

**Females**. Jewish FSU females enjoyed a net advantage of 0.4 years in $e_{15}$ in 1990-1994 over Jewish Other Israelis, which became a very small net disadvantage of -0.1 and -0.2 years in 1995-1999 and 2000-2004 respectively; but in all periods advantages from some causes of death were counterbalanced by disadvantages from others. Disadvantages due to other neoplasms contributed -0.6 to -0.7 years in each of the periods, whereas lower mortality for tobacco-related cancers provides FSU females with a small advantage of 0.1 years in each of the periods. The very small disadvantage due to external causes found in 1990-1994, -0.1 years, declined in the subsequent periods. In contrast with males, for females

directly behaviour-related causes are not prominent in explaining the overall difference. The loss of the slight advantage Jewish FSU females enjoyed initially is due to the decline in the combined advantage for CVD and other cause mortality (chiefly respiratory diseases) at ages 75 and over. As with their male counterparts, at ages 15-74 in all periods they are at a disadvantage compared to Jewish Other Israelis, but in their case this is due almost exclusively to a disadvantage from other neoplasms alone.

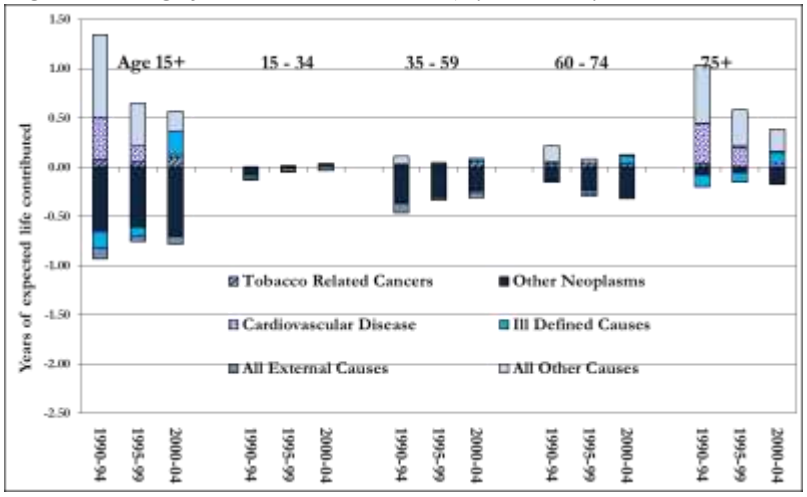



*Figure 4.13 Age and cause-specific contributions to differences in $e_{15}$ between Jewish FSU immigrants and Jewish Other Israelis; Females*

### *4.3.3.2 Decomposition by Ethnicity: Non-Jewish FSU immigrants and Jewish Other Israelis (figures 4.14, 4.15)*

Since the number of deaths in this sub-group in 1990-1994 were too small for decomposition by cause of death, examination is confined to the 1995-1999 and 2000-2004 periods.

**Males**. The large and deepening disadvantage in male non-Jewish $e_{15}$ compared to Jewish Other Israelis (-3.4 and -5.4 years in 1995-1999 and 2000-2004 respectively) was contributed mainly by the adult ages 15-59 (-2.8 and -4.0 years in each period respectively) and in common with the Jewish ethnic group, in particular by the 35-59 age group. All cause of death groups contributed to the disadvantage, with the exception of other causes of death (at the elderly ages 60-74 in 1995-1999 and at age 75 and over in both periods), most of which is explained by lower diabetes and respiratory disease mortality. As with Jews, directly behavioural-related causes play a prominent role, but with a larger impact. 38% of the disadvantage in $e_{15}$ is explained by external causes of death in both periods, contributing a substantial -1.3 years of the disadvantage in 1995-1999, and -2.1 years of the disadvantage in 2000-2004. Tobacco-related neoplasms contributed -0.5 and -0.6 years in each of the periods. CVD and other neoplasms together contributed -1.0 year to the disadvantage in 1995-1999, which increased to -1.7 years by 2000-2004. The role played by CVD contrasts with Jewish immigrants, where it was a very small contributor to net disadvantage. Ill-defined causes contribute a substantial -

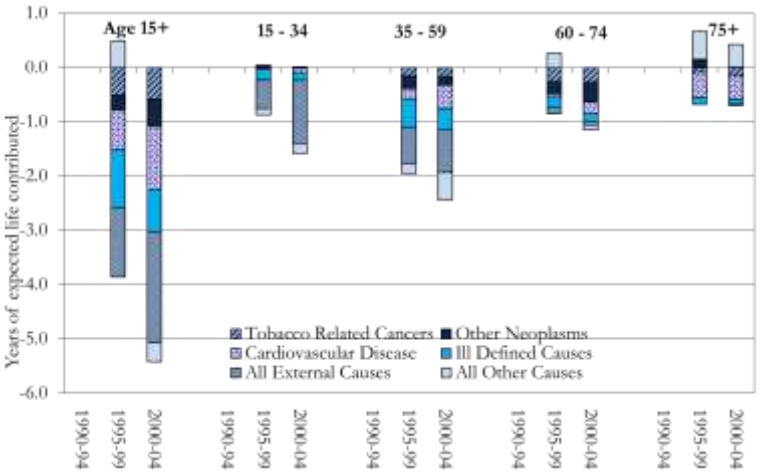



*Figure 4.14 Age and cause-specific contributions to differences in $e_{15}$ between non-Jewish immigrants and Jewish Other Israelis; Males*

1.1 years in 1995-1999, decreasing only slightly to -0.8 years in 2000-2004. This too contrasts with ethnic Jews, for whom ill-defined causes declined rapidly over the period of observation.

**Females**. Non-Jewish females shared the direction of trend over calendar time with Jews, as well as the concentration of advantage in the elderly age range, but there pattern of change by cause differed from Jewish immigrants.. The substantial advantage in $e_{15}$ of female non-Jewish migrants compared to Jewish Other Israelis decreased over time, from 3.8 years in 1995-1999, falling by more than 50% to 1.7 years in 2000-2004. However, all of the advantage is due to elderly mortality at age 60 and over, and especially age 75 and over. The later age group contributed 2.8 years to the gap in $e_{15}$ in 1995-1999, and 1.8 years in 2000-2004.

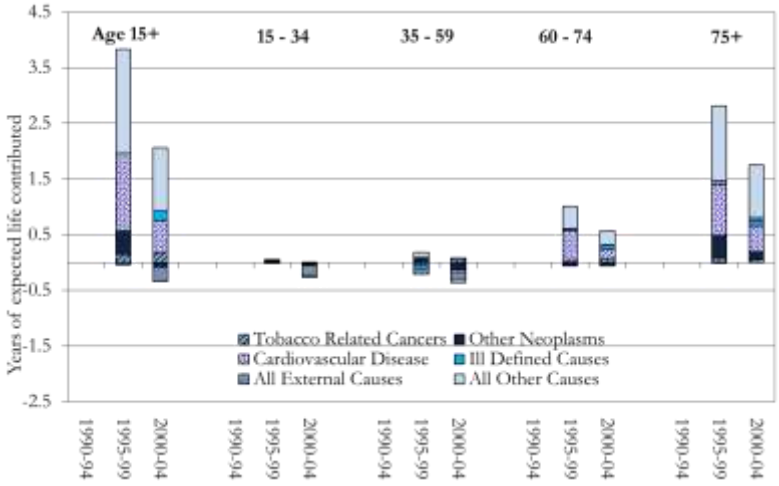



*Figure 4.15 Age and cause-specific contributions to differences in $e_{15}$ between non-Jewish immigrants and Jewish Other Israelis; Females*

This contrast with Jewish females where in 2000-2004 ages 60-75 contributed a disadvantage of -0.2 years, offset by an equal small advantage at age 75 and over. At adult ages, 15-59, initial parity with other Israelis deteriorated to a disadvantage of -0.6 years, whereas for Jewish females in this age range in 2000-2004 the disadvantage was -0.2 year only. The advantage in elderly mortality was due to CVD mortality ( a contribution of 1.4 years declining to 0.6 years) and all other causes (declining from 1.8 to 1.2 – due chiefly to diabetes and respiratory diseases), in both cases an advantage not shared by elderly Jewish females. At adult ages (15-59), half of the disadvantage which emerged by 2000-2004, -0.3 years, derived from external causes (not shared by Jewish females), and a further -0.2 years was due to other neoplasms (in this case Jewish females shared the same disadvantage). There is no gap in mortality due to ill-defined causes between female non-Jewish migrants and Jewish Other Israelis.

#### *4.3.3.3 Decomposition by Geographic region: Jewish Immigrants from Moscow-St. Petersburg compared to Jewish Other Israelis (fig 4.16 4.17)*

Distinct patterns are found for regions representing the center and periphery of the FSU. But since Jewish immigrants from the European region (excluding Moscow and St. Petersburg) constitute 67% of all Jewish FSU immigrants (and 50% of the FSU immigrant population in our study), it is not surprising that the pattern of advantages and disadvantages found for this region is very similar to that of Jewish FSU immigrants as a whole and requires little additional comment. For males the pattern of disadvantage is explained by the same relative combination of causes by age, although the trend of net disadvantage is somewhat milder -0.3 years in 1990-1994 increasing to -1.7 years in 2000-2004. For females as well the trend is similar to the pattern for all Jewish females. For females from the European region the initial net advantage in $e_{15}$ of 0.3 years in 1990-1994 was a little smaller, declining to -0.2 years in 2000-2004. They enjoyed a greater advantage in CVD and other cause mortality which declined from 1.2 to 0.3 years over the three periods.

Given that estimates of life expectancy at age 20 for Jews in Moscow in the early 1990s were some 2.8 years less, for both sexes, than that of Jews in Israel (Shkolnikov et al. 2004b), it is interesting to find clear evidence of positive health selection. Jewish males from this area enjoyed an advantage of 1.3 years in $e_{15}$ in 1990-1994 over Jewish Other Israelis. Lower CVD mortality contributes 0.8 years to the advantage, and 1.0 year is contributed by all other causes (0.7 years of which are due to lower mortality from diabetes and respiratory diseases). These were counterbalanced by higher mortality from tobacco-related cancers, external causes, and ill-defined causes( -0.5 years in all). Once again, the advantage in $e_{15}$ was entirely due to lower mortality at age 60 and over. It was lost in the subsequent periods, principally due to rising mortality from external causes of death and other neoplasms at adult ages 15-34 and 35-59, while above age 60 the advantage due to CVD mortality and all other causes diminished but was maintained (1.1 years in total).

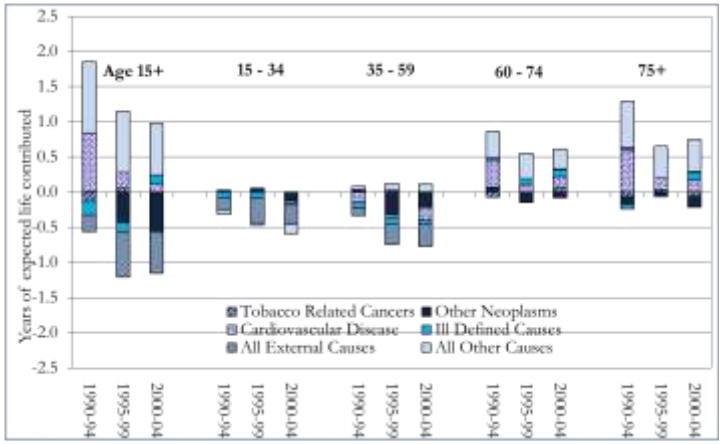



*Figure 4.16 Age and cause-specific contributions to differences in $e_{15}$ between immigrants from Moscow – St. Petersburg, and Jewish Other Israelis; Males*

Surprisingly, the initial disadvantage due to tobacco-related neoplasms disappeared in subsequent periods. Throughout the years, these immigrants suffered a very small but persistent disadvantage from CVD mortality at age 35-59 (-0.1 -0.2 years), which contrasts with the distinct advantage from this cause which they enjoyed at older ages.

Evidence of positive health selection is apparent for Jewish females from Moscow-St. Petersburg as well, and in their case it is not lost. They enjoyed a sustained advantage in $e_{15}$ over Jewish Other Israelis: 2.3, 1.9 and 2.1 years across the three periods. Although the advantage conferred by lower CVD mortality diminished from 1.6 years in the initial period to 0.8 in 2000-2004, this was offset by relative improvement in other neoplasm mortality, diminishing their disadvantage from -0.9 in 1990-1994 to -0.3 years by 2000-2004. All other causes conferred an advantage of 1.2 years by 2000-2004, 0.4 of which was due to lower mortality from respiratory diseases, and 0.2 was due to lower diabetes mortality. The advantages are concentrated at elderly ages, in the 60-74 and, especially, in the 75+ age groups. The disadvantage due to other neoplasms occurs between ages 35 and 74, but it was smaller than for the Jewish group as a whole, and diminished over time. This origin group is unique

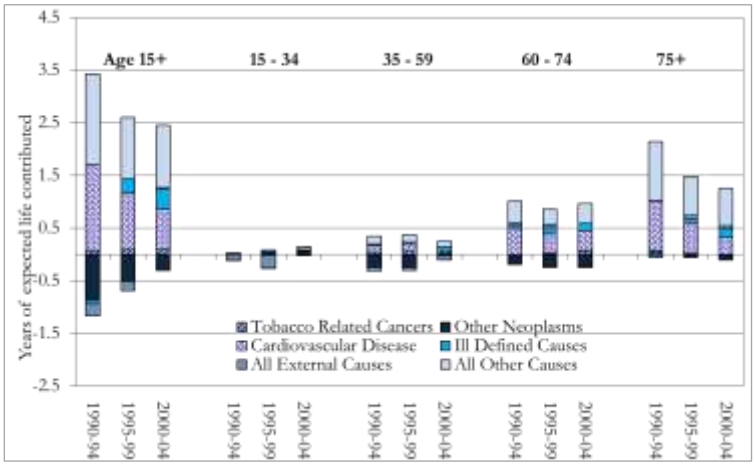



*Figure 4.17 Age and cause-specific contributions to differences in $e_{15}$ between immigrants from Moscow – St. Petersburg, and Jewish Other Israelis; Females*

since, in balance, at ages under 60 female mortality improved over calendar time, and although by 2000-2004 the improvement contributed only a small advantage (0.3 years) it contrasts sharply with the disadvantage contributed at these ages in all other geographic/ethnic groups.

#### 4.3.3.4 *Decomposition by Geographic region: Jewish Immigrants from the Asian-Caucasian region compared to Jewish Other Israelis (fig 4.18 4.19)*

Unlike the groups we have considered so far, both male and female Jewish immigrants from the Asian-Caucasian region of the FSU suffer persistent disadvantages with minimal compensation by lower causes of death for any cause at any age. Male $e_{15}$ is lower by -2.5, -3.4 and -3.3 in each of the periods, and female $e_{15}$ is lower by -0.7 -1.7 and -1.4 years in each period respectively. Unlike the other groups, rather than progressive deterioration, in both cases the middle period appears somewhat worse than the initial and final periods.

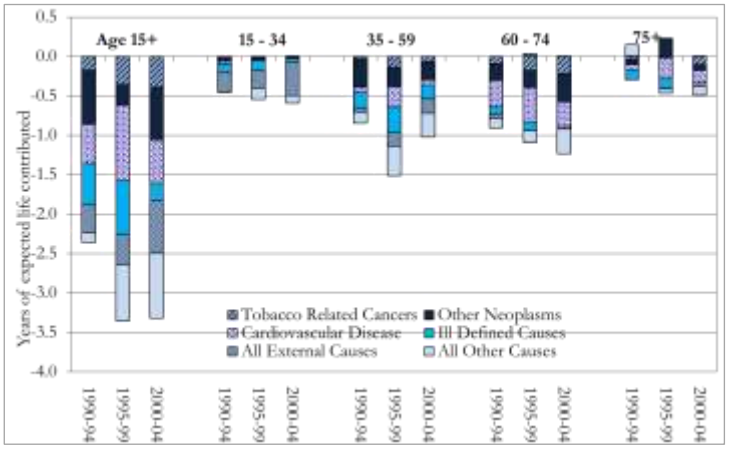



*Figure 4.18 Age and cause-specific contributions to differences in $e_{15}$ between immigrants from the Asian-Caucasian region and Jewish Other Israelis; Males*

Among males each of the cause of death groups contributed substantially to the net difference. In 1995-1999, the period in which the difference in $e_{15}$ was greatest, CVD contributed -1.0 years. -0.7 years each were contributed by other causes (of which causes related to alcohol and substance abuse and liver diseases[8] contribute -0.3 years), ill-defined causes, and all neoplasms (of which tobacco-related contributed -0.4). Although most of the disadvantage, -2.1 years, is contributed at adult ages 15-59, unlike the groups we have considered so far, a substantial disadvantage, -1.1 years, was contributed by the elderly age range, age 60-74, of which behavioural-related factors such as tobacco and alcohol-related causes contributed -0.3 years.

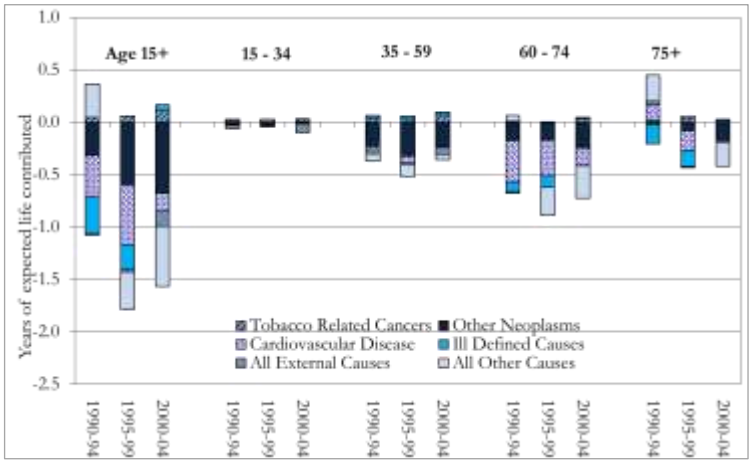



*Figure 4.19 Age and cause-specific contributions to differences in e15 between immigrants from the Asian-Caucasian region and Jewish Other Israelis; Females*

For females the disadvantage in e15 attributable to other neoplasms increases over the three periods, from -0.3 in the earliest period to -0.7 in 2000-2004, an increase due to elderly age groups. The overall disadvantage due to CVD increased from -0.4 to -0.6 then contracted back to –0.2, following an irregular pattern in

[8] Codes F10-F19 and K70-K76 in ICD10.

the various age groups. Other causes contributed -0.3 years in 2000-2004, of which half was contributed by higher mortality from diabetes. As with males, the disadvantages were not confined to the adult age groups: of the -1.7 years in the period of greatest disadvantage in e15, 1995-1999, -0.5 years were contributed at ages 15-59, and -1.2 at ages 60 and over.

### 4.3.4 Overview of calendar-year patterns

Sharply contrasting trends by gender appear prominently in the calendar year data. In 1991 $e_{15}$ for FSU males in Israel was equal to Other Israelis but thereafter a gap appeared, which only began to be closed in 2003. FSU females, on the other hand, had an advantage in 1991 which was lost by 1994, and thereafter their mortality improved in tandem with female Other Israelis. These annual trends are reflected in the decomposition by aggregated periods and age group. Males fell behind because a. in the elderly age range, from initial equality, improvement in mortality was slower than it was for Other Israelis and an initial advantage was lost; and b. in the adult age range an initial disadvantage was enhanced by a negative trend in death rates. Convergence of $e_{15}$ for FSU females with Other Israelis was achieved by countervailing trends: in the elderly age range they shared with males slower improvement than Other Israelis, but this was from a substantial initial advantage, especially above age 75 (falling from 0.8 years in 1990-1994 to 0.2 years in 2000-2004). In the adult age range, and unlike males, a positive trend offsets the negative trend at elderly ages. Initial disadvantages at adult ages diminished, from -0.5 years to -0.2 years, principally because adult females did not share adult males increasing burden of mortality from external causes.

Analysis by cause of death group shows, for males, that the increasing gap due to external causes mortality was due entirely to adult ages (-1.0 years), where it contributes 40 percent of the disadvantage in $e_{15}$ at all ages in 2000-2004. For females, the loss of advantages due to CVD and all other causes mortality (from 0.7 to 0.2 and 0.9 to 0.4 years, respectively), concentrated in the elderly age range, was the principal factor in the worsening trend. The substantial disadvantage from other neoplasm mortality remained unchanged, -0.7 years, but this was due to countervailing factors. At adult ages the deficit due to all neoplasm mortality was reduced, whereas at elderly ages it grew.

Disaggregation by ethnic and geographic and ethnic group revealed highly contrasting initial levels over calendar period in relative advantage by cause of death, but with a single exception (adult females from Moscow St. Petersburg) the overall direction of the trends by gender and age group are shared by all the sub-groups. Among males we see that although for all geographic-ethnic groups and for most age groups there was a pattern of worsening relative mortality over calendar time, initial positions ranged from an initial advantage in $e_{15}$ in 1990-1994 of 1.3 years enjoyed by Jewish FSU immigrants from Moscow and St. Petersburg, through equality in $e_{15}$ with Other Jewish Israelis for immigrants from the European region (without Moscow and St. Petersburg), a disadvantage of -2.4 years for Jewish males from the more peripheral Asian and Caucasian republics to a disadvantage of -3.4 years for non-Jewish immigrants (in 1995-1999) compared to Jewish Other Israelis. In all groups most of the increasing disadvantage in 2000-2004 was due to higher and rising relative mortality at adult ages (15-59), -1.3 of -1.5 years for the European region, and for non-Jews -4.0 out of -5.4 years. Even for immigrants from Moscow-St. Petersburg, who in 2000-2004 did not have a disadvantage in $e_{15}$ overall, rising disparities in mortality at adult ages contributed -1.3 years, although this was offset by lower mortality than Other Israelis at elderly ages. Unlike the other groups, for the Asian-Caucasian group the disadvantage in 2000-2004 was highest in the "younger" elderly age group (60-74), which contributed -1.2 years to the -3.3 disparity in $e_{15}$ with Other Israelis.

Females too shared the considerable difference in $e_{15}$ between the sub-groups in 1990-1994, ranging from a disadvantage -0.7 for the Asian-Caucasian Republics compared to Jewish Other Israelis, through a small advantage of 0.6 years for the large European Region, to a considerable advantage of 2.3 years for Moscow-St. Petersburg and an even larger advantage of 3.8 years for non-Jewish women (in 1995-1999). The order of advantage and disadvantage corresponds to the ordering of the groups by educational level. Bur for all female sub-groups, the 15-34 age group plays no part in differences in $e_{15}$ with Other Israelis, whereas for males this group contributes substantially due to differences in external cause mortality. Moreover, unlike males, the overall trends by calendar year were not shared by all female sub-groups. For female FSU immigrants from the European region there is a noticeable negative trend between 1990-1994 and 2000-2004, and for non-Jewish females between 1995-1999 and 2000-2004. For the Asian-Caucasian group disadvantage is lowest in 1990-1994 and peaks early, in 1995-1999. But for the Moscow-St Petersburg group no negative trend was evident. They retain an advantage in $e_{15}$ (of 2.3 to 2.1 years) throughout the period of observation, uniquely among the sub-groups and sexes.

The differing initial levels of relative mortality between the subgroups in both genders extend to specific causes of death. The Asian Caucasian group and non-Jewish males stand out negatively. For example: advantages in CVD mortality for males occurred only in the European regions and especially Moscow-Leningrad (0.8 years in 1990-1994, 0.1 in 2000-2004) and are confined to the elderly age range, whereas in the younger age ranges there is a persistent or increasing disadvantage for this cause group. For females, for most geographic areas and both ethnic groups an advantage in CVD mortality may occur in both age ranges, although it diminishes over time. However, the Asian and Caucasian republics are an exception for both sexes: disadvantages in CVD mortality occur in both age ranges. For females there is a positive trend, and the disadvantage diminishes over time, for males the disadvantage increases and then recovers, in a U-shaped pattern. In addition, for both the Asian-Caucasian group and non-Jewish males only there is a disadvantage owing to higher mortality from tobacco-related cancers, which increases over time. And although the pattern of diminishing advantages due to all other causes is shared by most geographic-ethnic groups and in particular at the elderly ages, again the Asian-Caucasian group is an exception, and their disadvantage increases.

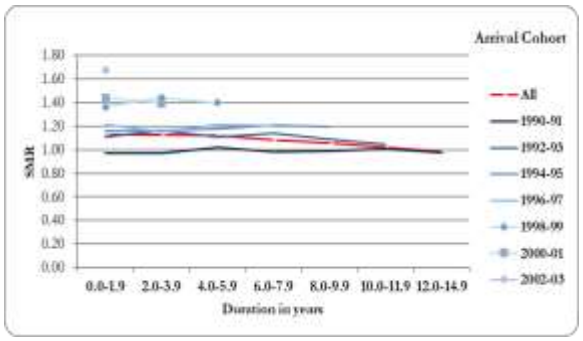
## 4.4 SMR **patterns** by duration, calendar year, arrival cohort, and by cause of death

The analysis of $e_{15}$ showed complex calendar year trends patterns by sex, by age by cause of death group and by geographic and ethnic sub-group. However, this analysis did not allow us to determine whether the patterns over calendar time reflect underlying duration effects, or whether they reflect the impact of the differences in composition between the arrival cohorts (which were described in section 4.2). To address these questions we will examine, first, SMRs by calendar year disaggregated by duration of stay, followed by SMRs by duration of stay, disaggregated by cohort of arrival, for each sex separately, and by cause of death group. The SMRs compare mortality of all FSU immigrants (irrespective of sub-group) with all Other Israelis. In addition, SMRs were examined separately for adults (age 15-59) and the elderly (age 60 and over). Only the most salient results will be presented here, graphically (complete results, including 95% confidence intervals which are not presented in the charts, can be found in Appendix Tables A3.5-A3.7).

### 4.4.1 Males, all causes of death

Figure 4.20a-b presents the trend of SMRs over duration of stay disaggregated by calendar year and by arrival cohort, for all causes of death, for FSU males aged 15+. All temporal variables are grouped by two-year intervals (except for the final calendar year and duration period which is up to three years long). Whereas life table analysis showed that relative to Other Israelis male FSU immigrant mortality worsened over calendar time, overall SMRs by duration (red line) decline from 1.13 (1.1-1.16) at 0.0-1.9 years of stay, to 0.98 (0.95-1.02) at 12.0-14.9 years of stay, appearing to indicate gradual assimilation of FSU mortality risks to Other Israeli mortality levels. When this duration pattern is broken down by arrival cohort and by calendar year the contrast between the calendar year and the duration pattern can be explained. Figure 4.20a shows that each successive cohort arrives with initially higher SMRs, and these are maintained as length of stay in Israel increases, with little alteration. Whereas the earliest arrival cohort (1990-1991) retains SMRs around 1.0 throughout the period of observation ( indicating no difference with Other Israeli mortality) the latest cohort (2002-2003) begins with a much higher risk 1.68 (1.44-1.93). These cohort patterns combine so that in every calendar year SMRs appear to fall by duration of stay, but at increasing initial levels, as shown in figure 4.20b. The aggregate pattern of decline in SMRs with duration of stay is revealed as an artefact produced by increasing and stable risk in successive arrival cohorts. And the pattern of decline over calendar years is produced by successive additions of arrival cohorts with higher risk levels.

a. Arrival Cohort




b. Calendar Year

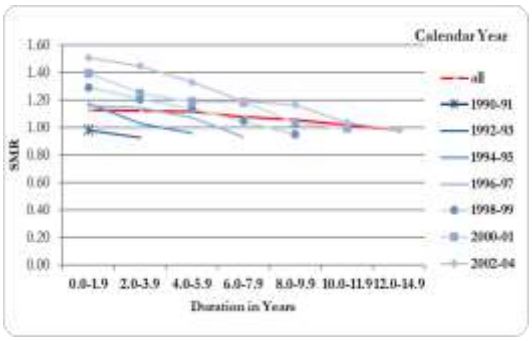
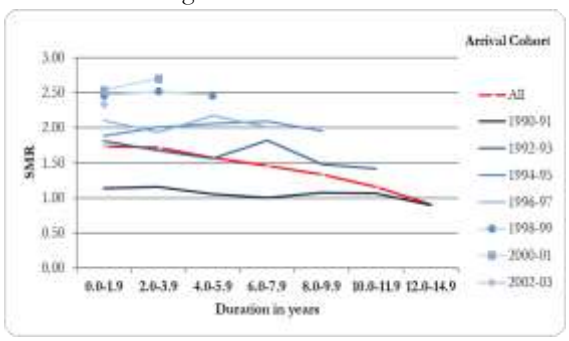



***Figure 4.20 SMRs for All Causes of death by duration of residence; Male FSU Immigrants aged 15+***

When duration by arrival cohort is further broken down by age group (figures 4.21a-b) we find that in the elderly age range the cohort distinctions are much less evident, but remain very prominent at adult ages. In the elderly age range both the 1990-1991 and the 1992-1993 cohort have SMRs near or equal to 1.00 at all durations; the 1994-1995 and 1996-1997 cohorts have slightly rising SMRS with duration (with values significantly different from 1.0 statistically for the earlier but not the later cohort); the 1999-1999, and 2000-2001 cohorts having SMRs of approximately 1.1, and only the latest cohort (2002-2003) has a significantly elevated SMR (1.47 (1.22-1.75)). At adult ages the rising disparities between the successive arrival cohorts is pronounced. Whereas the 1990-1991 cohort maintains SMRs near 1.00 over all durations, the 1998-1999, 2000-2001 and 2002-2003 cohorts reach SMRs of 2.3 to 2.5. The 1994-1995 and 1996-1997 cohorts maintain SMRs near 2.00, while, uniquely, the 1992-1993 cohort appears to display a downwards trend in relative mortality risk by duration, beginning with an SMR of 1.81 (1.59-2.04) at 0-1.9 years of stay, and reaching 1.42 (1.21-1.66) after 10.0-11.9 years of stay.

a. Under age 60




b. Age 60 and over

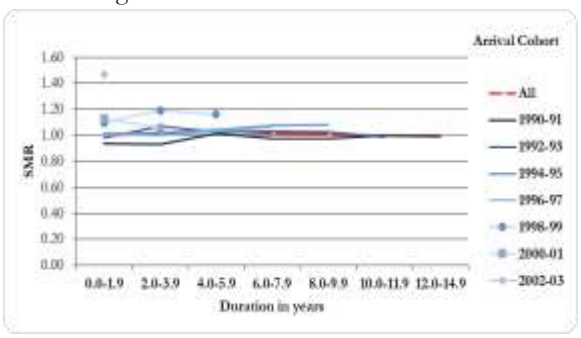


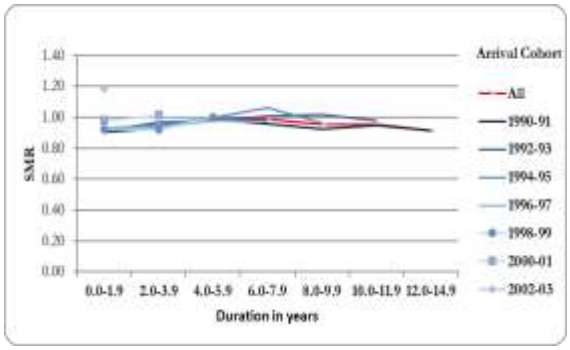

***Figure 4.21 SMRs for All Causes of death by arrival cohort and duration of residence; Male FSU Immigrants aged 15+***

Thus the pattern in all-cause SMRs at all ages for males appears to be driven principally by large arrival cohort differences in the adult age group, with relative mortality worsening progressively in later arrival cohorts. It should be noted that this effect is strong enough to affect all ages combined, although among male FSU migrants only approximately 20% of deaths at age 15 and over occur before age 60. At elderly ages, although there is a slight deterioration over arrival cohorts, with the exception of the latest arriving cohorts, mortality risk remains nearly equivalent to Other Israelis. In neither age range is a true duration effect evident, whether positive of negative.

### 4.4.2 Females, all causes of death

Figures 4.22a-b compare all-cause SMR duration patterns for females at age 15+ by calendar year and arrival cohort. Life table analysis showed that an initial advantage in $e_{15}$ was gradually lost, and subsequently FSU females' mortality improved in tandem with Other Israeli mortality. Analysis of SMRs by duration shows a somewhat different pattern, which is shared whether broken down by arrival cohort or by calendar year. The same overall pattern by duration of stay is shown both by arrival cohorts and calendar years, with only minor exceptions. An initial small advantage in SMR at 0.0.-1.9 years of residence, (0.92 (0.90-0.94)), erodes to equivalence of risk with Other Israelis at 4.0-5.9 years (0.99 (0.96-1.01), but by 12-14.9 years the advantage is regained (0.91 0.88-0.95). Only the cohorts which arrived earliest reach the longest durations, so the regained advantage is due to them only, but the pattern of erosion of an initial advantage is shared by all arrival cohorts.

a. Arrival Cohort




b. Calendar Year

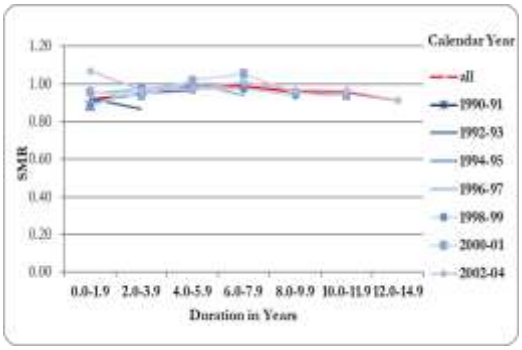
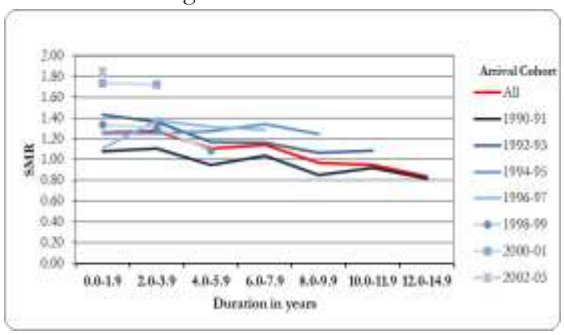


***Figure 4.22 SMRs for all causes of death by duration of residence; Female FSU Immigrants aged 15+***

When the duration pattern by arrival cohort is broken down by age group (figures 4.23a-b), the pattern of risk for the elderly ages (60 and over) is virtually identical with the 15+ pattern, whereas at adult ages (15-59) distinct differences between the arrival cohorts emerge, along with a positive trend over duration for some cohorts. In the younger group, as with males, SMRs tend to rise across

a. Under age 60




b. Age 60 and over

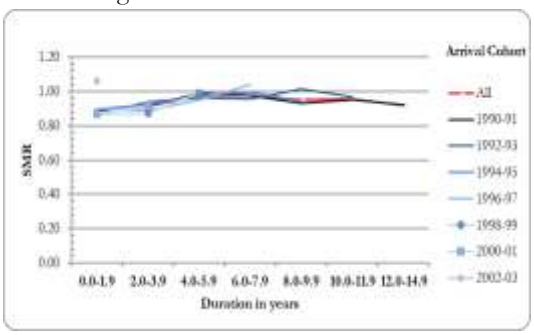



***Figure 4.23 SMRs for all causes of death by arrival cohort and duration of residence; Female FSU Immigrants aged 15+***

successive cohorts, although the sequence of increasing relative risk is not as consistent as it is with males, nor is the rise as extreme. For the earliest arrival cohort relative mortality risk is initially statistically indistinguishable from other Israelis, 1.08 (0.96-1.21), whereas females who arrived in 2002-2003 have an SMR nearly twice as high 1.84 (1.30-2.54). But unlike males, at adult ages female arrival cohorts vary in the trend of SMRs as well as in levels of relative risk. SMRs for the earliest arrival cohorts (1990-1991 and 1992-1993) decline over time. Although for the earliest cohort at shorter durations SMRs are not significantly different from 1.0, by the longest duration (12.0-14.9 years) they decline to 0.84 (0.73-0.96) and have achieved a distinct mortality advantage over Other Israelis. SMRs for the 1992-1993 cohort at adult ages decline from 1.43 (1.21-1.68) at the shortest duration to 1.09 (0.85-1.36) at 10.0-11.9 years. Later arrival cohorts, however, maintain near constant SMRs at adult ages, with higher risk of death compared to other Israelis.

Thus females share with males distinct arrival cohort patterns at the adult ages, reflecting ever higher mortality risk as the migration wave progresses; and at elderly ages, like males, there are virtually no cohort differences in risk. Unlike males, at the adult ages the earliest female arrival cohorts show a pattern of declining mortality risk with increasing duration of residence whereas at elderly ages there appears to be a mild pattern of increasing and then decreasing relative mortality. In aggregate (ages 15 and over) the cohort differences at the adult ages are not evident, because of the relatively small proportion of deaths below age 60: only 9.6% of deaths of FSU females at age 15 and over are before age 60.

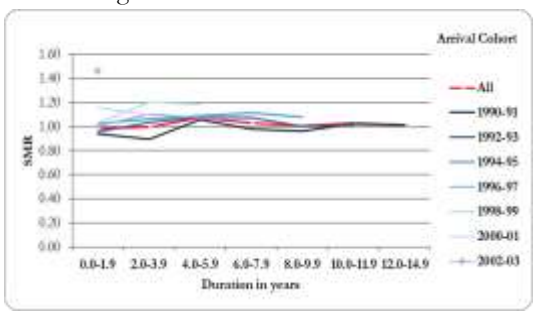
### 4.4.3 SMRs for detailed causes of death, by duration and arrival cohort

Life table decomposition showed that all-cause mortality levels and trends by calendar year are influenced by countervailing advantages and disadvantages by cause of death group and age. We will now disaggregate the overall patterns of relative risk by duration and arrival cohort by cause of death group, to attempt to see whether the all-cause temporal trends are shared by all cause groups, or whether specific causes dominate in creating the trends.

### 4.4.3.1 Males CVD (figure 4.24a-b)

Cardiovascular mortality constitutes nearly a third of all male deaths, but the well-defined arrival cohort pattern which we saw for all causes is not apparent for CVD. Overall SMRs rise slightly from 0.98 (0.94-1.03) at 0.0-1.9 years to 1.08 (1.03-1.12) at 4.0-5.9 years, falling back to 1.01 (0.94-1.09) at 12.0-14.9 years. This pattern of moderate rise and fall is shared by all arrival cohorts. The earliest cohorts have CVD risks equivalent to Other Israelis, and the SMRs rise very slightly over subsequent arrival cohorts. Only the latest cohorts have higher risks (which are statistically significant only for the 2002-2003 arrival cohort (1.46 1.06-1.97)).

a. Age 15+




b. Under age 60

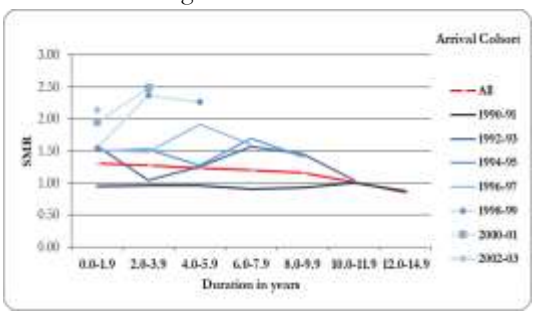


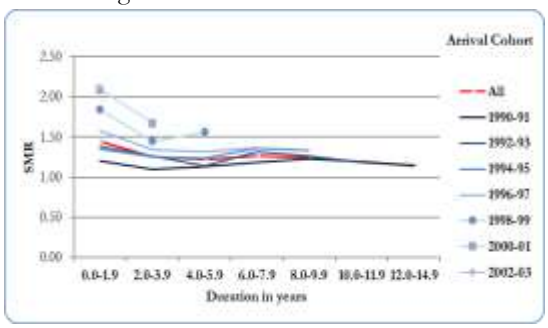

*Figure 4.24 Male FSU Immigrants, SMRs for CVD by arrival cohort and duration of residence.*

The cohort pattern for ages 15+ is displayed by elderly ages as well (See Appendix table A3.7a). However, at adult ages (Figure 4.24b) successive arrival cohorts show progressively worse SMRs: the 1990-1991 cohort maintains SMRs near 1.0 at all durations, but by the 2000-2001 arrival cohort SMR reaches 1.95 (1.26-2.67) in the first two years of residence. The pattern of increasing risk over arrival cohorts at adult ages creates an apparent overall decline of mortality risk by duration. But since the proportion of CVD deaths at adult ages is only 11% of all CVD deaths, the pattern at ages 15 and over appears to be free of arrival cohort effects.

### 4.4.3.2 Males all neoplasms (figure 4.25a-b)

At ages 15+ SMRs for all neoplasm mortality display both increasing relative risk by arrival cohort, as well as a distinct duration trend. Relative risk of neoplasm mortality for FSU immigrants is higher than Other Israelis' at all durations and for all arrival cohorts, unlike the near equivalence in the case of CVD mortality. All-cohort SMRs fall with duration from 1.45 (1.39-1.52) at 0.0-1.9 years of residence to 1.15 (1.07-1.24) at 12.0 -14.9 years. But the decline is not linear: it is sharpest over the first two intervals (down to 1.25 (1.20-1.32) at 2.0-3.9 years), falling moderately afterwards. This pattern of highly elevated relative risk at arrival is common to all but the earliest (1990-1991) arrival cohort (which maintains SMRs of around 1.20-1.10 at all durations). Initial risk rises with arrival cohort, reaching 2.11 (1.63-2.71) in the latest arrival cohort. Likewise, the slope of the fall over the initial two periods of duration increases over successive cohorts. The pattern points to an increase over time of the proportion of FSU immigrants arriving with advanced cancers.

a. Age 15+




b. Under age 60

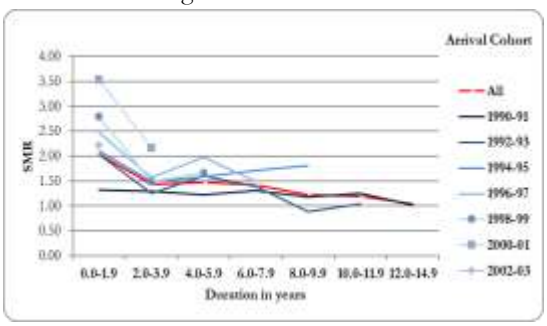


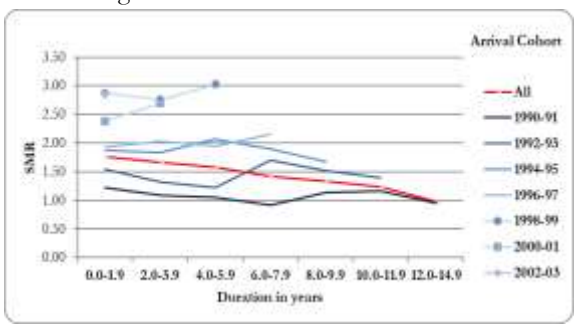

***Figure 4.25 Male FSU Immigrants aged 15+ SMRs for all neoplasms by arrival cohort and duration of residence.***

This pattern is shared by both the adult and the elderly populations, but in the former it is more pronounced. At adult ages (figure 3.21b) SMRs in the initial period rise from 1.32 (1.09-1.58) for the earliest cohort to 3.54 (2.73-4.52) for the 2000-2001 cohort, and risk falls very sharply in the early years of residence in cohorts arriving from 1992-1993 onwards. At elderly ages (Appendix Table A3.7) risk in the initial duration period rises from 1.18 (1.07-1.29) in the 1990-1991 cohort to 2.09 (1.54-2.76) in the 2002-2003 cohort, but the pattern of elevated risk at arrival with subsequent decline is evident only from the 1998-1999 arrival cohort, and the decline in risk itself is more moderate than at adult ages.

#### *4.4.3.3 Males all external causes (figure 4.26a-b)*

For external causes of death at age 15+ we find, as in all-cause mortality, an illusory substantial fall in relative risk over duration of residence for all cohorts (from SMRs of 1.76 (1.63-1.89) at arrival to 0.98 (0.82-1.15) after 12.0-14.9 years) which is created by rising relative risk over successive arrival cohorts. SMRs at arrival rise from 1.23 (1.06-1.41) in the 1990-1991 arrival cohort more than doubling to 2.85 (1.91-4.10) in the 2002-2003 arrival cohort. For all arrival cohorts SMRs fluctuate over duration around their initial levels, without a firm common pattern.

a. Age 15+




b. Under age 60

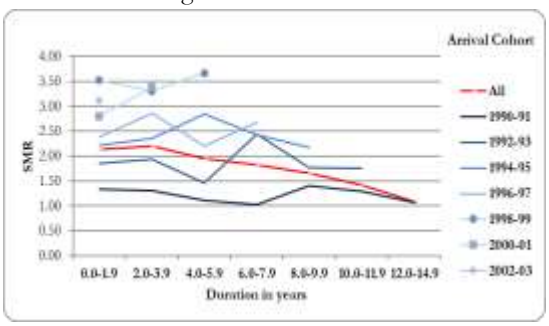



***Figure 4.26 Male FSU Immigrants, SMRs for all external causes by arrival cohort and duration of residence.***

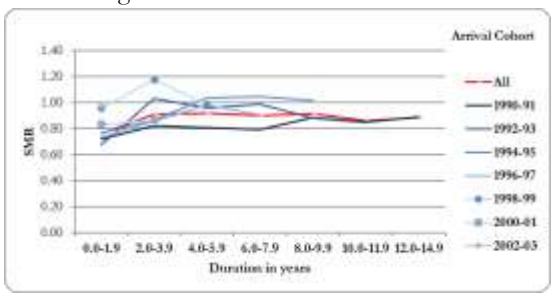
The findings for ages 15+ are determined by the adult age group (15-59). Deaths from this cause-group constitute 30 percent of all deaths at adult ages, and contribute nearly 74% of deaths from external causes at all ages. Moreover, relative risk is high in this age-group at all durations even for the 1990-1991 arrival cohort (fluctuating between 1.03 0.82-1.28 to 1.40 1.16-1.68), but it rises over successive cohorts, reaching extreme levels of 3.67 (2.94-4.53) for the 1998-1999 cohort at 4.0-5.9 years of residence. (Figure 4.26b)

At elderly ages the number of deaths from external causes is relatively small, and thus individual SMRs cross-classified by duration of residence and arrival cohort tend not to be significantly different from 1.0 at the 95% confidence level. There do not appear to be systematic cohort differences at these ages, or substantially elevated risk (Appendix Table A3.7).

#### *4.4.3.4 Males All Other Causes[9] (figure 4.27a-b)*

The pattern of change over duration in this broad and heterogenous cause of death group is unusual in several respects: SMRs for age 15+ rise with duration from an initial advantage over Other Israelis, both for all arrival cohorts combined and for most individual arrival cohorts. Differences among the cohorts are not large, and the pattern of steadily rising relative risk over arrival cohorts is only clearly apparent as duration increases. Since over 85% of deaths in this group are due to the elderly age group, it is not surprising that the pattern for all ages and for elderly ages is very similar. However, although overall numbers of deaths at adult ages are small, the pattern is quite different: there is a substantial rise in risk over arrival cohorts, with the 1990-1991 cohort following a distinct pattern. For this cohort SMRs decline from statistical equivalence to Other Israelis (from 0.86 (0.65-1.13) to 0.67 (0.50-0.88)) while later cohorts have significantly elevated risk – the 1998-1999 cohort having an SMR in the first two years as high as 2.05 (1.46-2.79), with no pattern of decline over duration of residence. Once again, at adult ages we find that the aggregate pattern for all cohorts combined results in an apparent decline in risk by duration of residence, a pattern which is not evident in the individual arrival cohorts themselves (Figure 4.27b).

a. Age 15+




b. Under age 60

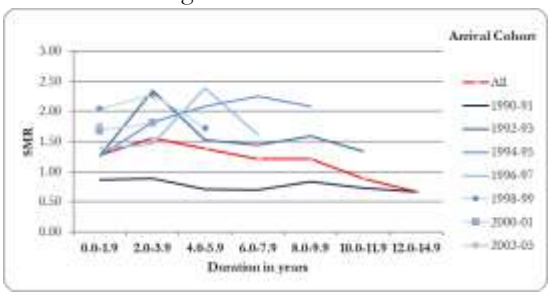



***Figure 4.27 Male FSU Immigrants, SMRs for all other causes by arrival cohort and duration of residence.***

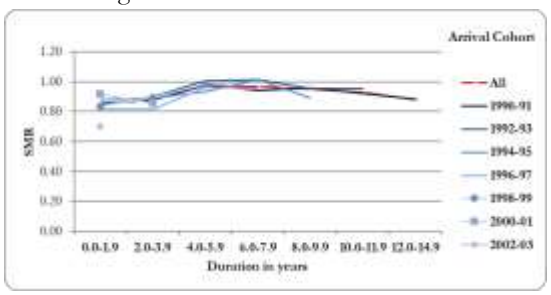
Some cautions are appropriate for the findings for this group. This is a heterogeneous group of causes. Informal examination shows that in the younger group alcohol-related causes feature prominently whereas respiratory diseases and diabetes are more evident in the older group, making the comparison between the age groups problematic. Moreover, the sharp decline with duration of residence of deaths coded as ill-defined, which is shared by all arrival cohorts, may contribute to the apparent rise in SMR with increasing duration of residence for this diverse group (Appendix Tables A3.6-A3.7). In order to test this an simulation was done, reassigning all ill-defined causes to the residual all other causes group and recalculating SMRs by duration and arrival cohort for this extreme case. The simulation shows that for the 1990-91 and 1992-93 arrival cohorts there was a possible decline of SMRs for all other causes over duration of residence, but not for later ones.

[9] In this group we are excluding the three previous groups and in addition infectious diseases and ill-defined causes: groups1-26, 32-38, 49, 51-55 in Appendix Table A2.1

### 4.4.3.5 Females CVD (figure 4.28a-b)

The pattern for female FSU cardiovascular disease mortality at ages 15+ (Fig. 4.28a) corresponds to the pattern for all-cause mortality, differing only in the greater advantage enjoyed at shortest durations.

a. Age 15+




Age 60 and over

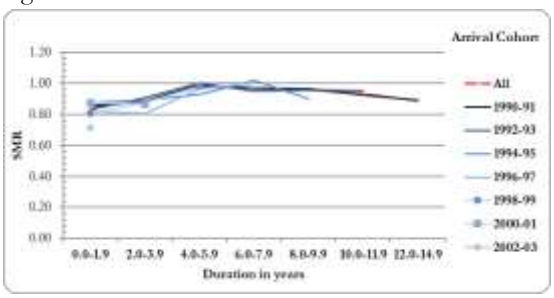


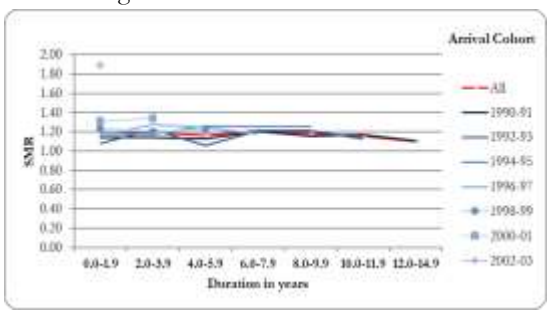

*Figure 4.28 Female FSU Immigrants, SMRs for CVD by arrival cohort and duration of residence.*

At 0.0-1.9 years of residence SMR is 0.85 (0.82-0.89) for all arrival cohorts combined, and there are no significant differences between the arrival cohorts. This initial advantage is lost over the subsequent 6-7 years, and regained subsequently for the cohorts arriving earliest. At elderly ages (Fig. 4.28b) the pattern is similar. Since there are only 394 CVD deaths at adult ages, it is not possible to discern a firm pattern by duration and cohort (Appendix Table A3.6). And while for all arrival cohorts combined it appears that relative risk of CVD mortality declines with duration at these ages compared to Other Israelis, SMRs at most durations are not significantly different from 1.0.

### 4.4.3.6 Females Neoplasms (figure 4.29a-b)

For neoplasm mortality of females of all ages we do not find the pattern that was found for males: there is no elevated initial relative risk followed by rapid decline (Fig. 4.29a). For all cohorts there is no pattern of change with increasing duration of residence. On the contrary, although relative risk is higher than for Other Israelis, SMRs of all arrival cohorts converge to a common pattern and remain around 1.20, with only the latest arrival cohorts, 2000-2001 and 2002-2003 displaying increased relative risk. At adult ages initial relative mortality rises over arrival cohorts, and relative risk declines with duration for all cohorts combined. This pattern is shared by the earliest cohorts, and perhaps for later cohorts as well, though in their case small numbers of deaths limit the statistical significance (Fig. 4.29b). At elderly ages the pattern appears to be of slightly increasing risk with duration of residence with SMRs rising from around 1.10 to 1.20. Thus the pattern of stability at all ages is a result of countervailing trends at the younger and older ages. The 2002-2003 arrival cohort is an outlier at elderly ages with an SMR of 1.58 (1.14-2.15) at arrival (Appendix Table A3.7b).

a. Age 15+




b. Under age 60

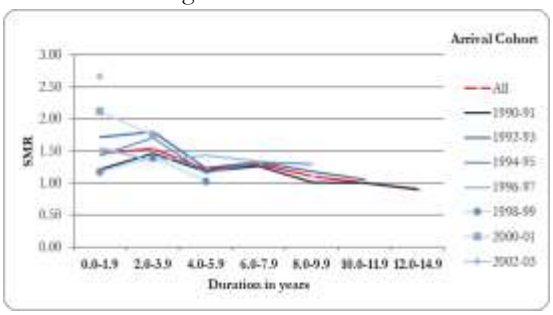
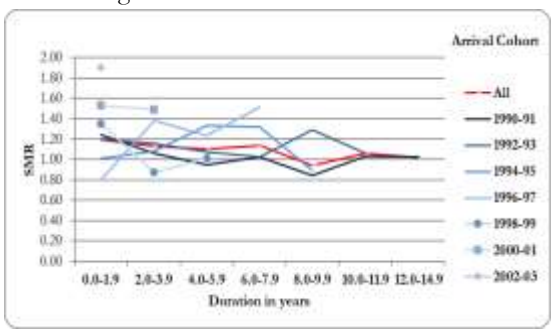



***Figure 4.29 Female FSU Immigrants, SMRs for all neoplasms by arrival cohort and duration of residence.***

### *4.4.3.7 Females External causes (figure 4.30a-b)*

Relative risk for female FSU mortality from external causes at age 15+ is elevated initially but declines with duration to equivalence with Other Israelis, from 1.19 (1.06-1.33) at 0.0-1.9 years to 1.02 (0.82-1.25) at 12.0-14.9 years of residence (Fig. 3.32a). Graphical analysis does not show a definite arrival cohort pattern over duration of residence. Relative risk declines with duration for the 1990-91, and 1992-93 arrival cohorts, but the pattern is not clear for later arrival cohorts.

a. Age 15+




b. Under age 60

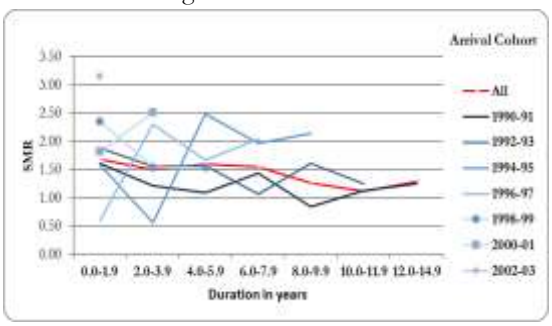



***Figure 4.30 Female FSU Immigrants, SMRs for all external causes by arrival cohort and duration of residence***

At elderly ages for all arrival cohorts, both combined and individually, SMRs do not show any difference in relative risk to Other Israelis (Appendix Table 3.7b) At adult ages for all cohorts combined relative risk declines with increasing duration, from very high initial levels 1.68 (1.40-2.00) to high but diminished levels at 12.0-14.9 years of residence - 1.29 (0.87-1.84). Although the earlier arrival cohorts appear to share the decline with duration, the duration pattern for later cohorts is not clear (Fig. 4.30b).

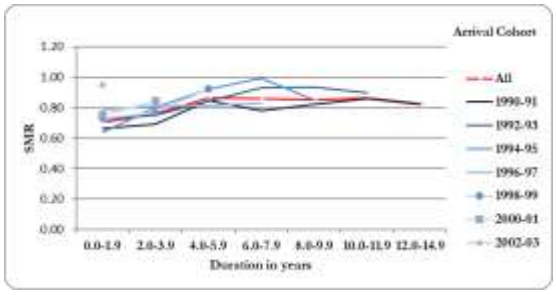
### *4.4.3.8 Females All Other causes (figure 4.31a-b)*

The pattern for all other causes for females corresponds to that found for males. At age 15+, for all cohorts combined and for each separately, relative risk rises over duration of residence from a substantial initial relative advantage near 0.7 ( 0.71 0.67-0.74), over the first 4.0-5.9 years, thereafter maintaining a stable relative advantage between 0.8 and 0.9.

The pattern in the elderly age group is very similar (Appendix Table 3.7b), but at adult ages (which account for less than 5% of deaths in this group) there is an apparent pattern of decline with duration derived from rising risk over arrival cohorts, although the numbers of deaths are too small to give statistical significance to this pattern (Fig 3.32b). As we observed for males (*3.6.3.4*), it is possible that

the patterns are affected by coding: the sharp decline with increasing duration of residence in deaths coded as ill-defined may increase deaths in the other causes category. The simulation reassigning ill-defined deaths into the all-other causes categories (section 4.4.3.4) does not reverse the findings reported above.

a. Age 15+




b. Under age 60

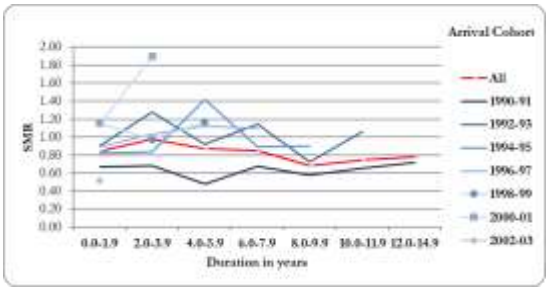



***Figure 4.31 Female FSU Immigrants, SMRs for All Other causes by arrival cohort and duration of residence.***

### 4.4.4 Overview of SMRs by duration and arrival cohort

Analysis of SMRs by gender, age group and cause of death group has found strong arrival cohort patterns for FSU migrants which vary by gender and age group, and much weaker duration of residence patterns, which also differ by gender and age group. The differences between successive arrival cohorts often create "apparent" overall duration of residence trends, which are not found in the individual cohorts themselves. By and large, arrival cohort differences are stronger for the adult (>60) age group than for the elderly age group (60+), and in fact for elderly females they do not appear to be present. Universally, the 1990-91 arrival cohort as a whole has significantly lower SMRs, in both sexes, for all cause groups, though for females in the elderly age range this is not the case. Equally, at adult ages SMRs were substantially higher than those at elderly ages for both genders and for all cause of death groups, with the exception of ill-defined causes.

For FSU adults, both male and female, we find SMRs for all causes combined increasing over successive arrival cohorts, with the rise much greater for males. When viewed in aggregate, the increase in SMRs over successive cohorts creates an apparent decline in all-cohort SMRs by duration of residence. The 1990-1991 cohort displays SMRs near 1.0 or below for all causes and for the major cause of death groups, (except for external causes). For the latest arrival cohorts, SMRs for some cause groups reach relative risk levels two or three times that of Other Israelis. For all causes we observe after 12 years of residence for the 1990-1991 arrival cohort a moderate decline in SMR over duration to relative risks lower than those of Other Israelis. The only other duration trends evident in this age group for individual cohorts is a sharp fall in neoplasm SMRs soon after arrival, a pattern which is not present in the earliest cohort but increases in later cohorts and is greater for males. For all other cause groups there are no apparent duration trends, with fluctuations in SMRs around the values at arrival.

At elderly ages (60+) SMRs show that relative mortality risks for FSU immigrants were similar or lower than Other Israelis for CVD in both genders and for females in the external causes and the all other causes group, and for males they were higher for neoplasms, external causes, and the ill-defined causes group. Arrival-cohort differences for females are not substantial in this age group; while they can be

detected for males, they are much weaker than at adult ages. They are prominent only for post 1998 cohorts in the all neoplasm and external causes group. For females the duration pattern displayed for all causes and for CVD is a shallow inverted U-shaped rise in SMRs from levels around 0.90 to approximately 1.0 over 6-7 years of duration with a subsequent fall. The all neoplasm group shares the rise, but from an elevated risk of around 1.1 and without the subsequent fall. Both males and females share the rise in SMRs for the all other causes group over the first 6-7 years from very low levels of risk (around 0.7) to higher but still lower risk than Other Israelis, of around 0.8-0.9. This cause of death group is dominated by respiratory disease and diabetes mortality.

## 4.5 Multivariate Analysis

Diverse calendar year effects, cohort effects and duration of residence effects by gender, age group, and cause of death group have been presented. It is clear that the temporal effects may be interacting and obscuring trends, and that these might differ by age group. Multivariate analysis will attempt to weigh their relative impact and determine which of the temporal dimensions, or which combinations of them, best describe the changes in SMR for each gender, for each cause of death group, and and whether there is an interaction with age group. It has been shown that changes in relative mortality differ by geographic and ethnic origin, and the models will control for these differences as well as for educational level, a factor which was considered so far, and which might modify geographic and ethnic origin effects. The models are designed to find the most parsimonious explanation for changes in SMRs over time, controlling for age, education, ethnic group, region of origin and interactions of these characteristics with the temporal variables.

The strategy for identifying the best Poisson regression model has three steps: to test reduction of deviance for nested models; to compare models by the AIC criterion when they are not nested; and finally, to assess models with similar AIC values by comparing their relative likelihood (section 2.6.5). Models were constructed with both discrete and continuous specifications of calendar year and duration of stay (seven levels) to examine non-linearity. Since the AIC criterion penalises a model with a higher number of parameters, the discrete specifications of the temporal variables were calculated with seven levels in each of the dimensions so as not to affect model choice. Continuous models of calendar year and duration of stay were calculated as well, to facilitate interpretation of the results. Nevertheless, even though the continuous models have fewer parameters, none of the best fitting models with continuous specifications proved superior in fit to the best models with discrete specifications. Moreover, in almost all cases both specifications pointed to the same model as being the best fit. Hence the analysis of fit and the findings will refer to the discrete specifications.

### 4.5.1 Choosing the best fitting model

Tables 4.6 and 4.7 show the results of test of fit of the 22 models (listed in Table 3.5) for each cause of death group and for each sex. The results for both sexes, for all causes, and for each cause of death group show that the addition of effects by age group and by each of the background variables are significant, usually highly so, with the sole exception being in the ill-defined causes group for females, where no significant differences are found between the ethnic groups.

***Table 4.5 Males – Deviance of discrete Models, significance of deviance difference with nested model. Best fitting model printed in blue***

| Model Number | DF difference with nested model | All Causes | CVD | All Neoplasms | External Causes | All Other Causes | Ill-defined Causes |
|---|---|---|---|---|---|---|---|
| 0 | | 55959 | 26836 | 25382 | 17190 | 23755 | 15494 |
| 1 | 14 | 54741 *** | 26719 *** | 25239 *** | 16819 *** | 23497 *** | 15286 *** |
| 2 | 1 | 53628 *** | 26469 *** | 25076 *** | 16693 *** | 23031 *** | 15151 *** |
| 3 | 1 | 53386 *** | 26431 *** | 25073 * | 16488 *** | 23019 *** | 15043 *** |
| 4 | 4 | 53290 *** | 26389 *** | 25065 * | 16474 ** | 22937 *** | 15005 *** |
| 5 | 6 | 53280 * | 26371 ** | 25037 *** | 16428 *** | 22901 *** | 14884 *** |
| 6 | 6 | 53188 *** | 26343 *** | 25038 *** | 16452 *** | 22867 *** | 14852 *** |
| 7 | 6 | 53033 *** | 26372 ** | 24942 *** | 16297 *** | 22853 *** | 14943 *** |
| 8 | 6 | 53016 *** | 26332 *** | 24937 *** | 16326 *** | 22843 *** | 14776 *** |
| 9 | 6 | 53021 * | 26345 *** | 24922 ** | 16290 | 22801 *** | 14849 *** |
| 10 | 6 | 53007 *** | 26338 | 24936 *** | 16284 *** | 22796 *** | 14752 *** |
| 11 | 5 | 53002 ** | 26317 ** | 24924 * | 16317 * | 22840 | 14757 ** |
| 12 | 5 | 52832 *** | 26312 *** | 24887 *** | 16310 ** | 22787 *** | 14771 |
| 13 | 6 | 52995 *** | 26324 | 24931 | 16308 ** | 22835 | 14768 |
| 14 | 6 | 52992 *** | 26321 * | 24932 | 16298 *** | 22837 | 14738 *** |
| 15 | 5 | 52682 *** | 26293 *** | 24890 *** | 16270 *** | 22696 *** | 14824 *** |
| 16 | 5 | 52837 *** | 26325 *** | **24873 *** ** | 16274 ** | 22745 *** | 14844 |
| 17 | 6 | 53011 * | 26342 | 24914 | 16280 * | 22798 | 14835 ** |
| 18 | 6 | 53001 ** | 26335 * | 24918 | 16269 *** | 22796 | 14813 *** |
| 19 | 5 | **52669 *** ** | **26287 *** ** | 24903 *** | **16263 *** ** | **22692 *** ** | **14728 *** ** |
| 20 | 5 | 52993 ** | 26323 ** | 24922 ** | 16275 * | 22793 | 14734 ** |
| 21 | 6 | 52997 * | 26335 | 24928 | 16274 * | 22793 | 14737 ** |
| 22 | 6 | 52985 *** | 26330 | 24932 | 16266 ** | 22786 * | 14742 * |

*** p<0.001, ** 0.001<p<0.01, * 0.01<p<0.05

For males the results of model selection are remarkably alike: model 19 is the best model by the AIC criterion for all cause of death groups except for all neoplasms, for which model 16 is favoured. Measures of relative likelihood based on AIC do not show that any other model provides a fit with a close level of probability. Model 19 indicates that arrival cohort effects and calendar year effects contribute to SMR for males across all groups of causes of death, with the cohort effects modified above age 60. Model 16 shares arrival cohort effects but omits calendar year effects, and points to the presence of duration effects which are modified in the elderly age group (above age 60).

For females there is no uniform best fitting model, nor are temporal effects always present in the best model for every cause of death group. Four of the best fitting models for females include duration of stay effects. For the all external causes group the best fitting model (model 3) does not include any of the temporal variables nor geographic origin. The all other causes group is the only one for which arrival cohort effects are present in the best model. Model 12 is the best fit for both the all neoplasms and CVD groups (calendar year effects and duration effects which are modified above age 60). And, although model 16 is the best fit by the AIC criterion for all causes (arrival cohort and duration effects,

*Table 4.6 Females – Deviance of discrete Models, significance of deviance difference with nested model. Best fitting model printed in blue*

| Model Number | DF difference with nested model | All Causes | CVD | All Neoplasms | External Causes | All Other Causes | Ill-defined Causes |
|---|---|---|---|---|---|---|---|
| 0 | | 47511 | 25425 | 26896 | 9246 | 24094 | 10200 |
| 1 | 14 | 47341 *** | 25402 * | 26849 *** | 9163 *** | 24068 *** | 10147 *** |
| 2 | 1 | 46404 *** | 24910 *** | 26841 ** | 9147 *** | 23571 ** | 10001 *** |
| 3 | 1 | 46341 *** | 24896 *** | 26793 *** | **9141 ***** | 23547 *** | 10001 |
| 4 | 4 | 46182 *** | 24830 *** | 26784 * | 9135 ** | 23426 *** | 9959 *** |
| 5 | 6 | 46129 *** | 24771 *** | 26777 | 9131 | 23345 *** | 9845 *** |
| 6 | 6 | 46090 *** | 24768 *** | 26763 *** | 9129 | 23309 *** | 9704 *** |
| 7 | 6 | 46144 *** | 24826 | 26742 *** | 9123 * | 23392 *** | 9951 |
| 8 | 6 | 46068 *** | 24749 *** | 26732 *** | 9123 | 23297 *** | **9681 ***** |
| 9 | 6 | 46066 *** | 24762 *** | 26735 | 9120 | 23281 *** | 9817 *** |
| 10 | 6 | 46071 ** | 24759 | 26732 *** | 9116 * | 23280 *** | 9684 ** |
| 11 | 5 | 46057 * | 24745 | 26712 *** | 9115 | 23290 | 9671 * |
| 12 | 5 | **45966 ***** | **24735 ** ** | **26665 ***** | 9117 | 23279 ** | 9677 |
| 13 | 6 | 46055 * | 24741 | 26729 | 9113 * | 23289 | 9675 |
| 14 | 6 | 46064 | 24740 | 26730 | 9117 | 23287 * | 9675 |
| 15 | 5 | 45977 *** | 24749 ** | 26699 *** | 9106 ** | 23248 *** | 9814 |
| 16 | 5 | 45965 *** | 24749 ** | 26668 *** | 9115 | 23263 ** | 9814 |
| 17 | 6 | 46062 | 24754 | 26733 | 9106 * | 23276 | 9814 |
| 18 | 6 | 46062 | 24753 * | 26733 | 9114 | 23272 | 9811 |
| 19 | 5 | 45983 *** | 24745 ** | 26696 *** | 9102 ** | **23248 ***** | 9682 |
| 20 | 5 | 46060 * | 24755 | 26711 *** | 9109 | 23273 | 9675 * |
| 21 | 6 | 46067 | 24750 | 26730 | 9102 * | 23275 | 9681 |
| 22 | 6 | 46057 * | 24750 | 26729 | 9106 | 23272 | 9679 |

*** p<0.001, ** 0.001<p<0.01, * 0.01<p<0.05

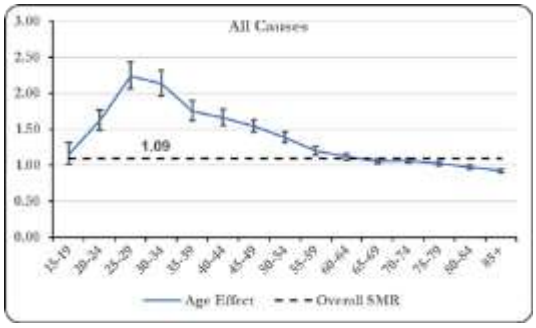
modified above age 60), model 12 with a very similar AIC value (43642 as compared to 43646) has a 62% relative probability of being a better fit. Thus for all causes either a calendar year or an arrival cohort interpretation is justified statistically. Since model 12 is the best fit when the temporal variables are given the alternative continuous specification, model 12 was preferred for all causes as well. The best fit for all other causes by the AIC criterion is model 15 (which along with duration of stay includes arrival cohort effects which are modified in the elderly age group). However, model 19 has a 71% probability of being a better fit and is the best fit when temporal variables are specified continuously. Thus model 19 was chosen for this group (excluding duration of stay effects and choosing arrival cohort effect with modification in the elderly age group, together with calendar year effects). For ill-defined causes model 8 has the best fit (arrival cohort and duration effects without any interactions).

For both sexes, models with interactions of the temporal variables with ethnic origin never provide the best fit. Whereas for males these interaction terms are significant compared to the nested model for all causes and for some of the cause groups, for females they are weakly significant only for external causes in interaction with arrival cohort. Hence ethnic group does not appear to be a strong modifier of temporal variables. On the other hand, as we shall see, its own strength as a socio-demographic modifier is reduced when temporal variables are controlled for.

### 4.5.2 Age effects on SMR

Although expected deaths by age is the offset for the Poisson regression, age is a significant variable in most of the models, indicating that the ratio of FSU immigrant deaths to All Other Israeli deaths is not constant by age. This is especially true for males: for all causes combined and for each cause of death group. For females the effects are more moderate. Figure 4.32 shows the age effect on the

Males




Females

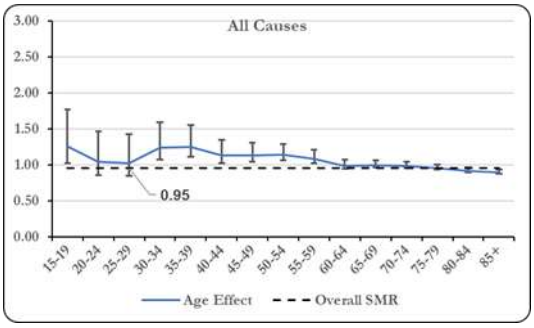



***Figure 4.32 SMR 1990-2004 and differential age effects for all causes of death, both sexes***

SMR for 1990-2004 for all causes for both sexes. In both cases we see that the rate ratios are elevated at adult ages, below age 60, which supports our decision to use age 60 as the cut off point for interactions with our temporal variables. The pattern for males is more extreme, with rate ratios reaching 2.23 (2.06-2.43) at age 25-29, whereas the peak for females is at age 35-39 and is much lower, 1.25 (1.11-1.41). Moreover, for both sexes at elderly ages SMR is near to 1.0 and even significantly lower than 1.0 at the very oldest age groups. This contrast is evident by cause of death group as well (see Appendix Figures A3.1ab) For males the pattern of elevated rate ratios at adult ages is repeated for all the cause of death groups, although for all neoplasms the age range of elevated ratios is narrower (ages 45-69) and all but the very oldest ages share rate ratios near or above the overall SMR of 1.27(1.24-1.29). For females significantly-elevated rate ratios at adult ages are evident only for the all external causes of death group.

### 4.5.3 SMR for 1990-2004 and the effects of background variables

Tables 4.8-4.9 present the SMR for the total period of observation in aggregate (the null model) as well as the odds ratios for the demographic and education background variables as estimated together in Model 4; the odds ratios for each variable is net of the effects of the other background variables. Over the period of observation, without controls for the background variables, FSU males have somewhat higher relative mortality than Other Israelis for all causes, and considerably highermortality for all neoplasms and especially for external causes. This is counterbalanced by the CVD group for which there is no significant difference with Other Israelis, and the all other causes group for which SMR is significantly lower. FSU females have significantly lower relative mortality than Other Israelis for all causes, and for the CVD and all other causes groups. This is counterbalanced by higher mortality for all neoplasms and external causes, as for males, but with much lower SMRs. For ill defined causes SMRs are higher for males and lower for females.

There is a considerable gradient in relative mortality risk by educational level. It is similar for both sexes for all causes, and for most cause of death groups, except all neoplasms (for females the educational gradient is very small, while large for males) and all external causes (for which, again, the educational gradient is larger for males).

***Table 4.7 Males -SMR 1990-2004 and socio-demographic background variables (Null model and Model 4)***

| Background variables | All Causes | CVD | All Neoplasms | All External Causes | All Other Causes | Ill-defined Causes |
|---|---|---|---|---|---|---|
| **SMR – Null Model** | 1.09 *** (1.08 -1.10) | 1.02 (1.00-1.04) | 1.27 *** (1.24-1.29) | 1.50 *** (1.45-1.55) | 0.88 *** (0.86-0.90) | 1.13 *** (1.09-1.18) |
| **Model 4** | | | | | | |
| **Age group[a]** | | | | | | |
| **Years of education** | | | | | | |
| 0-8 | 1.52 *** (1.48-1.56) | 1.40 *** (1.34-1.47) | 1.35 *** (1.28-1.42) | 1.66 *** (1.48-1.86) | 1.78 *** (1.68-1.89) | 1.79 *** (1.61-1.98) |
| 9-12 | 1.34 *** (1.31-1.38) | 1.27 *** (1.21-1.33) | 1.23 *** (1.18-1.29) | 1.54 *** (1.42-1.67) | 1.50 *** (1.42-1.59) | 1.42 *** (1.29-1.55) |
| 13+ | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| **Ethnic Origin** | | | | | | |
| Non-Jews | 1.36 *** (1.31-1.41) | 1.28 *** (1.19-1.38) | 0.92 (0.99-1.16) | 1.86 *** (1.71-2.02) | 1.18 *** (1.08-1.29) | 1.85 *** (1.66-2.06) |
| Jews | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| **Geographic Origin** | | | | | | |
| Moscow St. Petersburg | 0.95 * (0.92-0.99) | 0.95 (0.89-1.01) | 0.92 * (0.86-0.98) | 1.11 (0.97-1.26) | 0.89 ** (0.82-0.97) | 1.15 * (1.00-1.32) |
| Russia and Baltic States | 0.99 (0.97-1.02) | 0.97 (0.93-1.03) | 0.95 (0.90-1.00) | 1.17 *** (1.07-1.28) | 0.97 (0.91-1.03) | 1.09 (0.98-1.21) |
| Asian and Caucasian Republics | 1.13 *** (1.10-1.16) | 1.15 *** (1.10-1.21) | 0.99 (0.94-1.04) | 1.02 (0.93-1.12) | 1.26 *** (1.19-1.34) | 1.37 *** (1.24-1.51) |
| USSR unspecified | 0.91 (0.82-1.00) | 0.93 (0.78-1.11) | 0.95 (0.79-1.14) | 0.89 (0.66-1.19) | 0.82 (0.65-1.04) | 0.98 (0.69-1.38) |
| Ukraine, Belarus, Moldova | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |

*** p<0.001, ** 0.001<p<0.01, * 0.01<p<0.05

a. age was included in the models in 17 five year age groups. To save space coefficients are not displayed in the table. The pattern is similar to that of the model with age only (Appendix Figure A3.1a)

The odds ratios for ethnic origin reveal substantial differences between the sexes: for all causes for males there is a considerable disadvantage in relative mortality for non-Jews (1.36 (1.31-1.41)), whereas for females non-Jewish ethnicity confers an advantage (0.83 (0.79-0.87)). The differences between the sexes extend to cause of death groups as well. The disadvantage for non-Jewish males is consistent across all cause of death groups except all neoplasms, for which there is no ethnic group effect, but it is especially large for all

external causes and ill-defined causes of death where it reaches odds ratio values near 1.9. For females non-Jewish ethnicity conveys an advantage near 0.8 for all cause groups except for all external causes, for which there is a disadvantage, and for ill-defined causes, where there is no effect.

The odds ratios for geographic origin are compared to the largest group, Ukraine, Belarus and Moldova. The direction and relative magnitude of the area of origin effects are similar for both sexes. For all causes of death, origin in the cultural and administrative centers, Moscow and St. Petersburg, conveys an advantage of 0.95 (0.92-0.99) for males, and somewhat larger and more significant for females 0.87 (0.84-0.90). Origin in the peripheral Asian and Caucasian republics conveys an equivalent disadvantage for both sexes with an elevated odds ratio of around 1.10. When the individual cause of death groups are examined, the advantage of origin in Moscow and St. Petersburg (and the weaker significance for males) is maintained for each of the groups, with the exception of ill-defined causes where the sexes diverge, with origin in the cultural and administrative center conveying a disadvantage for males, and a somewhat larger advantage for females than for the other groups. The disadvantage for origin in Asia and the Caucasus is maintained as well, reaching especially high levels for all other causes (1.26). Differences between the reference origin and Russia and the Baltics states is small (for females) or not significant (males), except for external causes for males where it is 1.17 (1.07-1.26). Notably, among females none of the geographic origin coefficients are significant for the external causes of death group.

***Table 4.8 Females -SMR 1990-2004 and socio-demographic background variables (Null model and Model 4)***

| Background variables | All Causes | CVD | All Neoplasms | External Causes | All Other Causes | Ill-defined Causes |
|---|---|---|---|---|---|---|
| **SMR – Null Model** | 0.95 *** (0.95-0.96) | 0.92 *** (0.90-0.93) | 1.18 *** (1.16-1.20) | 1.10 *** (1.05-1.16) | 0.82 *** (0.80-0.83) | 0.89 *** (0.85-0.94) |
| **Model 4** | | | | | | |
| **Age group[a]** | | | | | | |
| **Years of education** | | | | | | |
| 0-8 | 1.45 *** (1.41-1.49) | 1.59 *** (1.52-1.66) | 1.06 * (1.01-1.12) | 1.31 *** (1.13-1.52) | 1.72 *** (1.63-1.81) | 1.87 *** (1.66-2.11) |
| 9-12 | 1.20 *** (1.17-1.23) | 1.32 *** (1.26-1.38) | 1.02 (0.97-1.06) | 1.22 ** (1.07-1.38) | 1.34 *** (1.27-1.42) | 1.25 *** (1.11-1.41) |
| 13+ | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| **Ethnic Origin** | | | | | | |
| Non-Jews | 0.83 *** (0.79-0.87) | 0.84 *** (0.77-0.92) | 0.77 *** (0.71-0.83) | 1.23 * (1.04-1.45) | 0.78 *** (0.71-0.86) | 1.00 (0.82-1.21) |
| Jews | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| **Geographic Origin** | | | | | | |
| Moscow St. Petersburg | 0.87 *** (0.84-0.90) | 0.87 *** (0.82-0.92) | 0.93 * (0.88-0.99) | 0.92 (0.77-1.11) | 0.85 *** (0.79-0.91) | 0.73 *** (0.62-0.87) |
| Russia and Baltic States | 0.94 *** (0.92-0.97) | 0.92 ** (0.88-0.97) | 0.94 * (0.90-0.99) | 1.10 (0.96-1.26) | 0.95 (0.90-1.00) | 0.92 (0.81-1.05) |
| Asian and Caucasian Republics | 1.10 *** (1.07-1.13) | 1.11 *** (1.06-1.16) | 0.97 (0.92-1.02) | 0.98 (0.85-1.13) | 1.26 *** (1.19-1.32) | 1.16 *** (1.13-1.41) |
| Unknown | 1.02 (0.93-1.12) | 1.00 (0.86-1.17) | 1.07 (0.91-1.26) | 1.35 (0.92-1.99) | 0.99 (0.82-1.20) | 0.73 (0.45-1.19) |
| Ukraine, Belarus, Moldova | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |

*** p<0.001, ** 0.001<p<0.01, * 0.01<p<0.05

a. age was included in the models in 17 five year age groups. To save space coefficients are not displayed in the table. The pattern is similar to that of the model with age only (Appendix Figure A3.1a)

Since we have already seen (Section 4.2) that composition of the FSU cohort by these socio-demographic variables alters by duration, arrival cohort and calendar year, controlling for them is necessary for estimating

the impact of the temporal effects. We will also examine whether controlling for temporal effects changes the relative impact on mortality of these variables themselves.

### 4.5.4 Males – Arrival cohort, calendar year and duration effects (Table 4.9)

The best fitting models for males, overall and for all cause of death groups include arrival cohort effects but generally exclude duration effects. For all but one cause group Model 19 provides the best fit, in which the cohort effects are modified at elderly ages and are combined with calendar year effects. For the exception, the all neoplasms group, arrival cohort effects (at all ages) are present together with duration effects, which are modified above age 60. The pattern of arrival cohort effects is depicted in figure 4.33 below.

At adult ages for all causes, CVD, and external causes, relative risk rises over successive arrival cohorts, (and for all neoplasms at all ages), resulting in post-1998-99 cohorts having an estimated relative risk twice that of the 1990-91 cohort. For the all other and ill-defined causes groups the change in relative risk at adult ages is better described as a sharp elevation in risk between all later arriving cohorts and the 1990-91 cohort.

***Table 4.9 Males: best- fitting models by cause of death group***

| | **All causes** | **CVD** | **All External causes** | **All Other causes** | **Ill-defined causes** | **All neoplasms** |
|---|---|---|---|---|---|---|
| **Best Model** | **19** | **19** | **19** | **19** | **19** | **16** |
| **Age group**[a] | | | | | | |
| **Education (years)** | | | | | | |
| 0-8 | 1.52 *** (1.48-1.56) | 1.42 *** (1.35-1.48) | 1.73 *** (1.55-1.94) | 1.80 *** (1.70-1.91) | 1.72 *** (1.55-1.91) | 1.37 *** (1.30-1.44) |
| 9-12 | 1.32 *** (1.29-1.35) | 1.26 *** (1.21-1.32) | 1.48 *** (1.36-1.61) | 1.48 *** (1.40-1.57) | 1.37 *** (1.25-1.50) | 1.23 *** (1.17-1.29) |
| 13+ | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| **Ethnic Origin** | | | | | | |
| Non-Jews | 1.17 *** (1.12-1.22) | 1.18 *** (1.09-1.28) | 1.46 *** (1.33-1.60) | 1.05 (0.95-1.16) | 1.64 *** (1.46-1.06) | 0.94 (0.87-1.02) |
| Jews | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| **Geographic Origin** | | | | | | |
| Moscow St. Petersburg | 0.97 (0.94-1.01) | 0.96 (0.89-1.01) | 1.21** (1.07-1.38) | 0.91 * (0.84-0.99) | 1.15 (1.00-1.32) | 0.93 (087-1.00) |
| Russia and Baltic States | 0.97 * (0.94-1.00) | 0.96 (0.90-1.02) | 1.11 * (1.02-1.22) | 0.95 (0.89-1.01) | 1.04 (0.94-1.16) | 0.92 * (0.87-0.97) |
| Asian and Caucasian Republics | 1.12 *** (1.09-1.15) | 1.14 *** (1.09-1.20) | 1.02 (0.92-1.12) | 1.24 *** (1.17-1.32) | 1.32 *** (1.20-1.46) | 0.98 (0.93-1.04) |
| Unknown | 0.90 (0.81-0.99) | 0.93 (0.78-1.11) | 0.90 (0.67-1.22) | 0.80 (0.63-1.01) | 0.87 (0.61-1.23) | 0.96 (0.82-1.00) |
| Ukraine, Belarus, Moldova | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| **Arrival Cohort** | | | | | | |
| 1990-91 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1992-93 | 1.41 *** (1.32-1.51) | 1.28 *** (1.10-1.50) | 1.42 *** (1.25-1.61) | 1.81 *** (1.52-2.16) | 1.79 *** (1.51-2.13) | 1.10 ** (1.04-1.16) |
| 1994-95 | 1.67 *** (1.56-1.79) | 1.36 *** (1.15-1.62) | 1.79 *** (1.57-2.04) | 2.09 *** (1.75-2.49) | 1.99 *** (1.66-2.39) | 1.11 *** (1.04-1.18) |
| 1996-97 | 1.71 *** (1.59-1.85) | 1.52 *** (1.25-1.84) | 1.80 *** (1.56-2.08) | 1.86 *** (1.52-2.29) | 1.97 *** (1.59-2.44) | 1.19 *** (1.10-1.28) |
| 1998-99 | 2.01 *** (1.85-2.19) | 1.78 *** (1.43-2.20) | 2.34 *** (2.01-2.72) | 2.16 *** (1.73-2.69) | 2.01 *** (1.55-2.60) | 1.40 *** (1.29-1.53) |

***Table 4.9 Males: best- fitting models by cause of death group***

| | All causes | CVD | All External causes | All Other causes | Ill-defined causes | All neoplasms | |
|---|---|---|---|---|---|---|---|
| 2000-01 | 2.07 *** (1.86-2.30) | 1.86 *** (1.40-2.46) | 2.09 *** (1.72-2.54) | 1.74 *** (1.28-2.37) | 2.54 *** (1.87-3.45) | | 1.61 *** (1.44-1.80) |
| 2002-03 | 1.93 *** (1.52-2.43) | 1.82 *** (0.97-3.41) | 2.24 *** (1.51-3.32) | 1.85 (0.99-3.49) | 1.37 (0.61-3.09) | | 1.75 *** (1.38-2.21) |
| **Arrival cohort * over 60** | | | | | | **Duration (years)** | |
| 1990-91 | 1.00 | 1.0 | 1.00 | 1.00 | 1.00 | 0.0.-1.9 | 1.00 |
| 1992-93 | 0.74 *** (0.68-0.79) | 0.78 ** (0.66-0.92) | 0.72 ** (0.57-0.91) | 0.54 *** (0.45-0.65) | 0.75 ** (0.61-0.93) | 2.0-3.9 | 0.72 *** (0.62-0.83) |
| 1994-95 | 0.62*** (0.57-0.66) | 0.73 *** (0.61-0.87) | 0.71 ** (0.57-0.90) | 0.47 *** (0.39-0.57) | 0.60 *** (0.48-0.76) | 4.0-5.9 | 0.76 *** (0.66-0.88) |
| 1996-97 | 0.59 *** (0.54-0.64) | 0.64 *** (0.52-0.79) | 0.68 ** (0.51-0.91) | 0.48 *** (0.38-0.60) | 0.69 ** (0.52-0.90) | 6.0-7.9 | 0.76 *** ( 0.65-0.89) |
| 1998-99 | 0.56 *** (0.51-0.62) | 0.55 *** (0.43-0.69) | 0.65 ** (0.48-0.90) | 0.48 *** (0.37-0.61) | 0.81 (0.59-1.12) | 8.0-9.9 | 0.67 *** (0.56-0.80) |
| 2000-01 | 0.52 *** (0.45-0.59) | 0.51 *** (0.37-0.70) | 0.54 * (0.32-0.89) | 0.47 *** (0.33-0.67) | 0.64 * (0.42-0.96) | 10.0-11.9 | 0.67 *** (0.55-0.81) |
| 2002-03 | 0.73 * (0.56-0.97) | 0.86 (0.34-1.37) | 1.04 (0.42-2.54) | 0.50 (0.24-1.06) | 1.32 (0.47-3.75) | 12.0-14.9 | 0.59 *** (0.48-0.73) |
| **Calendar Year** | | | | | | **Duration * over 60** | |
| 1990-91 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.0.-1.9 | 1.00 |
| 1992-93 | 0.97 (0.90-1.04) | 0.98 (0.88-1.10) | 0.95 (0.74-1.22) | 0.92 (0.78-1.10) | 1.19 (0.90-1.59) | 2.0-3.9 | 1.31 *** (1.12-1.54) |
| 1994-95 | 1.03 (0.97-1.11) | 1.08 (0.97-1.20) | 0.87 (0.68-1.10) | 1.00 (0.84-1.18) | 1.27 (0.96-1.67) | 4.0-5.9 | 1.24 ** (1.05-1.46) |
| 1996-97 | 1.04 (0.97-1.11) | 1.13 * (1.01-1.26) | 0.81 (0.64-1.03) | 1.06 (0.90-1.24) | 1.06 (0.80-1.39) | 6.0-7.9 | 1.38 *** (1.16-1.64) |
| 1998-99 | 1.05 (0.99-1.13) | 1.12 * (1.00-1.24) | 0.85 (0.67-1.07) | 1.11 (0.95-1.30) | 1.03 (0.78-1.36) | 8.0-9.9 | 1.62 *** (1.34-1.96) |
| 2000-01 | 1.07 * (1.00-1.14) | 1.19 ** (1.06-1.32) | 0.94 (0.74-1.18) | 1.23 ** (1.05-1.44) | 0.53 *** (0.40-0.70) | 10.0-11.9 | 1.59 *** (1.29-1.95) |
| 2002-04 | 1.08 * (1.01-1.15) | 1.17 ** (1.05-1.30) | 0.81 (0.65-1.02) | 1.24 ** (1.06-1.44) | 0.77 (0.59-1.01) | 12.0-14.9 | 1.85 *** (1.47-2.34) |

*** p<0.001, ** 0.001<p<0.01, * 0.01<p<0.05

a. Age was included in the models in 17 five year age groups. To save space coefficients are not displayed in the table. The pattern is similar to that of the model with age only (Appendix Figure A3.1a)

At elderly ages arrival cohort effects are nullified for all causes, CVD, and all other causes, once relative risk is calculated together with the coefficients of interaction with age stratum. For the external and ill-defined causes groups relative risk rises non-monotonically with successive arrival cohorts but at a more moderate rate than for adult FSU males (under age 60).

The calendar year effects estimated in model 19 differ by cause of death group. For all causes, CVD and all other causes relative risk decreases from 1990-91 to 1992-93, but afterwards increases monotonically over calendar time, controlling for arrival cohort effects. For the CVD group most of the discrete year effects are significant, reaching levels near 1.20 by 2002-2004 as compared to 1990-91. For all causes and all other causes only the effects for 2000-2001 and 2002-2004 are significantly different than 1990-91. For external causes of death none of the individual year effects are significant (although model 19 is the best fitting model), nor is calendar year significant when it is specified in the alternative continuous variable model (not shown). For ill-defined causes the direction of the calendar year effect is reversed, and relative risk decreases with increasing calendar year, although only one of the individual year effects is statistically significant.

In the only cause group for which a duration effects model provides the best fit among males, all neoplasms, the pattern of effects is complex (Figure 4.34). At adult ages relative risk follows a wave pattern, decreasing sharply to 0.72 (0.62-0.83) after 2 years of residence, rising after 4 years and thereafter decreasing monotonically

to 0.59 (0.48-0.73) after 12 to 14.9 years (compared to 0 to 1.9 years). In the elderly age group there is a slight drop in relative risk after the earliest years and the rise thereafter is not statistically significant, nor are the other duration intervals.

The coefficients of the socio-demographic background variables (education, ethnic group and geographic origin) are not substantially affected by controls for temporal effects. The exception is the ethnic group variable, not surprisingly since the proportion by ethnic group changes greatly over time(section 4.2.1-4.2.3). The increased relative risk estimated for non-Jews (section 4.7.3) overall is reduced once temporal variables are introduced, for all causes from 1.36 (1.31-1.56) (model 4) to 1.17(1.12-1.22) and for most cause of death groups by similar or greater proportions (apart from all neoplasms, for which ethnicity was not significant to begin with).

For all causes, CVD, all external causes and all other causes, as later arriving cohorts join the population, the combined effect of cohort and calendar year coefficients (as specified by model 19) progressively worsens relative risk for FSU males, since the arrival cohort effect is stronger than the calendar year effect. For ill-defined causes the effects are countervailing, with worsening arrival cohort effects counterbalanced by improving calendar year effects. For all neoplasms too there are countervailing forces. On the one hand, when all ages are examined together, strong arrival cohort effects increase the relative risk over successive cohorts, on the other, at adult ages duration effects reduce relative risk with duration of residence, while at elderly ages risk remains constant over duration.


*Figure 4.33 Relative risk of FSU immigrants by arrival cohort adjusted for age, education, ethnic origin, calendar year/duration of residence. By sex and cause of death group.*


*Figure 4.34 Relative risk of FSU immigrants by duration of residence adjusted for age, education, ethnic origin, calendar year/arrival cohort. By sex and cause of death group.*

### 4.5.5 Females – Arrival cohort, calendar year and duration effects (Table 4.10)

Among females the dominant best fitting models include duration of residence effects, except for external causes, for which SMR is not significantly modified in any temporal dimension. Duration effects are present in the best model for all causes, and 3 more cause groups: CVD, all neoplasms and ill-defined causes (model 8 – in which the duration effects are not modified above age 60). For all groups (except external causes) calendar year effects are included in the best model. Unlike males, only for all other causes are arrival cohort effects selected in the best fitting model (model 19), modified at age 60 and over, together with calendar year effects.

*Table 4.10 Females: best-fitting models by cause of death group*

| | All causes | CVD | All neoplasms | Ill-defined causes | All external causes | | All other causes |
|---|---|---|---|---|---|---|---|
| **Best Model** | **12** | **12** | **12** | **8** | **3** | | **19** |
| **Age group**[a] | | | | | | | |
| **Education (years)** | | | | | | | |
| 0-8 | 1.48 *** (1.44-1.52) | 1.63 *** (1.55-1.70) | 1.08 * (1.021-1.14) | 1.71 *** (1.51-1.92) | | 1.31 *** (1.14-1.52) | 1.78 *** (1.69-1.88) |
| 9-12 | 1.21 *** (1.18-1.24) | 1.32 *** (1.27-1.39) | 1.02 (0.97-1.06) | 1.22 ** (1.08-1.37) | | 1.23 ** (1.09-1.47) | 1.36 *** (1.29-1.43) |
| 13+ | 1.0 | 1.0 | 1.0 | 1.0 | | 1.0 | 1.0 |
| **Ethnic Origin** | | | | | | | |
| Non-Jews | 0.80 *** (0.76-0.84) | 0.83 *** (0.76-0.91) | 0.71 *** (0.66-0.77) | 1.02 (0.84-1.24) | | 1.25 * (1.06-1.45) | 0.74 *** (0.67-0.82) |
| Jews | 1.0 | 1.0 | 1.0 | 1.0 | | 1.0 | 1.0 |
| **Geographic Origin** | | | | | | | |
| Moscow St. Petersburg | 0.88 *** (0.85-0.91) | 0.87 *** (0.82-0.92) | 0.95 (0.89-1.01) | 0.72 *** (0.61-0.85) | | | 0.86 *** (0.80-0.92) |
| Russia and Baltic States | 0.94 *** (0.91-0.96) | 0.92 *** (0.88-0.97) | 0.93 * (0.89-0.98) | 0.92 (0.81-1.05) | | | 0.94 * (0.88-0.99) |
| Asian and Caucasian Republics | 1.09 *** (1.07-1.12) | 1.10 *** (1.05-1.15) | 0.96 (0.92-1.01) | 1.27 *** (1.13-1.42) | | | 1.24 *** (1.17-1.30) |
| Unknown | 1.03 (0.94-1.12) | 1.00 (0.86-1.17) | 1.09 (0.93-1.28) | 0.72 (0.44-1.16) | | | 0.98 (0.81-1.18) |
| Ukraine, Belarus, Moldova | 1.0 | 1.0 | 1.0 | 1.0 | | | 1.0 |
| **Duration (years)** | | | | | **Arrival Cohort** | | |
| 0.0.-1.9 | 1.00 | 1.00 | 1.00 | 1.00 | 1990-91 | | 1.00 |
| 2.0-3.9 | 0.98 (0.89-1.08) | 0.77 (0.58-1.03) | 1.03 (0.91-1.17) | 0.86 * (0.75-1.00) | 1992-93 | | 1.50 ** (1.17-1.92) |
| 4.0-5.9 | 0.83 ** (0.75-0.92) | 0.85 (0.63-1.15) | 0.77 *** (0.67-0.89) | 0.79 ** (0.68-0.93) | 1994-95 | | 1.37 * (1.05-1.78) |
| 6.0-7.9 | 0.83 *** (0.75-0.93) | 0.88 (0.63-1.21) | 0.80 ** (0.69-0.93) | 0.72 *** (0.60-0.85) | 1996-97 | | 1.52 ** (1.14-2.03) |
| 8.0-9.9 | 0.69 *** (0.61-0.78) | 0.62 * (0.41-0.92) | 0.66 *** (0.55-0.77) | 0.66 *** (0.55-0.81) | 1998-99 | | 1.66 ** (1.20-2.31) |
| 10.0-11.9 | 0.66 *** (0.58-0.76) | 0.76 (0.50-1.16) | 0.57 *** (0.47-0.69) | 0.67 *** (0.53-0.85) | 2000-01 | | 2.23 *** (1.53-3.25) |
| 12.0-14.9 | 0.59 *** (0.50-0.69) | 0.56 * (0.33-0.97 | 0.50 *** (0.40-0.61) | 0.63 *** (0.49-0.82) | 2002-03 | | 0.71 (0.18-2.87) |
| **Duration * over 60** | | | | | **Arrival cohort * over 60** | | |
| 0.0.-1.9 | 1.00 | 1.00 | 1.00 | | 1990-91 | | 1.00 |
| 2.0-3.9 | 1.04 (0.94-1.15) | 1.34 * (1.01-1.79) | 0.97 (0.84-1.11) | | 1992-93 | | 0.69 ** (0.54-0.89) |
| 4.0-5.9 | 1.29 *** (1.16-1.44) | 1.33 (0.99-1.80) | 1.28 ** (1.10-1.50) | | 1994-95 | | 0.72 * (0.55-0.94) |
| 6.0-7.9 | 1.27 *** (1.14-1.43) | 1.29 (0.93-1.78) | 1.24 ** (1.05-1.45) | | 1996-97 | | 0.61 ** (0.45-0.82) |
| 8.0-9.9 | 1.49 *** (1.32-1.70) | 1.80 ** (1.20-2.70) | 1.47 *** (1.23-1.76) | | 1998-99 | | 0.58 ** (0.41-0.81) |
| 10.0-11.9 | 1.55 *** (1.35-1.78) | 1.43 (0.93-2.18) | 1.61 *** (1.32-1.97) | | 2000-01 | | 0.40 *** (0.27-0.60) |
| 12.0-14.9 | 1.69 *** (1.44-1.98) | 1.89 * (1.10-3.25) | 1.78 *** (1.43-2.23) | | 2002-03 | | 1.72 (0.41-7.17) |

*Table 4.10 Females: best-fitting models by cause of death group*

| | All causes | CVD | All neoplasms | Ill-defined causes | All external causes | | All other causes |
|---|---|---|---|---|---|---|---|
| **Calendar Year** | | | | | | | |
| 1990-91 | 1.00 | 1.00 | 1.00 | 1.00 | | | 1.00 |
| 1992-93 | 1.03 (0.96-1.11) | 1.08 (0.97-1.21) | 0.94 (0.83-1.07) | 1.31 (0.98-1.75) | | | 1.06 (0.90-1.25) |
| 1994-95 | 1.08 * (1.01-1.16) | 1.07 (0.96-1.19) | 0.99 (0.87-1.12) | 1.63 ** (1.21-2.18) | | | 1.21 * (1.03-1.42) |
| 1996-97 | 1.12 ** (1.04-1.20) | 1.15 * (1.03-1.29) | 1.06 (0.94-1.21) | 1.28 (0.95-1.72) | | | 1.29 ** (1.11-1.50) |
| 1998-99 | 1.13 *** (1.06-1.21) | 1.10 (0.98-1.23) | 1.07 (0.94-1.21) | 1.70 *** (1.26-2.29) | | | 1.40 ** (1.20-1.63) |
| 2000-01 | 1.19 *** (1.11-1.27) | 1.22 *** (1.09-1.37) | 1.19 ** (1.04-1.35) | 0.66 ** (0.48-0.90) | | | 1.51 *** (1.30-1.75) |
| 2002-04 | 1.22 *** (1.12-1.31) | 1.16 * (1.04-1.31) | 1.21 ** (1.06-1.38) | 1.11 *** (0.82-1.52) | | | 1.51 *** (1.30-1.75) |

p *** p<0.001, ** 0.001<p<0.01, * 0.01<p<0.05

a. Age was included in the models in 17 five year age groups. To save space coefficients are not displayed in the table. The pattern is similar to that of the model with age only (Appendix Figure A3.1b)

For all causes of death combined, at adult ages relative risk declines continuously with duration of residence, reaching an odds ratio of 0.69 (0.50-0.69) by 12.0-14.9 years of residence. For the specific cause of death groups in this age group the pace of decline over duration is very similar (for ill-defined causes the decline is for all ages) although for CVD the duration coefficients are statistically weaker, with larger confidence intervals. At elderly ages for all causes of death and for the CVD group the duration coefficients show a shallow inverted U pattern, rising slightly up to durations of 6.0-7.9 years (for CVD 1.13 (1.05-1.21)) and falling thereafter back to equivalence with the initial duration.

Arrival cohort effects are present below age 60 in the all other cause group, but they are not ordered consecutively, increasing to a plateau of relative risk of around 1.50 for the 1992-93 to 1998-99 cohorts, rising sharply for the 2000-01 cohort and falling sharply for the 2002-03 cohort. At elderly ages the combined effect of the coefficients erases the differences between the arrival cohorts.

Calendar year effects are present and significant in all cause groups (except external causes of death), but they vary in level and direction. For the groups that share model 12 (all causes, CVD and all neoplasms) the effects rise monotonically, reaching relative levels of around 1.20 for 2002-04. For all other causes the trend is monotonic as well, but reaches higher levels – around 1.50 for 2000-01 and 2002-04. For ill-defined causes there is no apparent direction to the calendar year effects (in the continuous specification for this group the calendar year effects have a negative trend).

Unlike males, for whom controls for the temporal variables reduces the effect of ethnicity, for females in the case of all causes, all neoplasms and all other causes adjustment for temporal variables increases further the relative advantage of non-Jews, in the case of all neoplasms from 0.77 (0.71-0.83) to 0.71 (0.66-0.77).

For females, the combined effect of the temporal variables is countervailing in most cause of death groups. On the one hand, at adult ages, for major cause of death groups, relative risk falls with increasing duration of residence. On the other, the presence of strong negative calendar year effects curtails the beneficial effect of increasing duration of residence. Above age 60, the calendar year effects are strong enough to overcome the influence of duration effects. For the all other causes group strong arrival cohort effects at younger ages combine with worsening the calendar year effects. But since for females the SMR for all causes shows lower mortality for FSU females, the overall direction of the trend over time is to equalize relative risk of FSU females with Other Israelis.

### 4.5.6 Overview of Multivariate models

**SMRs** Over the total period of observation, age-adjusted relative mortality for males is slightly higher (1.09 (1.08–1.10)) and for females slightly lower (0.95 (0.95 – 0.96)) compared to Other Israelis. Male FSU disadvantage is greater for all neoplasms, ill-defined and especially for external causes, but for CVD there is no disadvantage and for the residual all-other causes group there is an advantage. Female FSU advantage is greater for CVD, all other causes and for the ill-defined causes group, whereas the SMR for external causes and for all neoplasms points to higher mortality relative to Other Israelis.

**Age effects** There are strong age effects on SMRs for males, and moderate ones for females, in both cases raising SMRs in the adult age range. The effect appears in all causes of death for males, with rate ratios reaching a peak at age 25-29, whereas above age 60 there are no effects. For females the major effect is for external causes of death, where the peak is at age 30-34. These differences between the under 60 and over 60 age groups also appear in estimation of trends over time: trends are weaker or non-existent in the elderly age range.

**Education**. There is the expected inverse relationship between years of education (controlling for age, ethnic group and geographic origin) and relative risk of death for all cause of death groups for both sexes, but there is one prominent exception: all neoplasms among females, for whom increasing education provides no relative advantage, controlling for other socio-demographic factors. For both sexes the education effect is not modified when temporal factors are added to the models.

**Ethnic Group**. The effect of ethnic group (controlling for age, educational level and geographic origin) contrasts between the sexes. Among males, non-Jews have substantially higher relative mortality for all cause of death groups, with the exception of all-neoplasm mortality, whereas among females, non-Jewish females have substantially lower relative risk for most cause of death groups, with the exception ill-defined causes, and external causes, where female non-Jews share a disadvantage with non-Jewish males. Female non-Jewish advantage is greatest for all neoplasm mortality. The addition of temporal factors to the models modifies the effect of ethnicity for both genders: for males higher relative risk is reduced, although it remains substantial, and for females the reduction in relative risk increases the advantage of non-Jewish women. For males relative risk falls for all causes of death from 1.36 (1.31-1.41) in model 4 with no temporal effects to 1.15 (1.12-1.22) for model 19, the best model with temporal effects. In contrast, the relative advantage of non-Jewish females is slightly increased when temporal factors are added to the models (0.83 (0.79-0.87) for model 4 without temporal effects and 0.80 (0.76-0.84) for model 12, the best model for all causes. This holds for all cause groups except external causes of death, for which non-Jewish females suffer a disadvantage (1.23 (1.04-1.45)) which is not modified by temporal factors.

**Geographic Origin**. Geographic origin (controlling for age, educational level and ethnic group) also has contrasting effects, as measured relative to the largest group, Ukraine, Belarus and Moldova. For both sexes origin in the Moscow and St. Peterburg area provides a statistically significant relative advantage in SMRs, whereas immigrants from the Asian-Caucasian Republics area have a relative disadvantage. For the Moscow and St. Petersburg group for both sexes the advantage (generally larger for females than for males) is for all causes combined, for all neoplasms and for all other causes, as well as for CVD among females only. For ill-defined causes there is a disadvantage for males and an advantage for females. For the Asian-Caucasian Republic area the disadvantage, similar in magnitude for both sexes, is for all causes, CVD, all other causes and ill-defined causes. For the Russian Federation and Baltic States area a relative advantage for all causes, CVD, and all neoplasms is enjoyed by females, whereas males from the same area suffer a relative disadvantage for external causes. For females, addition of temporal factors does not alter the effect of geographic origin. However, for males the advantage given by origin from Moscow and St. Petersburg is eliminated for all causes and all neoplasms, while a disadvantage of mortality for external causes becomes significant.

**Effects of temporal factors.** Among males, all best fitting models contain strong arrival cohort effects on SMR, which, except for all neoplasms, are modified in the elderly age range. For all cause groups, except neoplasms, these effects are combined with calendar year effects; for all neoplasms they are combined with duration of residence effects, which are modified above age 60. For all causes combined and for each cause of death group, relative risk rises substantially over successive arrival cohorts, for all causes combined reaching relative risks that are twice as large as those for the 1990-1991 arrival cohort. With the exception of all neoplasms, the arrival cohort effect is present only for adult ages, and cohort differences are not present at age 60 and above. The direction of trend for the calendar year effects differs between the groups. For CVD and all other causes there is a strong and significant rise with increasing calendar year, whereas for external cause and ill-defined cause the trend is reversed. The trend for all causes, aggregating these opposing directions, is for a minor increase in relative risk over calendar year. The duration effect for all neoplasms is for a sharp reduction in the first interval of stay and a gradual reduction thereafter. But this too is restricted to the adult age range.

Like males, calendar year effects are present in all but one of the best fitting models for females (external causes), but these are paired more frequently with duration effects rather than arrival cohort effects. In all cases where the effect is present, relative risk rises over calendar year. Arrival cohort effects are present only in the best-fitting model for the residual group – all other causes. The temporal variables are reduced or eliminated at elderly ages for all causes, CVD, all neoplasms and all other causes, but not for ill-defined causes. When duration effects are present, they show considerable decline in relative risk by duration, of around 40% by durations of 12-14.9 years for all causes CVD all neoplasms and ill-defined causes. This effect is confined to adult ages for all causes and CVD, and is very slight for elderly ages for all neoplasms (around 10%). For the all other causes group arrival cohort effects are present only for adult ages, and although they tend to rise over time the rise is not monotonic.

# Section 5.0 Discussion

## 5.1 Major Temporal Patterns

This discussion will have two focuses, the first based in a socio-demographic approach to understanding the dynamics of FSU migrant mortality and the second highlighting specific aspects of these mortality patterns within an epidemiological context. On the one hand, it will explore the ways in which the findings express the multidimensional temporal dynamics approach which was developed in the Introduction, and on the other hand, it will explore their contribution to and modification of substantive findings about relative mortality risk of FSU immigrants in Israel. A summary of the major findings of change in each temporal dimension will be presented to set the scene.

### 5.1.1 Change over calendar time

Previous studies have shown the deterioration of relative mortality of FSU immigrants in Israel over calendar time ( (Ott et al. 2009)and section 2.5). The increased resolution of the present analysis shows that the growing disadvantage of males, and the convergence from advantage of females varied by age range, geographic and ethnic group and cause of death. The difference in relative mortality between FSU immigrants by level of education could have been anticipated (given the substantial mortality benefits of education documented for Russia and the FSU generally (Doniec et al. 2018; Murphy et al. 2006; Shkolnikov et al. 1998b), as could the difference between immigrants originating from the center and the periphery of the FSU, given the gaps in levels of health between these areas (Shchur et al. 2021). But the differing temporal trends by gender and between age groups indicate that the patterns over calendar time cannot be explained by differences in overall levels of health in the origin regions, by socio-demographic characteristics alone, or by underlying changers over duration of stay. Rather, these characteristics interacted in a non-uniform way with changing self-selection patterns, and with the conditions encountered in Israel.

Decomposition of differences in $e_{15}$ between FSU immigrants and Other Israelis by gender, age and cause of death group shows that although the emerging gap with Other Israelis among males was shared by all age groups, most of the deficit in expected years of life was contributed at adult ages. The initial equivalence, when all causes are combined, was a result of offsetting levels of relative mortality between cause of death groups: already at arrival males had a disadvantage from all neoplasms and external causes and both disadvantages increased over calendar period, whereas for CVD an initial advantage, confined to the elderly age range, was lost. For females in the elderly age range convergence was from an initial advantage (a negative trend), but in the adult age range the convergence was from an initial disadvantage (a positive trend). When looked at by cause group the initial female advantage was due to lower deaths from CVD and the all other causes group, advantages which were partially offset by disadvantages from other neoplasms and, to a much lesser extent, external causes. The negative trend was primarily due to the loss of the advantages in the relevant cause groups, rather than deepening disadvantages.

Further heterogeneity in levels and trends are revealed when geographic origin and ethnic group are added to the analysis. Male immigrants from Moscow-Leningrad would have maintained an overall advantage in $e_{15}$ compared to Other Israelis throughout the period were it not for increasing disadvantages from external cause and non-tobacco related neoplasm mortality which were confined to the adult age range alone. Females from these cities did not conform to the overall pattern: they maintained an overall advantage in $e_{15}$ over other Israelis and, unlike males, reduced their disadvantage from all neoplasms over the period. Males and females from the Asian-Caucasian republics, on the other hand, had a persistent disadvantage in $e_{15}$ which was contributed by all cause of death groups and all age groups. The patterns for non-Jewish immigrants were quite distinct. Non-Jewish males suffered from a large and increasing disadvantage in $e_{15}$, reaching a deficit of -5.4 years by 2000-2004, as compared to -1.5 years for Jewish males from the European Republics. Over one year of the additional disadvantage of non-Jewish male immigrants was contributed

by higher external cause mortality at adult ages, but higher CVD mortality contributed a further -1.2 years, which was nearly equally distributed between both age ranges (-0.52, -0.64 respectively). This pattern distinguishes non-Jewish males from most other groups (except the Asia-Caucuses group), in which elderly immigrants were at an advantage. In the case of all neoplasm mortality, however, their disadvantage was only slightly greater than that of Jewish immigrants from the European republics, -1.1 years as against -0.89 for the latter. Female non-Jews presented a contrasting picture. They enjoyed a substantial but rapidly diminishing advantage over Other Israeli females, due principally to lower CVD and all other cause mortality, an advantage that was contributed entirely by the elderly age range, since at adult ages they suffered from a small deficit. Unlike Jewish females, they showed no differences in life expectancy from Other Israelis due to all neoplasm mortality.

These complex patterns of change over calendar time cannot be interpreted straightforwardly as a product of the impact of exposure to conditions in Israel. As multivariate analysis revealed, changes over calendar time interacted in a complex fashion with changes over arrival cohort and duration of residence, adding layers of complexity to the explanation of temporal change (section 5.1.3).

### 5.1.2 Change by duration of stay and arrival cohort

SMRs by duration and arrival cohort also revealed different temporal paths by gender, age group and cause. Previous analysis of patterns by duration of residence showed that mortality for all major cause of death groups decreased with duration of residence for males, but for females this was true only for neoplasms and external cause mortality (Ott et al. 2010). The present analysis overturns these findings. Notably, all cause SMRs for males show that apparent declines in SMR by duration of residence for FSU immigrants overall are an artefact of substantial increases in relative mortality over consecutive arrival cohorts, especially at the adult ages. Among females, on the other hand, the cohort effects on SMR were present only at adult ages, were weaker than for males, and within the arrival cohorts themselves they were accompanied by declines in SMR by duration. In the elderly age range, an advantage in mortality at the shortest durations of stay develops into convergence with Other Israeli mortality after 4.0-5.9 years of residence. The temporal patterns in SMRs differ by cause group. For the all neoplasms group, and for both genders in the adult age range, SMRs are especially elevated at shortest durations of stay and are followed by sharp falls followed by gradual convergence. This pattern (elevated risk at arrival followed by a sharp fall) is enhanced over consecutive arrival cohorts, especially for males. In the residual all-other cause mortality group, SMRs show sustained advantages which are greater at the shortest durations of stay.

The pattern of SMRs for the 1990-91 cohort is quite distinct. For all causes combined and for most cause groups, in both the adult and elderly age range and for both genders, the earliest arriving cohort enjoys either equivalent mortality or an advantage over Other Israelis. The exception is all neoplasm mortality, where both genders suffer a disadvantage. Nonetheless, convergence with Other Israelis is reached after 12 years of residence among females in the adult age range for this cause group as well.

### 5.1.3 Multivariate models of temporal dimensions

The decomposition of life expectancy by calendar year, and the analysis of SMRs by arrival cohort and duration found change in all three dimensions, but they could not determine the relative strength of their impact. Since simultaneous estimation of the impact of all three temporal dimensions together is prevented due to their linear interdependence, multivariate analysis tested which single temporal dimension or which binary combination of temporal effects, if any, provided the most efficient statistical description of changes in relative mortality (SMR): duration of residence by calendar year, arrival cohort by calendar year, or arrival cohort by duration of residence (while testing for possible interactions with age group or ethnic group). While adjusting for socio-demographic background variables, the analysis showed that models of SMR which provided for specific combinations of temporal trends improved the explanation of the data for all

causes and for broad cause of death groups, but, at the same time, that the combinations, strength and direction of temporal changes differed between the genders and were modified by broad age group. The only exception to this is external causes for females, for which the best model does not include temporal trends.

For males, the preferred models as selected by the AIC criterion, favour a dominance of arrival cohort and calendar year effects on all cause SMR and on most cause of death groups, with the cohort effects weaker or non-existent at elderly ages, while at adult ages SMRs increase substantially over successive arrival cohorts. For females the preferred models favour dominance of duration of residence and calendar year effects on all causes, all neoplasms, and CVD SMRs, with relative risk declining by duration of stay, but only in the adult ages. But in the residual all other causes group females share the arrival cohort and calendar year effects with males. For them as well the increase in relative risk over progressive arrival cohorts is confined to the adult age range. Thus for both males and females multivariate analysis confirms that elderly immigrants showed weaker temporal effects, and unlike the younger age group, they exhibited either mortality advantages or smaller disadvantages. Possible explanations of the relative mortality differences between adult and elderly immigrants will be addressed in section 5.4.3. Reasons for the sharp differences between the genders in the dominant temporal patterns are explored throughout this discussion.

Multivariate analysis allows us to examine the interaction of the effects of socio-demographic characteristics with temporal trends. In the period of observation overall, the population of FSU immigrants were older, more female, and better educated than the Israeli population, but as the immigration wave continued, arriving immigrants were progressively younger, increasingly of non-Jewish ethnicity, originating in the more peripheral areas of the FSU and somewhat less educated. Lifetable and SMR analysis showed strong differentiation in patterns of relative mortality risk by these socio-demographic variables. But adjusting for them in multivariate models does not eliminate the progressively worsening relative mortality over arrival cohort, which was especially significant for adult males.

Since the trend remains after adjustment for these variables, one can conclude that unmeasured factors determining relative health of immigrants were at work, driving the increase in SMRs over arrival cohort. Conversely, although the strength of the effect of education or geographic origin varies by cause and by gender, their effects are not modified by adjustment for calendar year, arrival cohort or duration of stay. However, this is not true for ethnic origin. Among males the increased risk due to non-Jewish ethnicity is reduced after adjustment for temporal factors (with the exception of all neoplasms, for which there are no differences in risk between the ethnic groups). Thus the overall disadvantage of non-Jewish males is partly accounted for by the unmeasured factors which drive the increasing relative disadvantage of all immigrants by arrival cohort. Whereas for non-Jewish females, their overall advantage in SMRs would have been slightly enhanced were it not for their shorter average durations of residence when compared to Jewish immigrants. This is further support for the conclusion that arrival cohort differences in mortality risk are driven by unmeasured factors.

### 5.1.4 FSU migrant mortality in a multitemporal context

The variety of patterns that were found show the fruitfulness and realism of the multidimensional analytic scheme discussed in section 1.3 and summarised in figure 1.2, which depicted how migrant health can alter through the three temporal dimensions. Previous analysis of this data set (Ott et al. 2008; Ott et al. 2009; Ott et al. 2010) concluded that FSU migrants displayed rapid assimilation to Israeli mortality patterns (based positive duration of stay trends and low all-cause and CVD mortality), modified by country of origin effects. These country of origin effects were inferred from relatively high neoplasm mortality and external cause mortality among males which corresponded to elevated rates for these causes in the FSU, while it was suggested that external cause mortality may also have been affected by adjustment difficulties in Israel. But the current analysis reveals the pitfalls of oversimplification: there is no simple overarching narrative that

fits these complex findings, as the environmental transition paradigm sought to be. The findings show clearly that omitting any of the three temporal dimensions from model estimation leads to biased and false conclusions.

Analysis that takes full account of temporal multidimensionality is justified not only due to considerable measurement difficulties (because temporal affects may confound one another in multiple ways), but on substantive grounds, because it reflects the temporal complexity which is, as was argued in the Introduction, the fundamental characteristic of migration. In the case of FSU immigrants in Israel, relative risk varies over all three temporal dimensions, as modified by gender, age group, geographic origin and ethnic group, and the cause group in question. The strong presence of arrival cohort effects on SMRs shows the crucial role played by the circumstances which created and altered the migratory wave itself, alongside specific conditions on arrival in Israel. These are factors that cannot be reduced to exposures either to a pre-existing origin or destination environment. Calendar period effects show that socio-political and economic conditions and policies in Israel may have had a differential impact on mortality of FSU immigrants as a group vis a vis Other Israelis, regardless of duration of stay or arrival cohort. Furthermore, although for each cause of death group only a maximum of two of the dimensions could be selected to model the patterns of change (omitting the determined dimension), it needs to be emphasized that this selection in itself cannot exclude the possible influence of the factors that operate through any omitted dimension. The selection can only indicate that the omitted factor(s) was weaker or operated in a less consistent fashion, and was thus, on statistical grounds, a less "informative" force than those chosen in the best model.

These findings have wider implications for the study of migrant health. Unfortunately, the migrant health literature still contains examples of studies where duration of stay itself serves as a measure of "acculturation" as though a unilinear process was inevitable (eg. Lee et al. 2013; Singh and Miller 2004; Singh and Siahpush 2002). In section 1.3 of the Introduction the emergence of theoretical discussions of multidimensional temporal dynamics in the migrant health literature was surveyed, many of these discussions were centered on adding life-course perspectives to analysis and with them a focus on cohort and period effects. This study is the first attempt to simultaneously evaluate arrival cohort, duration of residence and calendar period effects on migrant mortality in a true longitudinal setting, and it has found that all these dimensions play a significant role.

Over the last two decades the study of migrant mortality has moved away from a simplistic environmental transition framework, and multiple sources of change have been proposed, especially socio-economic factors other than changing values and behaviour, as well as racial discrimination (See sections 1.2.5.3 and 1.3 above, and Arévalo et al. 2015; Lebrun 2012; Riosmena et al. 2014; Ro 2014; Zufferey 2016). Several studies have raised theoretical and methodological grounds for challenging a unidimensional model, especially as implemented in cross-sectional surveys. They emphasise that in cross-sectional data duration of stay cannot be distinguished from period of arrival, period effects may bias estimates of the other temporal factors, and immigrants are often observed only after attrition of arrival cohorts through emigration and death (Antecol and Bedard 2015; Biddle et al. 2007; Hamilton et al. 2015; McDonald and Kennedy 2004; Read et al. 2020; Read et al. 2019; Sauzet and Razum 2019).

Yet despite these theoretical statements few studies have attempted to tackle temporal complexity empirically, and even when the challenge was confronted, major difficulties were encountered. Beginning with McDonald and Kennedy's (2004) pioneering study, research that has tried to control for arrival cohort effects has relied almost exclusively on synthetic cohort methodology. This technique was borrowed from the wage-assimilation literature (above, Section 1.4), pooling successive cross-sectional surveys into a single "longitudinal" dataset. However, the technique is particularly problematic for health and mortality studies, since synthetic cohorts are methodologically vulnerable precisely on the most health-relevant issue: attrition through mortality, as well as attrition through remigration of immigrants (Sauzet and Razum 2019).

Repeated samples are not of the same population – it will have altered in respects that are crucial for estimating health trends. These samples exclude by necessity individuals who have died between sampling periods (who represent the population who are most vulnerable to worsening health trends) as well as migrants who left between the sampling periods (who may have been motivated by negative health considerations, or selected for better health). Migration bias is amplified by differential migration, since emigration rates by long-term residents (the usual comparison group) are likely to be lower than for immigrants. Moreover, analysis has demonstrated that these attrition biases, and mortality attrition in particular, can lead to false affirmation of the existence of duration trends by synthetic cohort methodology, trends which disappear when true longitudinal measurement is undertaken (Beenstock et al. 2010).

Synthetic cohort studies are vulnerable when considering period effects as well. Several of them, emphasising the importance of controlling for arrival cohort effects when measuring duration effects, have assumed falsely that calendar period effects were equivalent for migrants and long-term residents and could thus be ignored or estimated for natives only (Antecol and Bedard 2006; Hamilton and Hummer 2011; Hamilton et al. 2015; Reynolds et al. 2016). Others have confined measurement of calendar year effects to the date of the surveys from which the data were drawn (Antecol and Bedard 2015; Constant et al. 2018; Read et al. 2020), limiting the span of years in such a way that the period variable cannot be cross-classified with duration or arrival cohort. The present study is unique in trying to estimate calendar year (period) effects on immigrant mortality in the presence of duration of stay and/or cohort effects and has found that calendar year effects play an important role over the period of observation, one that has been ignored not only in statistical models but in theoretical expectations.

Finally, apart from Ott et al. 2010, no study that simultaneously addressed arrival cohort and duration of stay effects on health has studied relative mortality risk as an outcome variable, although other temporal combinations have been addressed: for instance, (Syse et al. 2016) investigated the impact of duration and period of observation on immigrant mortality risks, and (Juarez et al. 2018) investigated the impact of duration of residence and age at arrival mortality differences between immigrants and natives. Rather, based as they are on large health surveys, the dependent variables in all synthetic cohort studies have been associated with morbidity: self-reported health, chronic conditions, or BMI variables.

## 5.2 Factors modifying relative mortality in each temporal dimension

The multidimensional temporal model is not a theory and does not provide explanatory hypotheses. Rather it seeks to provide the framework for a fuller and more accurate depiction of the impact through time of the array of factors which impact the relative mortality rates of migrants, factors which we have organised through the health field concept (above Section 1.3.3): genetic and biological factors; behavioural and lifestyle factors; environmental factors (economic, social, cultural, physical); and, health care systems and services. Time is not a causative force in itself (Ro 2014). Changing levels of risk by calendar year, arrival cohort or duration are due to risk factors and exposures whose effects unfold and vary through each dimension of time. Since the dataset for this study does not contain variables on any of the categories of the health field concept, any interpretation of the underlying reasons for our temporal findings is speculative. Nevertheless possible explanations of the patterns will be suggested, based on the literature of migrant health, and other investigations of the social and economic circumstances of this migration wave, as summarised in section 2.6.

**Calendar Year**. In our context, calendar year effects are factors which alter concurrently for all FSU migrants (whatever their arrival cohort or duration of residence), in a manner which differentiates them from Other Israelis. It is noteworthy that although the models tended to select arrival cohort effects for males and duration effects for females, in both cases these were combined with calendar year effects, which indicates that factors affecting the FSU population as a whole were powerful influences on mortality.

Not all categories of the health filed concept are relevant: genetic and biological factors do not effect calendar-year trends in migrant mortality, because their impact does not alter over calendar time. As for behavioural or lifestyle factors, differences in behaviour between immigrants and long-term residents are more likely to alter with duration of stay rather than simultaneously by calendar year. However, given the long latency of some behavioural factors impacting mortality, measured negative calendar year effects on relative risk may reflect differences in long-term trends between the populations, differences which have their origin in past collective behavioural changes in diet, smoking, alcohol consumption, etc. Consideration of such long-term factors is one of the insights of the life-course perspective, which pointed to differential accumulation of exposures in the pre-migration period as a source of differences in current risk (Section 1.3.1.2)

Past collective improvements in behaviour which altered risk factors with long latency among Other Israelis may have resulted in more rapid improvement in mortality for them over a calendar year span, creating a growing gap with immigrants over calendar time. A hypothetical example would be the significant long term decline in Israel of smoking prevalence and hypertension, both risk factors for CVD mortality, and the former for cancer mortality (World Health Organization 2018). If the pace of past positive trends in behaviour of Other Israelis of all ages was more rapid that that of potential immigrants (while still in the FSU), a difference in calendar-year trends in CVD could emerge, years later, in Israel. This gap would not be attributable to measurable contemporary changes after migration. It was shown that the gap in $e_{15}$ between FSU migrants and other Israelis due to CVD mortality that developed over calendar period (Section 4.3.2) was not due to mortality reversals among immigrants, but due to unexplained differences between the groups in the pace of positive change. And indeed, such differential trends can vary by age. Disaggregation showed that overall stagnation of male FSU mortality between 1990 and 2003 was due to a negative trend at adult ages which was counterbalanced by a positive one at elderly ages. The negative calendar year trend at adult ages was a product of worsening relative risk over consecutive arrival cohorts. But there was no deterioration over arrival cohort in the elderly age group. Thus the slower pace of improvement over calendar year compared with Other Israelis at elderly ages is unexplained, and may be due to unmeasured life-course factors benefiting Other Israelis.

As for calendar year impacts of the third category in the health field concept, environmental factors, change in the collective economic and social circumstances of FSU migrants in Israel, and/or policy factors affecting them, or changes in the collective strength of migrant social resources (which grow as the migrant community establishes itself), can all be classified under this heading. The findings did not confirm the direction of impact of such factors on FSU immigrants that was anticipated, as we will see immediately. The fourth category of heath-field factors, changes in the Israeli health system which simultaneously affect all FSU migrants differently than Other Israelis, were also anticipated to have had positive calendar year impacts, which were not found. Among these are the introduction of universal health insurance in 1995 and the growth of widespread employment of FSU immigrants in health professions, gradually improving the accessibility of the health system and its adaptation to their needs and cultural preferences. Differences between the health care systems of the origin and destination countries may also have a lagged effect on states of health of migrants and long-term residents which create differential calendar-time trends: differences in child immunization regimes would be an example of this. Sections 2.2-2.5 mentioned some of the health-system factors.

The confirmation of calendar year effects in the preferred models confirms the contention of the multidimensional approach that the temporal context of migrants' life course differs from the context for long-term residents. However, our expectation was that calendar-year effects for FSU immigrants in Israel would be positive, since for immigrants as a group, economic and social conditions in Israel were harsh at first and improved over time, as did the provision of services by the health system. But the direction of calendar year effects points to moderately or substantially increasing relative risks throughout the period of

observation for most cause groups for females, and for all causes combined, CVD, and all other causes for males (after adjustment for duration of residence or arrival cohort effects, Tables 4.10-4.11). When the best model combines calendar year with arrival cohort effects (primarily for males), all cohorts share the same increase in relative risk over advancing calendar year; and when the best models combine calendar year with duration of stay effects (primarily for females), the decline in relative risk by duration of stay is reduced (or reversed) by the same proportion for all durations of stay with each advancing calendar year. Among males, calendar year effects are excluded from the best model for neoplasms only, as they are for external causes for females. However, for external causes among males the best model finds that relative risk improves over calendar period.

There are two possible explanations for these findings: The first, that however much the collective socio-economic circumstances of FSU immigrants improved over the period of observation, these improvements did not keep pace with those of other Israelis, leading to negative calendar year trends in relative mortality risk associated with these circumstances. Although this interpretation is possible, it is hard to reconcile it with the positive calendar year trend for external causes among males: relative deterioration in conditions for FSU migrants would have been most likely to express itself in this cause group. On the contrary, the positive effect of calendar year on external causes for males tends to confirm the idea that collective conditions for FSU immigrants improved over the period of observation. The second possible explanation seems more likely, that the trend is due to differences between the long-term impact of past exposures in the FSU and Israel. Past improvement in behaviours or exposures for Other Israelis (some of them due to differences in public health measures provided through the respective health systems) may have created a positive trend among Other Israelis which FSU immigrants could not match over the period of observation. This underlying positive trend for Other Israelis would act as a comparative "weight" on FSU immigrants, further burdening the influence of negative arrival cohort effects, and dampening positive duration of stay effects on SMRs.

**Arrival Cohort**. Arrival cohorts do not have an effect in themselves. Their effect is due to changes in the composition of a migration stream through self-selective factors, as well as changing circumstances in the receiving country on arrival and possibly negative factors affecting conditions during transit (Jasso 2014; Jasso et al. 2004). Self-selection was discussed in section 1.9.1 of the Introduction. In the economic wage-assimilation literature unmeasured arrival cohort characteristics are referred to, rather judgementally, as factors influencing cohort "quality". Differences in health-related characteristics would be accounted for by factors from three of the elements of the health field concept: unmeasured risk-factors deriving from differing genetic characteristics, differences in health-related behaviour, and in past socio-economic and environmental exposures. Together these may result in differential collective relative frailty by year of arrival. Health system factors are not relevant in this context, except insofar as they may have influenced initial and/or transit conditions differentially by year of arrival, and these are not substantial effects in most circumstances.

The pattern of strong arrival cohort effects which the analysis revealed in the best models for males (and in the all other causes group for females) points to changes in the "push" and "pull" factors driving this migration stream, as presented in section 2.6.1. The effects persist after adjustment for education, geographic and ethnic origin, and are found almost exclusively in the adult age range. They show that a trend in negative self-selection in mortality risk was due to factors that are not an artefact of the changing geographic origin of the migration wave or its ethnic composition, nor due to a decline in its level of education. This "deterioration" over time in "health quality" of arriving immigrants, for males and much less so for females, for the adult age range but not for the elderly, requires an extended discussion (see Section 5.4, below).

**Duration of Residence**. Determining whether there are changes in mortality risk with increasing duration of residence is, naturally, a primary focus of migrant mortality studies, because it reflects the degree (and the direction) to which life in a new country has changed these risks, the extent to which the transition was a "success" or "failure" in health terms. Potentially, factors from all four of the fields of the health-field concept can be reflected in patterns of change by duration of residence, as pre-existing biological risk factors are progressively expressed, along with changes in behaviour and new environmental exposures, all within the continuing cumulative impact of a new health system. The risk factors and exposures that influence relative risk progressively and/or cumulatively with increasing duration of residence were discussed in section 1.6. Along with increasing exposure to possibly new pathogens, climate and health system, they include time-sensitive patterns of stress, and gradual changes in behaviour and lifestyle factors which accompany adjustment. The latter have often been subsumed under the blanket term "acculturation", as though increasing duration of residence leads (inevitably) to an adoption of the pre-existing behaviours and exposures of a destination culture and society and thus an equalization of mortality risks between natives and migrants.

For adult FSU females the transition to Israel brings about progressive improvements for all causes combined, for all neoplasms and for CVD (although for the last group the decline is weaker statistically). For adult males improvement over duration is found for all neoplasms. Within the categories of the health field concept, given that the improvements for females are seen in most cause groups, the most likely explanation for this trend is benefits of exposure to the Israeli health system (early detection and/or curative treatment), since neither behavioural nor environmental factors are likely to have had such a sweeping effect in such a short time. For the all other causes group, where for both sexes risks increase over calendar time and over successive arrival cohorts, there may be a trade-off with ill-defined causes, where (for males at least) risks decline over calendar time. As immigrants were assimilated into the Israeli health system, certification of cause of death improved and SMRs for ill-defined causes declined dramatically by duration (Appendix Tables A3.5ab). Multivariate analysis confirms this for females, but strong arrival cohort effects obscure this for males. Lack of concrete medical information and administrative follow up is less likely to have effected neoplasms as a group or cardiovascular mortality as a group, but may have affected specific cancers or cardiovascular diseases, where continuous follow-up would have strengthened certification. However, lack of medical records would have affected diabetes as a cause of death, for instance, and thus may have affected the all other causes group, where diabetes is a large component (Section 4 3). A simulation test reassigning all ill-defined causes into the other causes category did not substantially alter trends in SMRs for all other causes, but it did confirm that all-other causes may have declined by duration of residence for males as well (section 4.4.3.4).

With the exception of all neoplasms, for males the strength of arrival cohort and period factors is so great that possible duration of residence effects on relative mortality risk are not selected in the best models. This strong differentiation in duration effects by gender and age group requires explanation which our data itself cannot offer, because information on changing behaviour, exposures, or health interventions are not available to us. Tentative suggestions will be made in the following section through the lens of the literature on the HME model. But one firm finding should be emphasised: for both sexes and age ranges, and for all cause of death groups, there is no increase in SMRs by duration of residence which could be explained by "regression to the mean", exposure to stress, or loss of protective behaviour, patterns which the HME model predicts.

## 5.3 FSU migrants, health selectivity and the healthy migrant effect

We observed in the Introduction that although several studies of FSU immigrant health and mortality have found evidence for negative health/mortality selection among FSU immigrants to Israel, studies based on the present dataset found, on the contrary, advantages or equivalence in relative mortality risk for FSU immigrants in Israel. One of the objectives of this study was to examine whether these findings stood up to a multidimensional temporal analysis, and whether the temporal patterns that the HME model predicts are found among FSU immigrants in Israel (Section 1.9.1).

A recent systematic review of mortality in international migrants to high-income countries presented evidence confirming the HME model. It found that SMRs for all causes of death in 13 broad ICD categories (with the exception of external causes and infectious diseases) are lower for both male and female migrants, including refugees (Aldridge et al. 2018). This conclusion was reinforced by findings of a common U shaped pattern of excess mortality by age vis a vis countries of destination (Guillot et al. 2018), and of origin (Wallace and Wilson 2019). Mortality advantages were especially pronounced for males in the young adult age group who tend to be the dominant group in most migrations, both numerically and with regard to their decision-making roles. This advantage has been interpreted as due to a combination of selection and duration effects. Excess mortality at advanced ages was interpreted as due both to the fading of advantages over duration of residence through aging, the loss of temporary and cultural advantages through "negative assimilation" and regression to the mean, combined with the absence of favourable self-selection among older immigrants who arrived as accompanying relatives.

The age and sex pattern for FSU migrants in Israel found here is in striking contrast to this model: the U shape pattern of relative risk for males is consistently inverted for all cause of death groups, and for females it is weakly so, primarily due to higher external cause mortality at adult ages (Appendix figures A3.1ab). Relative mortality is highest for working age males, and increasingly so across successive arrival cohorts. Relative risk for elderly migrants, and especially females, is most favourable, and for them, by and large, risk does not rise over successive arrival cohorts. Nor is the time pattern predicted by the HME model found in our data. Modeling shows that for males an increase in relative risk over calendar time is not explained best by uniform deterioration over duration of residence, but rather through a combination of negative arrival cohort and period effects. For females, in contrast, relative risk improves by duration of residence in the adult age range (from an initial disadvantage in SMRs), and in the elderly age range an advantage was maintained over time, although it diminished.

This reversal of the HME model could be read as confirmation of the "sick immigrant effect" which was proposed to explain lower health of FSU immigration to Israel (section 1.9.1, and especially (Constant et al. 2018)). However, the findings presented here do not support a conclusion that FSU migration to Israel is uniformly characterised by negative selection. Rather they show evidence of negative selection in some arrival cohort, age, and geographic groups which coexists with positive selection in others. The low relative mortality risk of the elderly is especially remarkable and inconsistent with a "sick immigrant" narrative. And rather than convergence, where the advantages of positive selection fade over duration of residence and the disadvantages of negative selection diminish through processes of "assimilation" or environmental transition, we find more varied patterns.

The HME model argues that positive selection is promoted by employment-driven migration, because the latter places a premium on employment-related characteristics which are associated with better health. Since migration to Israel is classed as non-economic, "ideologically or religiously driven" (as characterised by Constant et al. (2018)), this is used to explain findings of poor relative health. But this portrayal is unhelpful. Previously it was suggested that this migration wave is better depicted as an instance of diaspora, or ethnic-return migration (above, Section 1.1 and 1.9.1), comparable to the migration of ethnic Germans to Germany

from Eastern Europe, ethnic Greeks from Eastern Europe to Greece, ethnic Russians from Eastern Europe and former areas of the Soviet Union to Russia, Japanese and Koreans from South America to their "homeland", etc. The motivations for both diaspora and economically motivated migration overlap. As in the Israeli case, such migrations are driven not only (or even primarily) by the urge to reunite with an ancestral nation which provides an open door and privileged assistance to persons with suitable ancestry, but by a combination of economic and political pressures and incentives, among them the social and economic difficulties engendered by the marginal status of the ethnic group in their country of origin, and the perceived greater wealth of the destination country (Shuval 1998; Tsuda 2009). Our results show that the balance of these economic and social pressures and incentives on migration decision making can, in the right circumstances, create positive self-selection effects.

Understanding health selection requires understanding not only the specific context which generates push and pull factors, but how these factors are changing over time (Acevedo-Garcia et al. 2012). The balance of attracting and repelling forces generating diaspora migration create their own self-selection patterns, and, as we have shown, FSU migration to Israel over the years 1990-2003 displays changing outcomes of socio-economic and demographic self-selection as measured by sex, age, education, geographic and ethnic variables (above, sections 1.7.2, 1.9.1 and 3.2). The present analysis shows an advantage or equivalence in relative mortality to Other Israelis for the following groups: elderly immigrants of both sexes for all causes combined as well as in most broad cause of death groups; for females in general but especially for non-Jewish females; for immigrants from Moscow and Leningrad; and for immigrants who arrived at the outset of the wave, in 1990-91. They show a disadvantage in relative mortality for adult immigrants, one which was greater for males than for females (and especially for non-Jewish adult males), and a disadvantage for migrants from the Asian and Caucasian republics. Crucially, it appears that the changing balance of incentives and disincentives created two distinct phases of self-selection in this migration wave – all arrival cohorts after 1991 show (increasing) disadvantages. In short, "healthy" and "sick" immigrant effects existed side by side in the FSU population in Israel.

## 5.4 Positive selection of 1990-91 cohort

Paradoxically, the early "panic phase" of 1990-91 brought healthier immigrants to Israel, and the "routinised" phase afterwards, brought successively less healthy migrants. The early stage of the migration wave had near refugee-like characteristics (Paltiel et al. 1997). Suddenly confronted with a rapidly deteriorating economy and rising anti-Jewish populism, and with new regulations closing the option of obtaining USA refugee visas, portions of the Jewish population who had not previously considered migration to Israel or elsewhere were swept up by a migration wave (Brym and Ryvkina 1994; Gitelman 1998). It is notable that in this period the average level of education of immigrants was higher and there is a higher proportion of the of immigrants from Moscow and St. Petersburg and a lower proportion of immigrants from the peripheral Caucasian and Asian Republics than in subsequent years (section 4.2 and (Remennick 2007b)). This finding is reinforced by the wage assimilation literature, which found that 1990-91 immigrants to Israel were selected more favourably than subsequent immigrants in earning capacity, and especially education, with levels of education much higher than previous immigrants from the FSU to Israel in the 1970s and 1980s (Cohen and Haberfeld 2007). One previous small study (sample size 2,000) of self-reported health among FSU immigrants in Israel finds, similarly, that health was better in the earlier phase of migration (1989-1991)and worsened progressively among those arriving later (1992-94, 1995-99) (Baron-Epel et al. 2005). And a recent comparative study of immigration from the FSU and eastern Europe to the United States, Israel and Germany found that emigrants before and immediately following the collapse of the Soviet regime were more positively selected in human capital characteristics than those who departed later (Abramitzky et al. 2022).

For both genders the earliest arrival cohort maintains equivalent relative mortality to Other Israelis at age 15+. For adult males there is convergence from a small disadvantage, and for elderly females an advantage is maintained throughout the period of observation (Appendix Tables A3.5-A3.7). Differences in geographic origin or education do not explain the SMR advantage of the early arrival cohort over subsequent ones. Multivariate models confirm that SMRs for the 1990-91 arrival cohort among adult males are substantially lower than among other cohorts for all cause of death groups, even after adjustment for age, education and geographic origin. For females the preferred multivariate models do not select arrival cohort effects, so we do not have findings that are adjusted for education and geography, but adjustment is unlikely to moderate the advantage found in descriptive data.

The pattern of low relative risk and improvement (or stability, for some cause groups) over duration for this cohort does not correspond to our expectations, based on the history of this migration wave outlined above (section 1.7.2-1.7.3) Given the chaotic conditions in the FSU and the relative disorganization confronting these early immigrants on arrival, the expectation was that the stresses of migration would have been much greater for the first to arrive, and would have brought about higher stress-related mortality for CVD, and especially, external cause mortality. This expectation received only weak support, if any. For elderly females SMRs worsened very slightly and then recovered, which may show a moderate affect of deteriorating and then improving conditions. For adult females the SMR for external cause mortality in the 1990-91 arrival cohort is higher than for Other Israelis (1.60 (1.17-2.14)– Appendix Table A3.6b) for a brief period shortly after arrival, with risk declining over duration of stay. With these exceptions, we find a maintenance of advantage or improvement in relative risk over time. After 12.0-14.9 years of residence both genders of the 1990-91 cohort in both the adult and elderly age range have either an advantage in relative risk or equivalence for all cause of death groups with the exception of all neoplasm mortality in the elderly age range (males 1.17 (1.08-1.27) and females 1.15 (1.06-1.24)). This achievement is all the more remarkable given that this arrival cohort had the longest exposure to potential attrition by its healthiest members through emigration. Analysis of the odds of emigration showed that they were much higher for immigrants from Moscow and Leningrad and for those with over 13 years of education, characteristics associated with lower SMRs, both of which were more frequent among 1990-91 immigrants (Section 3.2.1). Although they are an exemplary case of migration which was not driven by wage-considerations, clearly self-selection of the 1990-91 immigrants favoured better health when compared both to the origin and to the Israeli population.

One can suggest two possible explanations for this positive selection. In the first place, just as the the more enterprising and active members of the population are more likely to choose to migrate and that these traits are correlated with better health( as argued by wage-assimilation theory (Chiswick et al. 2008; Jasso 2003; Jasso 2014)), similarly the most enterprising and active (and therefore healthier) members of the Jewish population of the FSU may have been the first to see and act on the opportunities and dangers presented by the sudden collapse of the USSR, and to take up the offer of "diaspora" migration to Israel, despite the uncertainties involved. These migrants had no time to weigh the benefits of the welfare package that Israel offered, or their own employment prospects. They were scrambling to leave what they felt was as a sinking ship, and Israel was the only lifeboat immediately available. It is evident that the first to realise this "push" were younger than average in the Jewish population of the USSR, more likely to come from the elites who lived in the administrative and cultural center of the USSR, who had more to loose from the disintegration of the institutions in which they worked, and more to gain from the possible opportunities of life in a country which, however peripherally, belonged to the ascendant West, where they hoped their education and professional accomplishments would prove valuable (Remennick 2007b). These more "resourceful" migrants are likely to have been drawn from the higher end of the distribution of health among FSU Jews, a group who, as a whole, had lower mortality than other groups in the FSU.

The second possible explanation is based on the suggested favourable mortality pattern of Jews. It has been argued that the pattern displayed by Jews in the FSU (Shkolnikov et al. 2004b) and elsewhere (Staetsky 2011; Staetsky and Hinde 2015) may be due to health-protective cultural-behavioural characteristics of the Jewish ethnic group. These are not explained (but might be enhanced) by the favourable educational characteristics of the ethnic group as a whole. The behaviours suggested by these authors include dietary patterns, strong family structure (Shuval 1992) and limited health-destructive behaviour (low alcohol and tobacco consumption, and low risk-taking related external-cause mortality), all reducing the morality form "exogenous" causes. The pattern is present in both genders but has a much stronger relative impact on male mortality. Given the widespread assimilation of the Jewish ethnic group in much of the FSU, the authors suggest that these group characteristics are not limited to those who positively and actively identify with a Jewish cultural community, and other researchers have pointed to the persistence of Jewish cultural traits despite the erasure of Jewish community life during the Soviet regime (Shternshis 2017). Nevertheless, it is likely that the sense of vulnerability and panic which swept through the Jewish population of the FSU in the late 1980s and early 1990s would have been stronger among those individuals with the strongest Jewish identity, who would therefore have been more likely to share the health-protective cultural and social attributes that are attributed to the Jewish ethnic group. This would have been all the more true of the older generation, some of whom were born before the 1917 revolution or the Soviet annexation of parts of Poland, Western Ukraine and the Baltic States, who had less time to assimilate to Soviet culture, and greater chances to retain Jewish cultural characteristics and their health advantages. Unlike the situation in the FSU itself, where the comparison is to the ethnic Russian population, these behavioural patterns would not have conferred a substantial advantage compared to Other Israelis, but reduced the differences between hosts and migrants.

Comparison of the findings in this study to Shkolnikov et al. (2004b) study, provides strong confirmation of positive selection of early immigrants. The study of Moscow Jews was conducted in 1993-1995, when the population was already diminished by the emigration of tens of thousands of Jews from these cities in 1990-1991. Shkolnikov et al. estimated a gap in life expectancy at age 20 of 2.8 years between both male and female Moscow Jews and Jews in Israel. The data presented above show that FSU Jews from Moscow and Leningrad on arrival in Israel (1990-1995) had an advantage of 1.3 and 2.3 years in $e_{15}$ for men and women respectively over Other Israelis (section 3.5.3). Thus the earliest migrants to Israel from the more advantaged and healthier center of the USSR had lower mortality than the average in the Jewish population in their origin, strong evidence of positive selection.

### 5.4.1 Rising relative mortality in post 1991 arrival cohorts

After 1991, SMRs deteriorated over successive arrival cohorts, but the pattern was far from homogenous. As multivariate models confirm, the deterioration was pronounced for adult males, but less so for adult females, and for the elderly of both genders it was not present at all. Any explanation of the deterioration has to explain these differences as well. Returning to the health field concept, it is unlikely that what distinguished immigrants in later cohorts was increasing risk due to differing bio-genetic factors, worsening environmental exposures, or declining utilization of health care in the FSU or Israel. Rising mortality risks are most likely to be associated with behavioural factors, lifestyle and diet.

At first sight the pattern of socio-demographic change after 1991 which we have found could explain rising relative mortality. Average levels of education fell over successive arrival cohorts until 1996-97 which would have lowered average SMRs, other things being equal. But since the pattern of change in educational qualifications was U shaped (as shown in section 4.2.1), some recovery should have been expected after the middle of the decade. Geographic trends also point to lowering average SMRs. The proportion of migrants from the Asian and Caucasian Republics rose to a peak in 1992-1995 and the proportion of migrants from Moscow and Leningrad declined over time. Just as the immigrants from Moscow and Leningrad were the

most favourably self-selected group, lower selectivity is most evident in immigrants from the Asian and Caucasian republics, since the Jewish population of these areas relocated to Israel almost entirely. Their higher levels of mortality risk may reflect both the absence of economically-based positive self-selection, as well as the higher overall level of mortality in their areas of origin (section 2.6.3.4). Finally, the proportion of non-Jewish immigrants rose continuously (table 4.1), and both males and female non-Jews had lower educational levels (section 4.2.1) and male non-Jews had higher mortality rates.

But the analysis has shown that compositional factors cannot explain the deterioration: controlling for education, geographic origin and ethnic background does not eliminate the progressive rise in relative risk across arrival cohorts. On the contrary, as shown in section 5.5.3, not only are the coefficients of education and geographic origin in multivariate models unaltered by temporal trends, but the effect of ethnicity is reduced when temporal factors are introduced into the models, indicating that unmeasured factors common to all immigrants whatever their formal ethnicity are driving the deterioration in male SMRs over arrival cohorts. Economic theories of migration consider these unmeasured factors to be qualities such as motivation, ability and social capital which are all expected to produce better economic performance and be correlated with superior health. According to this approach, the relative increase in mortality would be explained by the decline in these unmeasured qualities.

In the economic approach the degree of positive self-selection falls as practical knowledge of the positive benefits of life in the destination spreads, and as economic and social barriers to migration are lowered. As an immigration wave develops, immigrants with ever-weaker employment and health profiles will join it (section 1.5.3). Among these theories are the "welfare magnet" hypothesis, which argues that welfare generosity leads to less-skilled migration (Razin and Wahba 2015) or the theory of "cumulative causation", which argues that as migratory experience grows within a community the costs and risks of migration fall and the benefits rise, raising the likelihood of migration and lowering the criteria for self-selection (Massey 1999; Massey et al. 1993). In the present case, in all the countries of the FSU the panic of 1989-91 subsided quickly but social, economic and political difficulties persisted throughout the following decade, sustaining a constant level of "push" factors. A financial crisis in Russia in 1998-99 briefly renewed anxiety and brought about a rise in emigration rates (Tolts 2003)but this crisis does not appear to have stimulated favourable self-selection, and the arrival cohort that followed it did not alter the pattern of successively worsening relative mortality for adult males. On the other hand, "pull" factors increased throughout the decade, and the role of the expanding basket of aid and incentives offered by Israel may have played a greater role than it had earlier, and may have attracted persons who met the eligibility criteria for subsidized migration to Israel who had not considered migration in the early 1990s. A unique survey of a representative sample of persons with Jewish background in Moscow, Kiev and Minsk in 1993, following the panic phase, found that most respondents did not plan to emigrate, but that among those who did, economic considerations in the broad sense (career advancement and prospects for children, rather than wages per se) were the chief motivating factors (Brym and Ryvkina 1994). Although Brym and Ryvkina find that (in this early period) the degree of Jewish identification was the strongest predictor of emigration to Israel specifically, the rising proportion of non-Jews among immigrants to Israel may be regarded as further evidence for the eventual dominance of economic considerations.

As conditions in Israel became clearer to prospective immigrants, immigration decisions transformed to the rational weighing of the alternatives. This entailed considering the value to the individual or to the family as a whole of a number of alternatives: remaining in the FSU; taking up the Israeli offer of free passage, Israeli social welfare benefits and free and advanced health care along with constrained employment prospects; accepting the greater economic benefits offered by Germany; or risking the chances of lower benefits but better employment in the USA for the most educated and highly skilled (Cohen et al. 2011). According to economic theory, if the most skilled were choosing the USA it is likely that a less healthy portion of the immigration stream was reaching Israel. Uncertainty and barriers to migration were

lowered further by the emergence of networks of family connections in Israel and the growth of a large and increasingly well-established established Russian-speaking culture. With lower barriers for the weakest prospective migrants and more remunerative alternatives elsewhere for those endowed with the greatest human capital and (presumably) health resources, the "health quality" of the stream of immigrants to Israel may have progressively deteriorated.

Indeed, the data suggest the possibility of a literal "sick immigrant" migration. As the wave progressed some immigrants may have been motivated specifically by health benefits, as the word spread that free and advanced treatment was available in Israel while health services in the FSU were deteriorating (Shkolnikov et al. 1998a). Increasing SMRs for neoplasms on arrival over successive arrival cohorts, followed by a sharp decline in the first years after migration, especially among males (section 4.4.3 and figures 4.25, 4.29) suggests that immigrants came seeking treatment for advanced cancers, which, in some cases ended with early death. Such motivations may have been true for immigrants with other diseases as well, especially heart disease. SMRs for CVD on arrival rise substantially over successive arrival cohorts at adult ages (Appendix table A3.6a), but since they do not decline rapidly over duration, the data do not expose a clear pattern of treatment-motivated migration. For chronic disease mortality in general, we cannot settle the question without data on morbidity. However, there is evidence that health-motivations for migration were limited. It is striking that the rise in mortality risk is confined to adult ages. If the attraction of unhealthy migrants seeking treatment was the prime driver of the rise in SMRs over successive cohorts we would have expected this to be all the more true of elderly migrants, where health needs are greater. Thus although ill-health-induced migration may have played some role in rising SMRs, we cannot conclude that it is the prime explanation for it. The negative selection of adult males may be explained by another factor.

During the 1990s and the early 21st century mortality in the FSU, especially among adult males, increased precipitously until 1994, followed by a moderate recovery until the reversal of 1998 which brought renewed decline. A number of explanation for this mortality crisis have been proposed in detailed studies (of Russia specifically, for which the most detailed data were available), chief among them the sudden impoverishment, institutional disruption (including deterioration of the health system) and the psycho-social stress it engendered, and the unhealthy behaviours and lifestyle, especially high tobacco and extreme alcohol consumption) which were enhanced by it. These affected adult men, and those with lower levels of education in particular (Bobak et al. 1998; Leon and Shkolnikov 1998; McKee and Shkolnikov 2001). These factors were expressed in heightened mortality from infectious diseases, and especially external causes and CVD (Notzon et al. 1998; Shkolnikov et al. 1998a). Given these findings, the deterioration of adult male mortality over successive arrival cohorts would appear to have a ready explanation: the routinization of migration after 1991 may have eased and/or encouraged migration to Israel of more typical FSU residents, who represented deteriorating mortality in the FSU.

Here too caution is in order. If increasing SMRs over adult male arrival cohorts in Israel reflects the deterioration of health in the FSU, the reflection is through a selective filter, since there are substantial differences between the patterns. The deterioration in SMRs among adult migrants from the FSU includes all causes of death, unlike the deterioration in the FSU. Indeed it is greatest for external causes, but it embraces all neoplasms as well as CVD and other causes. Only -0.3 years of the -2.3 year deficit in $e_{15}$ between FSU immigrants and Other Israelis in 2000-2004 is explained by higher CVD mortality, and most of the difference is contributed by external causes (-1.0 years) and neoplasm mortality (-0.9 years). Moreover, the overall difference in $e_{15}$ for male FSU immigrants and Other Israelis is only a fraction of the Russia – Israel gap (2.3 years as compared to 17.8 years (Ott et al. 2009)). Clearly, although mortality risks among arriving adult FSU immigrants were increasing, they did not represent the FSU average. Even in latter cohorts nearly 50 percent of FSU immigrants to Israel belonged to the higher education category, for whom mortality conditions in the FSU did not deteriorate substantially in the 1990s (Shkolnikov et al. 2006; Shkolnikov et al. 1998b). In addition, the prominence of all neoplasm mortality in accounting for the

disadvantage in Israel contrasts with decomposition of life expectancy between the USA and Russia in 1999 and 2001, respectively, where for both males and females external cause and circulatory cause mortality at adult ages, and at elderly ages circulatory diseases alone, explain almost all the gap in life expectancy (Shkolnikov et al. 2004a). Unlike in Israel, differences in levels of neoplasm mortality are not substantial contributors (although under registration of cancer mortality in the FSU may bias this comparison (Shkolnikov et al. 1999)).

Some of the difference in the gap may be due to the particular characteristics of the destination rather than to differences between the immigrating populations. Neoplasm mortality rates for males in Israel are among the world's lowest: age standardized all-site rates for Israel in the year 2000 were 127.0 per 100 thousand as against 144.5 for the USA, or 158.2 for Germany, whereas age standardized rates for women were similar to those of other western countries (Ervik et al. 2021). Even if FSU immigrants didn't have particularly heightened neoplasm mortality on an international scale, they did in comparison to Israeli males. Previous studies of this dataset which pointed out these elevated rates, argued that they may be due to a differential exposures, diet and behavioural factors which were characteristic of USSR mortality (Ott et al. 2008; Ott et al. 2009; Ronellenfitsch et al. 2009). For males, neoplasm SMRs worsen for all ages over arrival cohort, but even the positively selected 1990-1991 arrival cohort had elevated neoplasm mortality compared to adult Israeli males. Nonetheless, for both sexes the improvement in all neoplasm mortality which was found over duration of residence in Israel in previous studies of this dataset, was confirmed in the present analysis for adult ages. Since the period of observation is probably too short to show the effects of behavioural change on diseases with a long latency period, this positive duration effect is most likely due to effects of the Israeli health system: both superior treatment and early detection. The negative duration effect for males at elderly ages (fig. 4.34) remains unexplained and may point to failures of the Israeli health system for older immigrants.

The deterioration of relative risk over arrival cohort may also be due to a progressive decline in the proportion sharing the "protective" characteristics ascribed to Jews as an ethnic group, which are not controlled for by our indicator of Jewish ethnicity. The boundaries between the two groups as measured by the ethnic variable is not sharp and is not based on cultural identification. It reflects the religion variable as recorded in the Israeli population register, and this is based, primarily, on matrilineal descent from a Jewish parent. Many persons defined as "non-Jews" according to Israeli regulations were registered as Jews by nationality in the USSR, while some of those registered as "Jews" in Israel were registered as belonging to other nationalities in the USSR. The offspring of mixed marriages where the father was the Jewish partner are recorded as non-Jews in Israel (unless they underwent a religious conversion), and may have been registered as Jews by nationality in the FSU. Since the proportion of "mixed" marriages among both the FSU Jewish population and the arriving immigrants was large (Tolts 1992) many of the "non-Jews" had a Jewish father, and the "cultural" distinctions between many of those who are formally Jews according to Israel law and those who are not may have been small if present at all. Immigrants who arrived later in the wave, both Jewish and non-Jewish family members, may have been less likely to share the favourable behavioural traits ascribed to the Jewish ethnic group. If the sense of imminent danger which drove out many in 1990-1991 was greater among those with a stronger sense of Jewish identity, who shared the purported Jewish "life-style", it is possible that later in the wave these cultural traits may have been less common. More assimilated and more marginal members of the Jewish population may have been drawn to Israel only once the economic and other advantages offered by migration to Israel were clarified, and they would be more likely to exhibit the behavioural and life-style patterns typical of the FSU majority. Thus, from a methodological perspective, if the proportion of non-Jews among the FSU immigrants rose in parallel to the proportion of assimilated and only formally-Jewish immigrants from mixed-marriages, the power of the ethnic variable in our dataset to distinguish between a "Jewish" and "non-Jewish" group in a behavioural sense will have progressively weakened. For similar reasons the discriminating power of the

variable would have been weaker for adults and greater for the elderly, since very few if any of the latter age group were the product of mixed marriages and the sense of ethnic identification among them was stronger, even among migrants to Germany (Elias 2005).

It seems likely that the deterioration in adult male FSU immigrant mortality in post 1991 arrival cohorts may have multiple sources, none of which provides a perfect match to the process we observe, but which may have combined to produce the effect. A progressive decline of self-selection on unobserved health-promoting characteristics may have led to deteriorating mortality on arrival, and an increasing number of migrants may have been motivated by the offer of health treatment. But neither of these sources explain why their impact was on adult men in particular. The deterioration appears to correspond to the decline of adult male health in the FSU, but the correspondence is partial at best. It explains the rise in mortality from external causes, but the immigrants belonged to the sectors of FSU society who did not suffer a major setback in mortality. In addition, it is possible that these trends were compounded by an increasing loss of "protective" aspects of Jewish health behaviour (which also favour adult men), but our evidence for this is indirect, principally through the rise of external cause mortality.

### 5.4.2 The relative advantage of elderly FSU migrants

The contrast between adult and elderly FSU immigrant mortality found in this analysis is striking. For every cause of death and for both sexes the relative risk of elderly migrants is lower than that of adult migrants, and for all causes combined equal to or better than that of Other Israelis. SMRs by duration and arrival cohort for the elderly are systematically lower in every category (Appendix Tables A3.6ab and A3.7ab). Not only is relative risk lower, temporal patterns among the elderly are far more moderate if present at all. In particular, the multivariate models show that the pattern of increasing disadvantage by arrival cohort for males is absent or very weak in the elderly age group, and the pattern of decreasing SMRs by duration for females is absent at elderly ages, with the exception of a very small short-term rise and fall observed for CVD deaths. And as we have already emphasised (5.3), these findings conflict with the pattern predicted by the HME model. This is all the more important because this study is unusual in its ability to address mortality risks of elderly migrants at short and medium durations, rather than as survivors of more distant migrations. This may be true of other migrations as well. One longitudinal study of elderly Mexican immigrants in the USA also found, unexpectedly, that late-life immigrants had lower mortality than those who arrived at earlier ages and suggest possible genetic, social and behavioral reasons for their findings (Angel et al. 2010).

The lower mortality risks of the elderly are also difficult to reconcile with previous studies of FSU immigrants in Israel. Greater health difficulties were anticipated for them, since the hardships faced by elderly FSU immigrant to Israel appeared to be particularly severe and greater than those of younger immigrants. Loss of Soviet pensions and professional credentials meant that older people who had been self-sufficient professionals in the FSU were forced into dependency, living from low government benefits supplemented by unskilled, menial jobs (Remennick 2003c; Remennick 2007a). The multigenerational households in which most lived (Habib et al. 1998) may have provided social support in the early years after migration, but also generated conflict and emotional tensions (Katz and Lowenstein 1999; Litwin 1995; Lowenstein and Katz 2005). The elderly faced an abrupt transition to an alien cultural milieu and a foreign language which they found difficult to acquire and master at an advanced age, as well as the loss of a lifetime of accumulated social capital: friendship networks, professional prestige, and country-specific skills. At the same time a growing distance from younger family members who were increasingly integrated into the new culture (Lerner et al. 2005; Ritsner and Ponizovsky 2003). Older FSU immigrants were found to have lower levels of life satisfaction and greater levels of depression than immigrants to Israel from other origins, while controlling for length of residence and socio-economic and demographic variables (Amit and Litwin 2010). Difficulties of adaptation were used to explain findings of higher stress and psychopathology, lower

subjective health and self-reported chronic conditions, as well as higher mortality among elderly FSU immigrants (Baron-Epel and Kaplan 2001; Gross et al. 2001; Litwin and Leshem 2008; Ponizovsky et al. 2009; Rennert et al. 2002; Ritsner and Ponizovsky 2003; Zilber et al. 2001).

Although the negative consensus in these studies is striking, many of them were based on small and/or unrepresentative samples. One study takes issue with this assessment and hints at a possible reason for our findings: it finds that despite the real hardships and the cultural dislocation which older immigrants went through, their outlook remained positive and they did not regret their decision to migrate, not least because of their stronger sense of Jewish identity than younger immigrants (Remennick 2003c).

Lower risk is not homogenous in the elderly age group. Decomposition of $e_{15}$ qualifies the basic finding of lower risk by showing differentiation by age, sex, and cause (section 4.3). Life expectancy analysis shows that it is principally the very oldest age group (75+) that contributes most of the advantage that is found at age 60+ in SMR analysis. Lower mortality at age 75+ consistently contributed an advantage over Other Israelis, in contrast with the growing disadvantage for males at age 15+ and the near erasure of the advantage for females, although for both genders the advantage diminishes over calendar period. At age 60-74 the picture varies by gender and seems to point to an overlap with the pattern at adult ages. For both the older and younger elderly age groups and for both genders decomposition shows that the reduction over calendar time of the elderly advantage was due to the combination of the reduction in the advantage in CVD and all other cause mortality over calendar time counterbalanced by a deepening disadvantage due, principally, to an increasing gap in all neoplasm mortality. Below we will suggest an explanation for this difference due to a unique selective pattern.

In addition to these age-sex differences, we have seen that patterns of advantage and disadvantage of the elderly vary considerably by geographic and ethnic group, and the differences may point to differential selection patterns which partially explain the relative advantage of the elderly age group as a whole. The overall advantage of the elderly is greatest among the very oldest non-Jewish females and among immigrants from Moscow and Leningrad, the two groups with the best relative mortality overall. In the groups with the worst mortality overall, the Asian Caucasian region and non-Jewish males, the pattern is reversed. On the positive side, among male immigrants from Moscow and Leningrad the advantage in $e_{15}$ of 1.1 years over Other Israelis in 2000-2004 is contributed by elderly (60+) males (counterbalancing a disadvantage of -1.3 years at adult ages), and among females an advantage of 1.9 years is contributed by elderly females (greatly adding to an advantage of 0.3 years at adult ages). Elderly female non-Jews contribute an advantage of 2.3 years over Other Israelis (reversing a disadvantage of -0.6 years at adult ages), but 1.8 years of this is provided by mortality at age 75+. On the negative side, higher relative mortality of elderly males and females from the Asian-Caucasian region, and elderly male non-Jews in 2000-2004 increase their gaps in $e_{15}$. Elderly males from the Asian-Caucasian region contribute -1.7 years of a total gap of -3.3 years in $e_{15}$ with Other Israelis, and elderly females contribute -1.1 years to total gap of -1.4 years. Finally, elderly male non-Jews contribute -1.4 years of a total gap of -5.4 years in $e_{15}$.

The pattern of rising relative risk across arrival cohorts after 1991 was explained above as due to a dual process: on the one hand, a falling proportion of immigrants with favourable "Jewish" cultural patterns, and complementing this, negative self-selection due to falling economic barriers. Both factors would have been weaker among the elderly: among them the proportion of non-Jews was far smaller than at younger ages (and the discriminating power of our ethnic variable greater), and the potential benefits of prospective employment in the USA would have been a negligible contributor to negative selection of the Israeli destination by the less "robust". Support for the idea that cultural-behavioural patterns at elderly ages lowered relative risk can be found in the contrast between contributions among elderly males to difference in $e_{15}$ between Jews and non-Jews as compared to Other Israelis in 2000-2004. At age 75+ there are virtually no differences in mortality between male FSU Jews and Other Israelis, but among non-Jewish males there

is a negative contribution due to causes with behavioural origins: -0.2 years due to Tobacco-related cancers and -0.4 years due to CVD. But this behavioural-cultural explanation for males leaves unexplained the substantial mortality advantage of elderly female non-Jews. This will be discussed in section 4.5.

Health-promoting qualities associated with drive and resourcefulness may have characterised a large portion of the elderly who chose to move to Israel, even though positive self-selection among the elderly cannot be traced to labour market motivations. Unlike other migration movements, rather than relatively passive family members who only accompany or join the active, younger migrants, the elderly FSU migrants were equal or independent participants in the rapid decision to migrate in 1990-1991, and subsequently. Although the elderly formed over 22% of arriving FSU immigrants in 1990-2003 (Table 4.1) this high proportion reflects the old age structure of the Jewish population of the FSU. When compared to the origin population, rates of migration in the elderly age group were far lower (and thus more selective) than for other age groups, and were greater for those among the elderly who had children (Paltiel et al. 1997). Since data for the Russian Federation showed that nearly 18 percent of elderly Jewish women were childless, this points to another strong selective force: the childless, more isolated and perhaps less robust members of the population must have been left behind. Most of the elderly arrived as members of mutually-supporting family units, and, as previously noted, after immigration they continued to live in multi-generational households. Although in other contexts family-based migration is often regarded as encouraging migration of the less-healthy, the emotional support and practical help provided by close family ties may themselves have been a factor promoting better health for the elderly after arrival. Nevertheless, although family migration was the most common pattern, around 25% arrived alone or with a spouse (Remennick 2003c) demonstrating that many of the elderly were sufficiently motivated to face the risks of migration on their own. Even when family members were absent many managed to develop extensive networks of social support (Litwin 1995). At least one researcher has concluded that the FSU elderly in Israel, on the whole, became active participants in their new society, with a positive view of their migration choice and a strong sense of belonging in their new home. They were far more likely than younger immigrants to have strong connections to a Jewish heritage and share Jewish cultural traits, and for this reason find themselves more "at home" in Israel (Remennick 2007a).

One further life-course selective factor should be considered: elderly Jewish FSU migrants were survivors of a particularly severe regime of selection. They had endured both the economic and political adversities of Stalinism and the devastation of the Holocaust and World War II, both of which reduced their numbers considerably (Gitelman 1990). One might suppose that this would leave many of them burdened by the long-term effects of psychosocial trauma, poor nutrition and other environmental factors. Studies of birth cohort effects on mortality risks in the FSU found an elevated mortality risk for persons who were children or were born in the second world war (1930 to 1945 birth cohorts, who would have been aged 45-60 in 1990 and increasingly older throughout the study period) (Anderson and Silver 1989; Willekens and Scherbov 1992). But the literature on holocaust survivors points to a more complex picture: higher morbidity from a variety of conditions which is combined, paradoxically, with lower overall mortality (Barel et al. 2010; Fund et al. 2019; Keinan-Boker et al. 2009; Sagi-Schwartz et al. 2013). These studies show that survivors were selected for resilience and relative physical and psychological strength (Sagi-Schwartz et al. 2013). This pattern may be a partial explanation of the seemingly paradoxical difference between findings documenting lower mortality risks, and studies which found lower self-reported health levels among the FSU elderly (Constant et al. 2018; Gross et al. 2001). The "sick immigrant effect" found in these studies (due to higher subjective and objective morbidity) and the "health immigrant effect" found here, may both reflect this paradoxical survivor selection effect, which combines higher morbidity with lower mortality due to the underlying adaptivity and resilience of this population.

These findings are not unique. A study of both subjective health status and mortality among late-life immigrants to the United States found that among elderly immigrants lower mortality compared to natives

coexisted with lower subjective measures of health and functional status (Choi 2012). It too pointed out that these results conflicted with the HME model. Recent studies of migrants in the UK also found evidence for a "health-mortality" paradox, with greater self-assessed functional limitations coexisting with lower relative morality (Cézard et al. 2022; Wallace and Darlington-Pollock 2022). Possible factors suggested to explain this paradox were selection effects, as we have proposed, and biogenetic differences that leave some groups of immigrants more vulnerable to non-lethal chronic diseases. In Europe as well, a survey of migrant populations found that greater longevity was found together with worse health, and thus lower healthy life expectancy (Reus-Pons et al. 2017).

Common life course factors and the nature of the reference population itself may also affect the level of relative risk. The high proportion of migrants in the Jewish population of Israel as well as in other countries has been proposed as a partial explanation for Jewish mortality patterns (Staetsky and Hinde 2015). The similarity in mortality risk to the elderly Other Israeli population may be due in part to a common background. Seventy percent of the Jewish Israeli population in these age groups in 1990 were born in eastern Europe. Most of them arrived in Israel in the late 1940s and 1950s, or in the previous migration from the FSU in the 1970s (ICBS 1991). Although they were exposed to Israeli conditions and the Israeli health service much longer than our study population, many of them went through similar early and mid-life experiences to the FSU immigrants. From a life course perspective, the FSU immigrants and a considerable proportion of the Israeli population in these age groups will share the long-term influence of these formative exposures (both before and including the brutality of the second World War), some of which may remain latent until old age (Fund et al. 2019). This overlap is not shared by younger FSU migrants who went through very different formative experiences, and for them, the comparative group is, by and large, Israel-born. To some extent the formative historical experience of the elderly non-Jewish immigrants from the FSU, among whom mortality risks differ substantially from those of the Other Israeli population (negatively for males and positively for females), may also have contributed to differences in mortality patterns. These ethnic group differences will now be considered.

## 5.5 Mortality differences between Jews and non-Jews

**Differences in risk.** No previous study has documented differences in mortality risk between Jews and non-Jews among the FSU immigrants to Israel. These are of particular interest given the differences in mortality patterns between Jews and ethnic Russians that were documented for Moscow in the early 1990s by Shkolnikov et al. (2004b), and the reversal of social position as members of majority and minority ethnic groups that this migration brought about. There are obvious reasons to expect differences between the groups in self-selection. Non-Jewish immigrants would not have been motivated by the cultural or identity-based motivations which drive diaspora migration, nor by the fear of persecution amidst political disorder which which may have brought about positive self-selection in the panic stage of this migration stream (although family members may have been affected by both). On the "pull" side, access to the economic benefits of life in Israel (broadly conceived), and on the "push" side economic decline and social and political disorder in the FSU, would appear to be the prime motivators of non-Jewish migration, and they may have been associated with weaker selection of "unmeasured" positive qualities. But there is no direct evidence for this. The data shows that for all immigrants consecutive arrival cohorts were increasingly less selective. However, while non-Jews will have lacked the positive motivation that fueled the early departure of many Jews, barriers due to cultural obstacles coupled with economic motivation might generate other forms of positive selection of non-Jewish migrants from among the general population of ethnic Russians in the FSU (Roelfs and Shor 2021). There is evidence that such positive selection occurred, in conformity with the lower risks of female non-Jews and despite the recorded higher mortality risks of male non-Jews.

The comparison between the ethnic groups is constrained because, as mentioned above, the boundaries between the two groups in our data are not sharp. Moreover, since non-Jews shared family relationships

and a social milieu with the Jews, they may also have been more similar in behaviour and lifestyle than the average members of the "Russian" or "Slavic" ethnic group in the FSU itself. This is borne out by the similarity of both groups' educational qualifications in Israel (Section 4.2), which is a further indication that the two groups came from similar milieus. These considerations might blur any life-style and behavioural differences between the groups, and the complex family relationships may also blur possible differences in mortality patterns based on bio-genetic factors. Yet despite this overlap and similarities, the results point to relatively large differences between the groups, which are, at the same time, smaller than those in the FSU itself.

Although in 1995-1999 immigrant non-Jewish FSU males have a disadvantage in $e_{15}$ of -1.9 years compared to FSU Jews and -3.1 years compared to Other Israelis, in comparison with the evidence from Moscow in the early 1990s (Shkolnikov et al., 2004b) the gap between the two ethnic groups was much smaller than that in the FSU. This indicates that the immigrants were positively selected, even when their high educational profile is taken into account. In order to compare the findings we have recalculated life expectancies for the ages used in the Moscow study. Life expectancy at age 20 for male Russians in Moscow in 1993-1995 was 42.8 years, whereas for non-Jewish FSU males in Israel in 1995-1999 it was over 11 years higher, 54.1 years. Much of this large gap may be explained by the higher educational profile of immigrants to Israel, but it is present even after educational attainment is controlled. The estimate of life expectancy at age 25 for male Russians in Moscow with "Higher and incomplete University education" in 1993-1995 was 46.2 years whereas for non-Jewish FSU immigrants (of all educational levels) in 1995-1999 at that age it was 49.5 years. For female non-Jewish immigrants, who had an advantage in $e_{15}$ of 3.9 years over FSU Jews and equivalence with Other Israelis, there is also strong evidence of positive selection in comparison to the origin population. Life expectancy at age 25 for female non-Jewish FSU immigrants in 1995-1999 was 59.4 years, whereas for female Russians in Moscow with higher education in 1993-95 it was much lower, 53.8 years. Thus, despite the low relative mortality of male non-Jewish immigrants (which appears to point to negative selection), both genders were positively selected when compared to ethnic Russians in the FSU.

Due to the family relationships between the members of both groups in Israel, it is reasonable to assume that they came from similar social milieus and that there are no substantial differences between them in environmental exposures in the FSU. In addition, although it has been argued that Jews have historically displayed a culturally-based greater concern with healthy behaviour (Staetsky and Hinde 2009; Staetsky and Hinde 2015) no substantial differences have been reported between the two ethnic groups in interactions with the health system either in the FSU or Israel. Thus the sources of differences in mortality risk between the two groups are to be found in the same factors singled out by Shkolnikov et al (2004b): culturally-based differences in behaviour, lifestyle and diet, as well as biogenetic differences. To a large extent differences in patterns of cause of death between the two groups that were found in Moscow were recapitulated in Israel, although the levels of risk in Israel was lower due to the favourable selection of the non-Jewish immigrant group. The cultural basis for higher alcohol-related mortality risks for ethnic Russians is reinforced by parallel findings in Caucasian and central Asian republics and successor states of the FSU (Bougdaeva 2010; Guillot et al. 2011; Sharygin and Guillot 2013).

As in Russia, non-Jewish FSU males in Israel had higher mortality due to diseases directly and indirectly related to alcohol consumption and smoking, and risk-taking behaviour. Looking at more detailed groups of causes of death in life expectancy decomposition shows that male non-Jews in 2000-2005 had a greater deficit in $e_{15}$ compared to Other Israelis than FSU Jews from: tobacco-related cancers (-0.6 for non-Jews vs. -0.2 years for Jews), all heart diseases (-0.2 vs. -0.5 years) cerebrovascular disease and athero-sclerosis (-0.6 vs. –0.1 years), alcohol related diseases (-0.6 vs -0.2 years) external causes (-2.1 vs -0.7 years) and ill-defined causes (-0.8 vs. 0.1 years). In Moscow, female non-Jews had a small advantage over female Jews only once levels of education were adjusted. In Israel, however, the advantage of female non-Jews was large, and it derived from a mixture of causes with behavioural, and possibly bio-genetic sources. Non-Jewish

FSU females had a small advantage in all neoplasms over Other Israelis (0.1 vs -0.6 years for Jewish females). Among the neoplasm cause groups they had lower relative mortality for, principally, breast, tobacco-related, colorectal, and the residual other cancers category, indicating both lower tobacco consumption, and a possible role of biogenetic factors in breast cancers and other cancers. They had a large advantage in all heart diseases (0.6 vs 0.1 years); a small advantage in respiratory diseases (0.4 vs. 0.2 years) and an advantage from the residual all other causes group(0.5 vs 0.1 years). Non-Jewish immigrants of both sexes enjoyed an advantage from diabetes mortality (0.1 vs 0.3 years for males, and 0.4 vs. -0.1 years for females), a category for which a genetic mutation among Ashkenazi jews may contribute higher susceptibility to Type 2 diabetes (Love-Gregory et al. 2004; Neuman et al. 2010).

The contrast between the sexes is most striking for all neoplasms, all heart diseases and cerebrovascular disease and atherosclerosis. Decomposition of $e_{15}$ showed that male non-Jews had higher mortality for all of these cause groups than both FSU Jews and Other Israelis, whereas female non-Jews had lower mortality risks than both comparison groups for all groups except atherosclerosis. Although the "genetic" boundary between the groups as represented on our data are not sharp, it is tempting to generalise and say that whereas male Jews enjoy lower mortality due to lower behavioural risk, female Jews suffer from higher risk due to bio-genetic factors, since differences are most evident in the lower neoplasm risk for female non-Jews compared to Other Israelis, and they are greatest in the oldest age group in which the overlap between the groups is least likely.

Higher cancer rates among Ashkenazi Jewish females are often ascribed to genetic variants that predispose them to elevated site-specific risks. The most widely studied are the *BRCA1* and *BRCA2* founder mutations which are associated with higher risk of breast and ovarian cancer in women (Rubinstein 2004) but also with elevated risks of pancreatic cancer in both sexes and prostate cancer in men (Hamada et al. 2019; Mersch et al. 2015). Higher genetic risks for breast cancer among Ashkenazi women extend to other mutations as well (Walsh et al. 2017). In addition, the possible genetic origin of high lifetime risks of colorectal cancer among Ashkenazi Jews has received much attention (Lynch et al. 2004). The *APC* gene, for instance, which is found in 6% of Ashkenazi Jews, is associated with an increased risk of colorectal cancer (Kedar-Barnes and Paul 2004). But despite the demonstrable presence of hereditary diseases within the relatively endogamous Ashkenazi group (Charrow 2004), research so far has not established whether genetically-based vulnerabilities raise mortality risks in aggregate, especially among women. While there is evidence that among *BRCA1/2* carriers life expectancy was reduced due to non-cancer mortality (Mai et al. 2009) and that they may suffer greater risks of cardiac failure (Shukla et al. 2011), present evidence of a genetically-based overall higher cancer risk among Ashkenazi Jewish women is inconclusive (Feldman 2001; Lynch et al. 2004).

Findings in this study provide evidence that overall mortality risks for FSU Ashkenazi Jewish women, especially for neoplasms, are higher. Given the similarity in life-style factors and social milieu between the two ethnic groups among FSU immigrants, especially at adult ages, and the fact that the mortality risks of female FSU Jews appear to resemble Other Israeli women more than those of female non-Jews do, the findings appear to lend support to a genetic rather than environmental explanation for elevated rates among Ashkenazi Jewish women. Future studies which address the complex subject of the interaction of differing environmental exposures with susceptibility due to genetic variation might well chose to concentrate on differences between these two groups of immigrants in Israel. This would be a classic "environmental transition" natural experiment, since the groups shared a common background and similar challenges of adjustment.

**Differences in temporal trends.** Non-Jews were an increasing proportion of all immigrants, and their arrival was biased towards the end of the wave (where they reached over half of arrivals) and thus it was not surprising that we found that the strength of the coefficient for non-Jewish ethnicity was altered for

both sexes after adjustment for temporal effects, lowering the relative risk for male non-Jews and raising the relative advantage of female non-Jews (section 4.1.3). The direction of the adjustment, dampening the negative influence of the temporal variables, demonstrates that non-Jewish ethnicity per se does not enhance the unmeasured factors behind the negative temporal trends. Although model selection did not favour models where temporal effects interacted with ethnic group, this may have been due to the shorter average duration of stay of non-Jews and the greater informative power of the age interactions which were chosen in the best models. Given the relatively short period of exposure, the possibility of temporal patterns that differed by ethnicity was not investigated here in depth. The large differences we found in relative mortality risks, the differences in selection patterns of non-Jews, and the possibly that their patterns of adjustment to life in Israel (as a minority whose personal status differed from that of the majority) there is room for a future comparative study of temporal trends.

## 5.6 FSU migrant CVD mortality and the "cardiovascular revolution"

The relatively low CVD mortality rates of FSU migrants and their temporal patterns may have indirect implications for one of the central overarching frameworks for understanding the history of population health, Abdul Omran's theory of the "epidemiological transition" and its modification by "the cardiovascular revolution". The patterns of FSU migrant mortality in Israel may have implications for the role of preventative and therapeutic medical techniques on the decline in CVD mortality.

Omran's original formulation of his theory (Omran 1971) argued that epidemiological regimes had been transformed in a three stage process whereby an original stage, dominated by high and fluctuating infectious disease mortality and gross malnutrition ("the age of pestilence and famine") was transformed in a second stage which began in the nineteenth century, "the age of receding pandemics", when infectious disease mortality declined due, principally, to rising standards of living and nutrition, and improved sanitation. Only in the mid-twentieth century did curative medical and public health measures have a substantial impact on mortality, and these led to "accelerated transition" in the less developed world. In the developed nations, a third stage, "the age of degenerative and man-made diseases" was reached by mid twentieth century, when, in the absence of infectious disease mortality, and due to modern lifestyles, cardiovascular disease and neoplasm mortality became the principal causes of death. Omran's original formulation was published at a time when death rates from these two cause groups were rising, and increases in life expectancy, which had been driven by the decline in infectious disease mortality, had slowed or halted. But beginning in the late 1970s it became apparent that, cardiovascular mortality rates were declining throughout the developed world, despite detrimental modern lifestyles, albeit from very different initial levels. Unexpectedly a new phase, "the cardiovascular revolution" had begun (which Omran now added as a 'fourth stage' of the epidemiological transition), and it has driven improvements in life expectancy for the last 40 years (Caselli et al. 2002; Omran 1998; Vallin and Meslé 2004).

The cardiovascular revolution has been defined as "a continuous and irreversible reduction in cardiovascular mortality driven by both fundamental changes in behavioral risk factors and advancements in medical technology and disease prevention" (Grigoriev et al. 2014). In Omran's formulation the second stage was "accelerated" in developing countries by medical advances such as the use of antibiotics and vaccines which had not been available earlier. The second stage had reached Europe without the aid of curative medicine. But medical technology was crucial to this new stage of the transition wherever it occurred. And along with the demarcation of this "fourth phase" came the recognition that eastern Europe and the USSR remained stuck in the third stage, with life expectancy stagnating (especially for men) throughout the region in the 1970s and 1980s and declining sharply in the successor states, and especially Russia, following the breakup of the Soviet Union.

Stagnating and rising CVD mortality rates were central to the explanations of the east-west gap and the mortality crisis of the 1990s, although they encompassed, in addition, a wide variety of social, behavioural, and health care factors, and differences between the countries were not limited to one cause of death group (Andreev et al. 2003a; Bobak et al. 1998; Cockerham 1997; Shkolnikov et al. 2004a). This divergence necessitated an explanation of why these countries failed to take part in the revolution. Indeed, when life expectancy began to improve in eastern Europe in the mid-1990s and in Russia a decade later, this was seen as due to the spread of the cardiovascular revolution to these countries as well (Fihel and Pechholdová 2017; Grigoriev et al. 2014; Meslé and Vallin 2002; Shkolnikov et al. 2013). Both the delay and the eventual spread of cardiovascular mortality decline were explained in the same terms, as due to higher and then declining lifestyle risk factors. But these were accompanied by failures and then improvements in medical services and the adoption of medical technologies and interventions, some of which targeted specific metabolic risk factors. The behavioural factors included alcohol and tobacco consumption, diet (levels of consumption of unsaturated fats and fresh fruit and vegetables) and physical activity; the metabolic factors

included high systolic blood pressure, hyperlipidemia, obesity and high fasting glucose levels; the medical treatment included control of hypertension, anti-arrhythmic and lipid-lowering drugs, and percutaneous and surgical interventions. The absence of effective medical treatment, management and prevention appeared to be due to the relative economic weakness of the eastern European countries, which could not afford the new technologies, coupled with the failures of Soviet-style medical services, which were unable to encourage personal responsibility for changes in lifestyle and behaviour (Vallin and Meslé 2004). With the collapse of the Soviet system, changes in institutional organization and the provision of health services, it was argued, were crucial to the spread of the cardiovascular revolution to the former Eastern-bloc countries (Fihel and Pechholdová 2017).

The same array of risk-factors and interventions were used to explain and study the decline of circulatory disease mortality in the forerunners of the cardiovascular revolution in western countries. Beginning with the American Framingham heart study (Levy and Brink 2005; Mahmood et al. 2014), and continuing with the WHO MONICA multinational surveillance system (WHO MONICA Project 1988), these behavioural and metabolic risk factors have been central both to clinical guidance and to analysis of levels and change in CVD mortality. The framework combines autonomous behavioural change, primary, secondary and tertiary prevention through alteration of risk factors behaviourally or through focussed medical treatment, along with surgical interventions and development of hospital protocols for dealing with myocardial infarction (Gale et al. 2014; Nabel and Braunwald 2012).

Indeed, emphasis on particular risk-factors has changed over time and place, and in the context of the rise of post-Soviet Russian mortality and its later decline, the role of excessive alcohol consumption and binge-drinking received particular emphasis (Chenet et al. 1998b; Leon et al. 1997; McKee et al. 2001). Although this particular risk factor may have been dominant in Russia the overall explanatory framework for CVD risk decline remained. Socially-induced stress has also been suggested as a significant risk factor for CVD mortality, whether in the case of routine adversity or socio-economic inequality (Marmot et al. 1997b; Rosengren et al. 2004; Stansfeld et al. 2002) or in the context of socio-economic crisis that accompanied the collapse of the USSR (Bobak et al. 1998; Peasey et al. 2006). However, whatever its contribution to the explanation of variance between and within countries in CVD mortality levels, this family of risk factors is usually omitted in assessment of the factors which govern changing CVD mortality trends, and specifically in the origins of the cardiovascular revolution (eg. Roth et al. 2015; Roth et al. 2020).

Attempts have been made to quantify the contribution of medical treatment to CVD mortality decline, and they have found that it is considerable. A widely-cited model-based analysis of the decline in coronary disease in the USA found that although 44% of the decline between 1980 and 2000 could be attributed to changes in the classic risk factors (reductions in total cholesterol, blood pressure, smoking and physical activity), 47% of the fall was due to treatments and secondary preventive therapies, including surgical interventions and drug treatments (Ford et al. 2007). Increases in BMI and diabetes partially offset the positive trend. Moreover, the substantial contribution of treatments to the overall decline were confirmed in parallel investigations which Ford et al. cite, in New Zealand, the Netherlands, Scotland, England and Wales, and Finland. Thus the major contribution of cardiovascular science and medicine to the cardiovascular revolution appears to be the established, consensus opinion (Nabel and Braunwald 2012), and is recapitulated in many studies, even in studies that present evidence showing that the relative contribution of specific risk factors is still uncertain, as is the relative role of primary versus secondary prevention, in both of which medical intervention has had a role (Mensah et al. 2017). Although the revolution encompassed countries with a variety of initial levels of CVD death rates, differences in the relative mix of cerebrovascular and coronary heart disease, and thus, presumably, their level of behavioural risk factors, the consensus view is that: "Some countries, like Japan first followed by almost all western countries, were quick to maximize the benefits of new technologies, and perhaps even more so, new means of prevention against cardio-vascular diseases, while other countries, mainly in eastern Europe, failed to do

so" (Vallin and Meslé 2004). According to Abdul Omran, the fourth stage of the epidemiological transition could not have been reached without medical breakthroughs in diagnosis, preventive management and emergency treatment of cardiovascular disease (Omran 1998).

Israel had clearly reached this stage. Between 1975-79 and 1985-89 age-adjusted coronary heart disease (CHD) rates in Israel had fallen by 31% for males and 37% for females, and age-adjusted cerebrovascular disease rates had fallen by 47% and 45% for each sex respectively (Levi et al. 2002). Rates for CHD in Israel in the late 1980s were slightly higher than the EU average (membership as of 1995), whereas they were lower for cerebrovascular disease. Given the extraordinarily high rates of CVD mortality in the FSU and the low rates in Israel, it is not surprising that a study based on comparative cause-specific mortality rates anticipated that FSU immigration would increase overall male mortality in Israel by 6% and female mortality by 4.4%. A proactive approach of the Israeli health system was recommended: "serious attention will have to be paid to coronary disease, hypertension and cerebrovascular disease among the immigrants" (Rennert 1994).

But the crisis did not materialise. The relatively low CVD mortality risks of both male and female FSU migrants to Israel were one of the least expected health outcomes of the migration. In light of what was known about the FSU and the cardiovascular revolution, not only should high rates of CVD mortality have been expected, but the temporal trend in Israel should have been determined by two dominant factors, gradual amelioration of rates due to increasing impact of the Israeli health system and its advanced level of CVD treatment (Kornowski and Orvin 2020), and the countervailing effects of the difficulties of adjustment. At the same time, a delay or moderation in the decline in CVD mortality may have been expected, due to long latency of cardiovascular diseases and the time lag between changes in some risk factors and disease outcomes (Ezzati et al. 2015). What is found in the present study was that relative CVD mortality for males was equivalent to Other Israelis, with strong arrival cohort increases at adult ages, but not at elderly ones, no duration of stay effects, but worsening SMRs over calendar year. And for females, an overall advantage in relative CVD mortality is found, with weak evidence for additional improvement in relative mortality by duration of residence, but, as with males, decreasing calendar year coefficients provide strong support for a slower underlying trend for FSU immigrants.

One would have expected that the sudden transition of these immigrants to a health system with advanced care for cardiovascular disease would have led to its increasing impact over duration of residence and a positive relative trend. Yet even in the 1990-91 arrival cohort, which had the longest exposure to conditions in Israel, SMRs show that among males there is no evidence for decline in CVD mortality over duration of residence, whereas for females their advantage at arrival was briefly lost after 4-6 years of residence but re-emerged after 10 years of residence (Appendix tables A3.5ab).

The calendar-year findings indicate that underlying trends in improvement of CVD mortality among FSU immigrants lagged behind Other Israelis, and we have already argued that this is unlikely to be due to increasing adjustment-difficulties in Israel (sections 4.3.2, 5.3). The calendar-year evidence indicates that while it is possible that the impact of the Israeli health system was positive, it was not more rapid than its impact on Other Israelis.

Are initial rates of CVD mortality of FSU immigrants in Israel due to an immediate effect of access to the Israeli health system and effective in-hospital treatment which was sufficient to lower mortality to equivalence with Other Israelis, although their underlying morbidity was higher? The effects of acute treatment alone are unlikely to have been strong enough to reduce rates to the low rates of Other Israelis, given that the impact of acute care on total CVD mortality is smaller than that of treatment for primary and secondary prevention, which could affect rates only after a considerable lag (Ford et al. 2007). Evidence for FSU migrant morbidity and hospitalization in Israel is available only for the period 2001-2012, after our

period of observation. In this period FSU immigrants had both higher rates of CVD morbidity than native Israelis, and higher rates of hospitalization (Reuven et al. 2019). It is possible that at longer durations of residence, beyond our study period, FSU mortality rates rose as well, but it is also possible that CVD morbidity rates were not matched by mortality rates. In a small study of self-reported chronic conditions among FSU immigrants in 1991, higher rates of heart disease and hypertension were reported, despite the lower mortality rates we have documented. (Rennert et al. 2002). A study of the population of Jerusalem in 1995-1997 (not restricted to immigrants) found high incidence of coronary heart disease combined with low case fatality, but the possibility that treatment differences or hospital care were responsible for this was excluded (Kark et al. 2005). Such a mis-match also appears among ethnic German migrants in Germany, where high incidence of acute myocardial infarction was combined with lower fatality (Deckert et al. 2014). In future studies of the FSU immigrant population it would be useful to investigate sudden cardiac death separately from other CVD mortality in order to better assess the possibility of treatment effects.

The low CVD SMRs of FSU immigrants were not uniform. Within the FSU population we found considerable heterogeneity in CVD relative mortality. Adult males, non-Jewish males of all ages, Asian-Caucasian immigrants of both sexes, all suffered from worse CVD mortality than Other Israelis; on the other hand, females in general, the 1990-91 arrival cohort, immigrants from Moscow and Leningrad, and elderly non-Jewish females enjoyed better, and in some cases considerable better relative CVD mortality. We have given a number of possible explanations for these contrasting patterns by age, ethnic, and geographic origin, and among them positive and negative selection by economic and motivational factors, and culturally-based positive and negative health behaviour.

But these explanations do not erase the underlying question: was heterogeneity of CVD mortality in the USSR sufficiently great that some sub-groups had equivalent or better CVD mortality than average Israeli rates, even after the latter rates had declined by 30-40%? And if so, what explains these low rates? Are selection and/or lifestyle factors sufficient to explain the advantage (or even equivalence) in CVD mortality in some FSU immigrant groups to those of a population in which CVD mortality had already declined considerably over the last decade, a population which had already joined the CVD revolution, in which medical treatment, which had not been available in the FSU, played a supposedly large role?

The difficulties these findings pose for the role of medical treatment in initiating the cardiovascular revolution is strengthened by the evidence of CVD mortality among immigrants from the FSU of German ethnic origin (Aussiedler) in Germany. They were studied in four retrospective cohort studies between 1990 and 2009 (Winkler et al. 2019) a period parallel to and longer than ours. As with FSU migrant to Israel, the Aussiedler were also found to have lower CVD mortality than the overall German population (although over time male Aussiedler may have reached equivalence in ischaemic heart disease mortality (Deckert et al. 2014)). These findings were unexpected, since, as in the Israeli case, the migrants were expected to reflect the high rates of CVD in the USSR (Ronellenfitsch et al. 2006). Unlike our study, common risk factors for CVD were examined in supplemental cross-sectional and nested-case control studies. Although these studies may have been weakened by low response rates, they showed that despite their low mortality the immigrants had higher rates of standard risk factors for CVD (Winkler et al. 2019), and alcohol consumption was surprisingly lower than native Germans (Kuhrs et al. 2012). Thus relatively low CVD mortality rates remain unexplained in this post-Soviet migration wave as well. The authors suggest that the Aussiedler may have had healthier CVD-related lifestyles than ethnic Russians in the FSU, just as Moscow Jews had culturally-based healthier lifestyles (Deckert et al. 2014). But this only begs our question: how could these lifestyle advantages provide mortality benefits equal to those of an advanced western health system, without the benefits of advanced medical treatment?

Lifestyle differences, and especially extreme alcohol consumption were found to explain the much higher CVD mortality rates of ethnic Russians compared to members of local ethnic groups in central Asia in the

1990s (Guillot et al. 2011; Sharygin and Guillot 2013). Although this evidence strengthens the argument for the role of alcohol in raising CVD mortality in the FSU, unfortunately these studies do not present long term trends for the non-ethnic Russian population themselves. It is possible that differences in CVD mortality that were found in the present study between Jewish and non-Jewish FSU immigrants in Israel may also reflect these culturally-based differences in alcohol consumption. A study of the educational gradient in Russian mortality in the 1980s also attributed much of it to alcohol abuse (Shkolnikov et al. 1998b), but in our context it is important to emphasize another finding, that for Russians with the highest levels of education in the late 1970s and in the late 1980s life expectancy estimates were equivalent to average life expectancy levels in France and Germany. Although the trend is based on two observational points only, it suggest that for the best educated group, life expectancy had improved at the same rate as in western Europe. Since decline in CVD mortality was the major driver of the rise in life expectancy in western Europe, this may be further indirect evidence that CVD mortality in the FSU improved for some groups, significantly, without the intervention of modern medical care for CVD.

Support for the idea that medical advance was a minor force in initiating the cardiovascular revolution can be found in a major review of studies of the causes of the decline of CVD mortality throughout the world. It focussed on whether changes in risk factor levels could explain changes in CVD mortality, and especially, the onset of the decline in CVD mortality (Ezzati et al. 2015). It concluded that "A more careful look at countries with long time-series of data indicates that decline in CVD mortality in at least some countries, may have begun before its classical risk factors started to decline" and that "none of the measured drivers explains the similarities and differences across countries or between men and women in when the decline began". Although the study affirms that advances in hospital care, secondary prevention after cardiovascular events, and primary prevention through pharmacological interventions (both treatment of high blood pressure and cholesterol-lowering treatments) have contributed to declining CVD mortality in high-income countries, it finds that they do not explain the onset of the decline. Moreover, it points out that although clinical trials had established the benefits of particular treatment for primary and secondary prevention, the extent of the contribution of efficacious medical treatment to declining trends is difficult to establish when other determinants of disease were falling as well. This leaves current explanations for the onset of the trends as largely correlational, and speculative.

Among the principal factors Ezzati et al. mention as candidates for future study are the decline in the burden of infections and resulting inflammatory response on the one hand, and life course factors relating to improved fetal and childhood nutrition and health on the other. A number of recent studies have provided evidence that early life exposures, including infectious disease and childhood and maternal nutrition, may play a strong role in adult cardiovascular mortality (Burgner et al. 2015; Lawson and Glenn 2021; Nguyen et al. 2015). The possibility that these may have played a role in the relative CVD mortality advantage of Jews and ethnic Germans in the USSR is strengthened by evidence that these two groups had much lower infant mortality rates (an indicator or fetal and neonatal and maternal health) in early twentieth century Tsarist Russia than ethnic Russians. In 1900-1904 infant mortality rates for Orthodox babies, primarily Slavs, were by far the highest for all religious groups, over 280 per thousand, whereas those for Lutherans (among whom were ethnic Germans) were over 40% lower (160 per thousand), and Jews had by far the lowest rates (less than 120 per thousand) (Patterson 1995).

Early explanations of the decline in infectious disease mortality in the nineteenth century had found that the role of curative medicine was restricted, since little treatment or preventive measures were available for particular pathogens (eg. McKeown and Record 1962). This was later challenged. Among other important factors, it was argued that there are synergistic relationships between general immunological status and resilience and the decline of infection from a particular cause. Through this broader immunological response, decline in mortality from a specific cause may have general effects on infectious disease mortality (Szreter 1988), an effect which may appear with a considerable lag. Hence it is possible that the low rates

of CVD mortality of FSU immigrants in Israel and of ethnic German migrants in Germany is more than an unexpected anomaly and an indicator of ethnic heterogeneity in CVD mortality in the USSR. They may reflect a more complex aetiology of the cardiovascular revolution, in which, as in the second stage of the epidemiological transition, medical technology played a greater role as an accelerator of change rather than as an initiator of change, which may lie in general immunological status due to early life exposures.

Such interactions between causes of death make unravelling the determinants of temporal trends far more challenging. This general conclusion is of particular relevance to migrant mortality studies, where the influence of differences in early life-course exposures may play an important role which is difficult to detect and measure. These synergistic and life course determinants may play a large part in health transitions that are very difficult to detect without population-based longitudinal data on morbidity and risk factors, which are usually unavailable. In their absence assumptions regarding long term trends based on shorter term studies should be treated with greater caution. This conclusion ties in with the broader argument that this thesis is pursuing in the context of migrant mortality: that unravelling temporal trends requires attention to several temporal dimensions and life course factors simultaneously, and that false conclusions may be reached when this is not done.

The framework of the epidemiological transition has been used to develop a hypothesis which (partly) explains the immigrant mortality advantage, the so-called accelerated health transition hypothesis (Razum and Twardella 2002; Spallek et al. 2011). The transition of migrants from lower to higher income countries (from countries in the second to the fourth stage of the epidemiological transition) allows them to benefit immediately from lower infectious disease mortality (both due to a healthier environment and advanced medical care) whereas the mortality consequences of their exposure to the risk factors for high chronic disease mortality in the developed world reveal themselves only over time (eg. lower physical activity, diets rich in fats and red meat and lower in fresh fruits and vegetables, environmental exposures, etc.). FSU migrants to Israel demonstrate another transition: from a setting in the third stage of the demographic transition to one in its fourth stage, according to Omran's framework. From an area where chronic disease mortality, and especially CVD was high and unchanging, they moved to one where it was falling rapidly, cardiovascular medicine was advanced, and consumption of fresh fruit and vegetables much higher. The expectation was that they would bring high disease rates which would eventually decline. But their CVD morality rates were lower than expected, and this very transition seems to have undermined the paradigm of fixed stages in which medical treatment plays a definite, if changing role. They provide evidence that the cardiovascular revolution may have begun before treatments were available, however effective they may eventually have become. And although the paradigm of fixed stages remains popular, and along with it depictions of the changing role of medical science (Caldwell 2001; Vallin and Meslé 2004), synergetic effects across the life course of declining infectious disease mortality rates may challenge this framework.

# Section 6.0 Conclusion

## 6.1 Principal Findings

This study is unique in its attempt to assess changes in migrant mortality relative to the destination population in three temporal dimensions: calendar year, duration of stay, and year of arrival cohort. This was undertaken on the basis of a theoretical claim that the nature of migration imposes temporal complexity on the factors changing migrant's relative mortality: changes in all three dimensions were potentially powerful. Moreover, due both to the linear mathematical interdependence as well as the substantive interdependence of these temporal dimensions, false conclusions can easily be reached concerning the temporal pattern of change in relative mortality, and the factors by which it is changed. All too often survivors of several arrival cohorts are pooled together in cross-sectional studies of migrants, with the consequence that duration of stay and period of arrival cannot be distinguished. Indeed, previous studies of this dataset had reached false conclusions because duration effects were confounded by cohort effects. The three-dimensional analytic framework developed in this study challenges the dominant "environmental transition" model, which places much of the emphasis on changing relative mortality among immigrants on duration of stay. The new framework seeks to express the fact that migrating populations live in a complex temporal flux in which, along with the adjustment processes measured by duration of stay, change in circumstances over calendar time and changing arrival cohort composition both play a potentially significant role.

The findings confirm this approach. Relative mortality was found to alter in all three temporal dimensions, differentially, in patterns which differed by gender, age, geographic origin, and ethnicity. The population of FSU migrants in Israel was changing in itself and changing the society it encountered. The evolution of its relative mortality both reflects and throws light on these processes. These findings strengthen previous attempts which went beyond the "environmental transition" paradigm of studying migrant mortality and proposed multidimensional analytic schemes. Rather than presenting the analytic schemes alone, this study is distinguished by the fact that it provides statistical analysis of multidimensionality in practice.

As proposed in the Introduction, the findings of this study support the view that migrant mortality outcomes depend on complex interactions between the migratory stream and the host country, with each side changing the other. Migrants help to create their new environment; they are not only affected by it. Changes in arrival cohort composition and changes in cohort mortality risk could emerge due to changing conditions in Israel and the FSU, changes in immigrant absorption and health policy, changes in the availability of alternative destinations, changes in the Israeli labour market and the place of immigrants within it, and changes in the migrant community itself. Calendar year effects, independent of duration effects, point both to the collective impact of conditions in Israel and differences in long term mortality trends between the local and the arriving population. But these potential impacts are not of equal strength in all circumstances. Although studies exist which have attempted to address duration of residence effects together with cohort effects, and the potential importance of cohort effects has been raised before, this study has attempted to determine, for the first time, which combinations of temporal effects, if any, are the most powerful determinants of mortality outcomes. It has shown that unpacking such effects are crucial to understanding the course of mortality of FSU immigrants to Israel, and it suggests that parallel complex patterns of temporal dynamics may exist in other immigration streams, which have never been examined.

The study has found considerable heterogeneity in these patterns, both by cause of death and by socio-demographic subgroup. Chief among these are the contrasting patterns between the genders, and within them, differences between adult and elderly migrants. Alongside these cross-cutting variations we have found disparities in temporal patterns by origin groups in the FSU, both geographically (between "central" cities and "peripheral" republics) and by ethnic group.

Moreover, the study has shown that a seemingly "unselective" diaspora migration is compatible with powerful positive health selection, in certain circumstances. With regard to mortality, it is not an example of "unhealthy migration", as some authors have sought to portray it. Despite higher mortality from specific cancer sites and from external causes of death, the FSU migrant population, on the whole, was positively selected with respect to relative mortality compared to the origin population, although positive selection declined over successive arrival cohorts. Indeed, one of the paradoxical outcomes of this study is that the group which is generally expected to have the most positive health selection according to the Healthy Migrant paradigm, adult males, were found to have the worst outcomes in Israel. Several reasons why elderly FSU migrants to Israel enjoyed better relative mortality were suggested, and an important conclusion of this study is that relative mortality advantages may coexist, paradoxically, with negative reports of self-assessed health and functional status. It was on the basis of the latter that FSU migrants were regarded as "unhealthy migrants". This study had added to the evidence that elderly migrants do not necessarily suffer from poorer mortality patterns than the local population, but the fact that they may simultaneously suffer from worse health, and thus lower healthy life expectancy, should alert policy makers to the complexities of understanding migrant health needs.

This is the first attempt to examine differences between mortality patterns of Jews and non-Jews among FSU immigrants. Although this migration wave was of mixed ethnicity and distinct mortality patterns are ascribed to Jews in various countries, and although different patterns of adjustment might be expected in a self-defined Jewish state between the ethnic groups, these differences have never been studied before. It was found that not only the levels of mortality differed, but temporal patterns by cause of death differed as well. It was found that female non-Jews had a mortality advantage not only when compared to Jewish immigrants, but more surprisingly, compared to Other Israelis, especially for all-neoplasms. Male non-Jews, on the other hand, and especially adult males, have the least favourable mortality outcomes in Israel, for CVD and external causes in particular. The findings confirm previous studies which point out favourable health behaviour of Jewish populations and greater genetically-based vulnerability of Jewish females. And yet, despite their higher relative mortality compared to Jewish immigrants and Other Israelis, life expectancy measures point to positive health selection compared to FSU populations of male non-Jews as well. Although these patterns appeared to reflect, to some extent, the patterns of ethnic Russians in the FSU before migration, male non-Jewish migrants had higher life expectancy than ethnic Russians in the FSIU from arrival onwards.

Finally, the lower relative CVD mortality than expected among FSU migrants and their patterns of change over time appear to raise questions concerning the role of medical treatment in initiating (rather than maintaining and accelerating) the cardiovascular revolution.

## 6.2 Strengths and Weaknesses

The principal strengths of this study derive from its basis in high-quality administrative data. The period 1990-2004 covers the entire wave of post-Soviet migration to Israel, until its numbers dwindled, the period when its impact on Israeli society was most intense. The large size and comprehensive coverage of the FSU immigrant population, without the challenges of sampling error, allowed for detailed tracking and analysis of temporal change in mortality by detailed cause of death within the same administrative system, and removed the possibility of numerator/denominator bias. Causes of death for both immigrants and other Israelis were classified in a national system with a reputation for high quality and full coverage. Similarly, national administrative data permitted accurate calculation of length of stay, including possible re-migration. Unlike most studies of migrant mortality, probabilities of remigration were calculated using the same characteristics that were controlled for mortality analysis, allowing some assessment of the impact of remigration on estimates. Although "return effects" are still possible, their extent and possible characteristics are known, and in this case unlikely to affect the results. This study is a true longitudinal

analysis of mortality trends, rather than a reconstruction from pooled independent samples, or from data linkage of sample surveys to mortality data, with all the statistical error to which such techniques are exposed.

There are substantial limitations to this study, both data-based and methodological. Chief among them are the absence of explanatory variables: morbidity, risk-factor data, health care utilization, nutrition and socio-economic circumstances in Israel, and (as is often the case in migration studies) parallel data for the country of origin. The absence of these inevitably means that all of our suggested explanations of the patterns we have found are speculative, and one can only hope that richer data will be available in the future. Nevertheless, as has already been stated, the desiderata of the ideal migrant mortality study are usually absent (if not utopian) and the data that were available for this study were rare in themselves.

A further limitation is that although the period of study is 14 years, this is true only for the earliest arriving immigrants. Duration of residence for the population was, on average, 6 years. This inevitably limits the estimates of patterns of mortality by duration of stay for immigrants who arrived later in the migration wave. Given the strong presence of cohort effects on arrival, and shorter length of observation for later arriving cohorts, statistical models were more likely to favour cohort and calendar year rather than duration effects. Moreover, given the long latency of risk factors for both neoplasms and CVD, the effects of changes in these risk factors will only be detected with a longer observation period. This bias can be corrected in the future when, it is hoped, mortality data covering the period from 2004 to the present will be added to the analysis. Moreover, despite the unique attention given here to dimensions of temporal change, two prominent temporal markers are not included: birth cohort and age at migration. In both cases the restricted period of study limits the influence of this deficiency: immigrants who arrived as children are not included, and age, birth cohort and age at immigration align in broad groups. Nevertheless, future considerations of temporal factors will have to include these dimensions as well, with all the challenges this entails.

A further limitation on cause-specific mortality patterns is the possible bias introduced by changes in the proportion of deaths classified as ill-defined. As the proportion of unclassified deaths declines, so the proportion of deaths for specific causes will rise, and the effect will not be distributed equally. Some causes of death are readily apparent. Others require and diagnosis and follow up within a medical system, and will be missed. As it happens, the selected multivariate models for ill-defined causes for both males and females corresponded to the most common models for each gender, so it is likely that changes in their proportion did not affect model-selection for other causes. Moreover, a simulation base on reclassifying ill-defined deaths in the other causes category did not substantially alter the findings. On the other hand, one may also view this limitation as a strength. The attention given to temporal change in ill-defined cause of death, and the demonstration that the decline in the proportion of ill-defined causes is a reflection of the process of acclimatization of an immigrant community and its integration into the local health system, is rare in migration studies. Such processes are likely to occur in all immigrant settings and should be considered when examining patterns of change for particular causes.

The statistical methods used to establish the findings have their own limitations. The technique selected the strongest two (at most) temporal dimensions of change, but one could not conclude that the omitted dimension was inactive, or unimportant, only that it was a weaker explanatory factor than those chosen. Moreover, the technique for establishing "goodness of fit" depended on minimum deviance. It is always possible that goodness of statistical fit reflects mathematical properties of the dataset, rather than underlying substantive properties of the phenomena measured, especially given the linear dependence of the three dimensions. To minimize this possibility, two-year intervals were chosen for all three dimensions, continuous and discrete representations of time were compared, and the results of models were compared to graphical two-dimensional representations of change, to confirm their plausibility. Nevertheless, the possibility that goodness of fit was purely mathematical remains.

## Section 7.0 Summary

**Objectives:** This dissertation investigates temporal change in all-cause and cause-specific mortality in a total of 744,263 immigrants aged 15 and over from the Former Soviet Union that arrived in Israel from 1990 to 2003, relative to the Israeli population. Mortality rates of migrants are analysed using administrative data. In the migrant health literature, temporal change in relative risk is usually examined over duration of residence, through an "environmental transition" paradigm. The existing literature is critically examined , showing the weaknesses of this approach. An alternative analytic scheme is developed here which provides a more realistic depiction of change in migrant mortality. It examines simultaneously change through duration of residence, calendar time, and year of arrival. This scheme guides a review of research on social and economic changes in this immigrant population in Israel in the 1990s. They changed their demographic and socio-economic characteristics over calendar time, over arrival cohort and over duration of residence, while changing the society they had entered. These characteristics had potential effects on factors affecting relative mortality patterns. Change in relative mortality is examined in detail in each dimension, separately and in combination. This study is the first attempt to simultaneously evaluate the effects of arrival cohort, duration of residence and calendar period on comparative migrant mortality in a true longitudinal setting. It is also the first to study differences in migrant mortality by geographic origin in the Former Soviet Union and by ethnic group (Jews and non-Jews).

**Methods and Results:** Migrant mortality was analysed using demographic and epidemiological methods (life expectancy decomposition, Standardized Mortality Ratios (SMR), and Poisson regression for all causes of death and for separately for cardiovascular disease, neoplasms, external causes, and all other causes). Patterns are examined by age groups (15-59 and 60+ years), education, geographic origin in the Former Soviet Union (Moscow and St. Peterburg, European republics, Asian and Caucasian republics) and ethnic group (Jews and non-Jews). Life table decomposition showed differing trends over calendar period of life expectancy at age 15 for adults and elderly, for males and females, and for central and peripheral areas of the country of origin. Advantages and disadvantages with other Israelis differed by these characteristics, and by the contribution of particular cause of death groups. SMR analysis by cause group revealed that apparent declines in relative mortality over duration of residence are often an artefact of large differences in arrival cohort SMRs, for males in particular. Increasing SMRs by arrival cohort are found for adults of both genders, but are small for elderly males and non-existent for elderly females. The 1990-1991 cohort displays SMRs near 1.0 or below for all causes and for the major cause of death groups, (except for external causes). Patterns by duration differ between the cause of death groups.

The effects of age, calendar year and time of migration were examined simultaneously using Poisson models, adjusted for education, ethnic group and region of origin, for all causes and for cause-of-death groups. They showed differing effects of arrival year and duration of residence between the genders and age groups. The only exception to this is external causes for females, for which the best model does not include temporal trends. For males, the best models identified arrival cohort and calendar year effects on SMR (all cause mortality and most cause of death groups). Arrival cohort effects were weaker or non-existent at elderly ages, while at adult ages SMRs increase substantially over successive arrival years. For females combined effects of duration of residence and calendar year on all causes, all neoplasms, and cardiovascular disease are found. Relative risk declines by duration of stay, but only at the adult ages. For the all other causes group the arrival cohort and calendar year effects are similar for both genders. Increasing relative risk by calendar year for both genders are surprising (with the sole exception of declining risk for all external causes for females). Arrival cohort effects are not accounted for by composition by age, education, geographic origin or ethnicity. The effect of ethnic group contrasts between the sexes. Male non-Jews have much higher relative mortality for all cause of death groups non-Jewish females have substantially lower relative risk for most cause of death groups.

**Discussion:** This migrant population displayed changes in relative mortality by each of the time dimensions which were examined, and in different combinations. This demonstrates that all should be examined together in order to obtain valid results. A limitation of this study is the absence of data on morbidity and behavioural and other risk factors. The findings conflict with expectations of the Healthy Migrant Effect literature. This "diaspora" migration was neither unselective of "unhealthy". Health advantages of the elderly, of non-Jewish females, of immigrants from Moscow and St. Petersburg show that "diaspora" migration can create positive health selection. These migrants in Israel invert the age pattern of relative risk found in the Healthy Migrant literature for other countries. The frequently observed negative duration of stay pattern is also absent. The early "panic phase" of 1990-91 brought immigrants who displayed better health. Arrival cohorts after 1991 show (increasing) disadvantages, perhaps due to the increasing dominance of "pull" factors in migration incentives. Patterns in neoplasm mortality may show treatment-motivated migration. "Healthy" and "sick" immigrant effects existed side by side. The advantage of the elderly points to strong positive selection but may also reflect common life-course factors with Other Israelis. Calendar year trends may indicate the long-term effects of past exposures in the FSU compared to those of Other Israelis. Early exposures may also explain similarities and differences in cardiovascular mortality patterns, raising questions concerning the role of medical technology in the "cardiovascular revolution". Ethnic differences in mortality appear to reflect similar differences found in the Former Soviet Union, but they are smaller, suggesting that non-Jewish migrants are also positively selected. The discussion explores possible behavioural and genetic reasons for the ethnic patterns, by cause of death and age group. These are discussed with reference to a so-called "Jewish pattern of mortality".

**Conclusions:** The three-dimensional analytic scheme developed in this study successfully challenges the "environmental transition" model, Migrant populations, and FSU migrants in particular, live in a complex temporal flux in which, in addition to the adjustment processes measured by duration of stay, changing circumstances over calendar time and changing composition by arrival cohort both play potentially significant roles. This study has demonstrated the crucial role played by the circumstances which created and altered the migratory wave itself, alongside specific conditions on arrival in Israel. These are factors that cannot be reduced to exposures in either a pre-existing origin or destination environment. Calendar year effects, often ignored, show that socio-political and economic conditions and policies in Israel may have had a differential impact on the relative mortality of FSU immigrants as a group compared to Other Israelis, regardless of duration of stay or arrival cohort.

## Section 8.0 Zusammenfassung

**Ziele:** Diese Dissertation untersucht die zeitlichen Veränderungen der gesamten und ursachenspezifischen Mortalität in insgesamt 744,263 Migranten ab 15 Jahre, die von 1990 bis 2003 aus der ehemaligen Sowjetunion (FSU) nach Israel einwanderten, relativ zur israelischen Bevölkerung. Anhand von amtlichen Datenquellen werden die Sterblichkeit von Migranten bis zum Jahr 2004 analysiert. In der Literatur der Migrationsforschung wird die zeitliche Veränderung des relativen Risikos in der Regel über die Aufenthaltsdauer durch ein Paradigma des „Umweltwandels" untersucht. Die bestehende Literatur wird kritisch betrachtet und zeigt die Schwächen dieses Ansatzes auf. Hier wird ein alternatives Analyseschema entwickelt, das eine realistischere Darstellung der Veränderung der Sterblichkeit von Migranten bietet. Es untersucht gleichzeitig die Veränderung durch Aufenthaltsdauer, Kalenderzeit und Ankunftsjahr. Dieses Schema erlaubt eine Überprüfung der Forschung zu sozialen und wirtschaftlichen Veränderungen in der Bevölkerung dieser Einwanderer in Israel in den 1990er Jahren. Sie veränderten ihre demografischen und sozioökonomischen Merkmale im Laufe der Kalenderzeit, der Ankunftskohorte und der Aufenthaltsdauer und veränderten gleichzeitig die Gesellschaft, in die sie eingewandert waren. Diese Merkmale hatten potenzielle Auswirkungen auf Faktoren, die die relativen Sterblichkeitsmuster beeinflussen. Die Veränderung der relativen Sterblichkeit wird im Detail untersucht, jede Dimension für sich und in Kombination. Diese Studie ist der erste Versuch, die Auswirkungen der Ankunftskohorte, der Aufenthaltsdauer und der Kalenderzeit auf die vergleichende Sterblichkeit von Migranten in einem echten Längsschnitt gleichzeitig zu evaluieren. Es ist auch das erste, das Unterschiede in der Migrantensterblichkeit nach geografischer Herkunft in der FSU und nach ethnischer Gruppe (Juden und Nichtjuden) untersucht.

**Methoden und Ergebnisse:** Die Kohorte der Migranten wurde unter Verwendung von Methoden der Demographie und Epidemiologie analysiert (Zerlegung der Lebenserwartung, standardisierte Mortalitätsverhältnisse (SMRs), Poisson-Regression für alle Todesursachen und separat für Herz-Kreislauf-Erkrankungen, Neubildungen, externe Ursachen und alle anderen Ursachen). Die Muster werden nach Altersgruppen (15-59 Jahre, 60+), Bildung, geografischer Herkunft in der FSU (Moskau und St. Petersburg, europäische Republiken, asiatische und kaukasische Republiken) und ethnischer Gruppe (Juden und Nichtjuden) untersucht. Die Zerlegung der Lebenserwartung zeigte unterschiedliche Trends über den Kalenderzeitraum der Lebenserwartung im Alter von 15 Jahren für Erwachsene und ältere Menschen, für Männer und Frauen sowie für zentrale und periphere Gebiete des Herkunftslandes. Vor- und Nachteile mit anderen Israelis unterschieden sich durch diese Merkmale und durch den Beitrag bestimmter Todesursachengruppen. Die SMR-Analyse nach Ursachengruppen ergab, dass der scheinbare Rückgang der Mortalität über die Aufenthaltsdauer häufig ein Artefakt ist, insbesondere bei Männern. Zunehmende SMRs nach Ankunftskohorte werden für Erwachsene beider Geschlechter gefunden, sind jedoch gering für ältere Männer und nicht vorhanden für ältere Frauen. Die Subkohorte von 1990-1991 zeigt SMRs nahe 1,0 oder darunter für alle Ursachen und für die Hauptursachengruppen für Todesfälle (mit Ausnahme externer Ursachen). Muster nach Dauer unterscheiden sich zwischen den Todesursachengruppen.

Mit Poisson-Modellen wurden simultan die Effekte von Alter, Kalenderjahr und Migrationszeitpunkt untersucht, adjustiert für Bildung, ethnischer Gruppe und Ursprungsregion, für alle Ursachen und für Todesursachengruppen. Sie zeigten unterschiedliche Effekte des Migrationszeitpunkts oder der Aufenthaltsdauer in Israel je nach Geschlecht oder Altersgruppe. Die einzige Ausnahme hiervon sind externe Todesursachen bei Frauen, für die das beste Modell keine zeitlichen Trends enthält. Für Männer identifizierten die besten Modelle Ankunftskohorten- und Kalenderjahreffekte auf das SMR (Gesamtmortalität und die meisten Todesursachengruppen). Die Kohorteneffekte waren im höheren Alter schwächer oder nicht vorhanden, während im Erwachsenenalter die SMRs mit späterem Jahr der Immigration deutlich zunehmen. Für Frauen zeigten sich Effekte von Aufenthaltsdauer und Kalenderjahr auf alle Ursachen, alle Neoplasmen und kardiovaskulären SMRs; Der Effekt von Aufenthaltsdauer nimmt mit der Aufenthaltsdauer ab, jedoch nur im Erwachsenenalter. Bei allen anderen Ursachen sind die Effekte

des Ankunftsjahrs und des Kalenderjahres bei Männern und Frauen ähnlich. Überraschend sind die ansteigenden Risiken mit dem Kalenderjahr für beide Geschlechter (Ausnahme nur bei externen Ursachen für Frauen). Der Effekt der Ethnie ist bei Männern und Frauen unterschiedlich. Männliche Nichtjuden haben eine viel höhere relative Sterblichkeit für die meisten Todesursachengruppen, während nichtjüdische Frauen ein geringeres relatives Risiko haben, mit Ausnahme externer Ursachen.

**Diskussion:** Bei dieser Migrantenpopulation zeigten sich unterschiedliche Effekte auf die Sterblichkeit relativ zu der Gesamtbevölkerung Israels durch jede der untersuchten zeitlichen Dimensionen. Dies zeigt, dass alle zusammen untersucht werden sollten, um valide Ergebnisse zu erhalten. Eine Limitation der Studie ist das Fehlen von Daten zu Morbidität oder Verhaltens- und andere Risikofaktoren. Die Ergebnisse widersprechen den Erwartungen der Literatur zu einem Healthy Migrant Effect. Diese „Diaspora" Migration nach Israel war nicht unselektiv und „ungesund". Gesundheitliche Vorteile älterer Menschen, nichtjüdischer Frauen, Einwanderer aus Moskau und St. Petersburg zeigen, dass Migration aus der „Diaspora" zu positiver Gesundheitsselektion führen kann. Diese Migranten in Israel kehren das Altersmuster des relativen Risikos um, das in der Literatur zu „Healthy Migrants" in anderen Ländern zu finden ist. Ebenso fehlt der häufig beobachtete Effekt der Aufenthaltsdauer. Die frühe „Panikphase" von 1990-91 führte zu Einwanderern, die eine höhere Gesundheit aufwiesen. Die Migranten nach 1991 weisen (zunehmende) Benachteiligungen auf, möglicherweise aufgrund der zunehmenden Dominanz von „Pull"-Faktoren bei Migrationsanreizen. Muster der Sterblichkeit durch Neoplasmen können auf eine behandlungsbedingte Migration hinweisen. „Gesunde" und „kranke" Immigranteneffekte existierten nebeneinander. Der Vorteil älterer Menschen kann auch gemeinsame Faktoren mit anderen Israelis widerspiegeln.. Trends der Kalenderjahre können auf die langfristigen Auswirkungen früherer Expositionen in der FSU im Vergleich zu denen anderer Israelis hinweisen. Frühe Expositionen können auch Ähnlichkeiten und Unterschiede in den Sterblichkeitsmustern von Herz-Kreislauf-Erkrankungen erklären, was die Frage nach der Rolle der Medizintechnik aufwirft. Ethnische Unterschiede in der Sterblichkeit scheinen ähnliche Unterschiede widerzuspiegeln, die in der FSU gefunden wurden, aber sie sind kleiner, was darauf hindeutet, dass auch nichtjüdische Migranten positiv ausgewählt werden. Die Diskussion untersucht mögliche Verhaltens- und genetische Gründe für die ethnischen Muster, nach Todesursache und Altersgruppe. Diese werden anhand eines sogenannten „jüdischen Sterblichkeitsmusters" diskutiert.

**Schlussfolgerungen**: Der in dieser Studie entwickelte dreidimensionale Schema stellt das Modell des „Umweltwandels" erfolgreich in Frage. Migrationsbevölkerungen und insbesondere FSU-Migranten leben in einem komplexen zeitlichen Fluss, in dem neben den an der Aufenthaltsdauer gemessenen Anpassungsprozessen auch die Veränderung der Umstände im Kalenderzeitraum und die sich ändernde Zusammensetzung der Ankunftskohorte eine potenziell bedeutende Rolle spielen. Diese Studie zeigt die entscheidende Rolle, die die Umstände spielten, die die Migrationswelle selbst geschaffen und verändert haben, neben den spezifischen Bedingungen bei der Ankunft in Israel. Dies sind Faktoren, die nicht auf Expositionen in einer bereits bestehenden Herkunfts- oder Zielumgebung reduziert werden können. Kalenderjahreffekte zeigen, dass die soziopolitischen und wirtschaftlichen Bedingungen und Richtlinien in Israel möglicherweise einen unterschiedlichen Einfluss auf die Sterblichkeit von FSU-Einwanderern als Gruppe im Vergleich zu anderen Israelis hatten, unabhängig von der Aufenthaltsdauer oder der Ankunftskohorte.

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## Section 10.0 Personal publications and contribution to data acquisition

This research project began as part of the DFG Graduiertenkolleg 793/2 "Epidemiology of infectious and chronic non-infectious diseases and their interrelationships" part of which was devoted to the study of the mortality of ex-FSU migrants in Germany who arrived in the 1990s. This project expanded to a comparison of the latter with ex-FSU migrants in Israel during the same period. I personally compiled, matched, and assured the quality of the detailed death records and population files from the databases of the Central Bureau of Statistics, and obtained permission for their use (as described in Section 3, above). These files were shared with my co-doctoral candidate (now Dr.) Joerdis J. Ott, whose dissertation compared mortality in the two populations. To maintain comparability her data file did not include immigrants from the Asian-Caucasian republics (except Kazakhstan). We collaborated on 4 articles which emerged from our dissertations, also joining with previous doctoral candidates who had analysed the German cohort, and our supervisor. Although these articles form the background and basis for the present dissertation and are referred to as "previous findings", the analysis in this dissertation was undertaken afresh, and they are not directly incorporated into the text.

These publications are the following:

1. Ott, J., Paltiel, A., Winkler, V. and Becher, H. (2008). **Chronic disease mortality associated with infectious agents: A comparative cohort study of migrants from the Former Soviet Union in Israel and Germany**. BMC Public Health *8*, 110.
2. Ott, J. J., Paltiel, A. M. and Becher, H. (2009). **Noncommunicable disease mortality and life expectancy in immigrants to Israel from the former Soviet Union: country of origin compared with host country**. Bull World Health Organ *87*, 20-29.
3. Ott, J. J., Paltiel, A. M., Winkler, V. and Becher, H. (2010). **The impact of duration of residence on cause-specific mortality: a cohort study of migrants from the Former Soviet Union residing in Israel and Germany**. Health & Place *16*, 79-84.
4. Ronellenfitsch, U., Kyobutungi, C., Ott, J. J., Paltiel, A., Razum, O., Schwarzbach, M., Winkler, V. and Becher, H. (2009). **Stomach cancer mortality in two large cohorts of migrants from the Former Soviet Union to Israel and Germany: are there implications for prevention?** Eur J Gastroenterol Hepatol *21*, 409-416.

**Publication 1** was initiated by Dr. Ott. It deals with specific causes of death. Its findings are referred to in section 2.5. My personal contribution to this publication consisted in the data acquisition, collaboration on the analysis and interpretation, and revision of the text.

**Publication 2** is an overview article, and its contents are reflected in sections 2.5, 4.3, and in the discussion. Aside from data acquisition, my personal contribution to this publication consists in the calculation of life expectancy rates and their interpretation, as well as in collaboration in the interpretation of the SMRs. The writing was initiated by Dr. Ott, but thoroughly revised and amended in collaboration with me.

**Publication 3** is an initial attempt to analyse duration patterns in FSU mortality, in this case comparing the German and Israeli cohorts. I contributed the data, and collaborated on the analysis and interpretation, revision of the text. In this case, the early findings of this article regarding Israel were overturned in the present dissertation, when controls for arrival cohort and calendar year were added to the analysis. These findings are reflected in sections 2.5, 5.1.2 and 5.1.4.

**Publication 4** was initiated by (now) Prof. Dr. U. Ronellenfitsch. It discusses the comparative change in a specific cause of death, and its results are reflected in the present publication only insofar as it provides

further evidence for relative calendar-year change in neoplasm mortality among FSU migrants to Israel. My personal contribution consisted in providing the data on Israel, and collaborated on the analysis, interpretation, revision of the text.

Further personal publications were used in this dissertation, but were not part of the DFG funded research project. They are:

5. Beenstock, M., Chiswick, B. and Paltiel, A. (2010). **Testing the immigrant assimilation hypothesis with longitudinal data**. Review of Economics of the Household *8*, 7-27.
6. Paltiel, A. (2002). **Mass migration of highly skilled workers: Israel in the 1990s**. In: International Mobility of the Highly Skilled, OECD, Paris, pp. 161-176..
7. Paltiel, A. M., Sabatello, E. F. and Tal, D. (1997). **Immigrants from the former USSR in Israel in the 1990s: Demographic characteristics and socio-economic absorption**. In: Russian Jews on Three Continents: Migration and resettlement, eds. Lewin-Epstein, N., Ro'i, Y. and Ritterband, P., Frank Cass, London, pp. 284-324.
8. Rottenberg, Y., Litwin, H., Manor, O., Paltiel, A., Barchana, M. and Paltiel, O. (2014). **Prediagnostic self-assessed health and extent of social networks predict survival in older individuals with cancer: a population based cohort study**. J Geriatr Oncol *5*, 400-407.

**Publication 5** was my first attempt to explore comparative temporal change among migrants and natives in Israel, but with wages as the dependent variable. My personal contribution included sole responsibility for data acquisition and analysis, and collaboration in interpretation and writing. The findings of this publication are reflected in sections 1.5.1, 1.5.3 and 5.1.4.

**Publication 6**, for which I am solely responsible, was used in sections 2.2 and 2.3 to establish conclusions concerning integration of FSU immigrants in Israel.

**Publication 7** was an early survey of the socio-demographic background an integration in Israel of the migration wave of FSU Jews, with data for the years 1990-1993. I was responsible for compilation and analysis of most of the socio-economic data, and for the writing. This article forms the basis for the analysis in Section 2.

**Publication 8** is referred to in section 1.6. to establish the importance of social networks in mitigating mortality. I was responsible for data acquisition.

# Section 11.0 Appendices

## 11.1 A classic study and the weaknesses of the "environmental transition" approach

Weaknesses of the environmental transition paradigm clearly emerge when we examine the analytical framework of one of the classic studies in the literature of migrant health, the Japanese American Coronary Heart disease study (eg. (Kagan et al. 1974; Marmot et al. 1975; Reed 1990; Syme et al. 1975).

This collaborative, long-term research project is one of the best known, and even "the most influential" (Biddle et al. 2007; Jasso et al. 2004) series of studies of migration, acculturation and health. It sets out from an observed gradient in coronary heart disease (CHD) mortality in men of Japanese ancestry in the 1960s, increasing from Japan through Hawaii, to California. It investigated samples of nearly 12 thousand men in these three sites in order to understand the causes of this gradient and, by implication, the factors explaining the higher rates of CHD in America as compared to Japan. A large amount of physical and biochemical data was collected, along with information on diet, socio-economic characteristics, and "cultural" variables such as language spoken in various settings, religious practices, and social interactions with other ethnic Japanese.

Early published findings seemed to show that differences between the geographic locations were not explained by biomarkers and other conventional proximate risk factors, such as blood pressure, serum cholesterol levels, and smoking (Marmot et al. 1975). To account for this observation a bold hypothesis was proposed, explaining the differences as due to culture (as distinct from diet): the emphasis in traditional Japanese culture on community strength, group cohesion and social stability may be stress-reducing and thus protective, whereas the American emphasis on individual achievement and social and geographic mobility may be conducive to the "type A" behaviour pattern (people who are ambitious, impatient, highly organized and competitive) and "coronary prone behaviour". This protective effect was lost to the extent that Japanese-Americans relinquished their traditional culture and adopted American practices and values, resulting in the observed gradient.

In order to investigate this hypothesis on the California sample Marmot and Syme developed three indices of "acculturation", and these indices, with some modifications were later used on the Hawaii sample as well (Marmot et al. 1975; Reed et al. 1982a). The indices drew on Milton M. Gordon's sociological theory of the nature and role of assimilation in American society (Gordon 1964). Ostensibly following Gordon's distinction between "behavioral" and "structural" assimilation, the indices distinguished: 1. culture of upbringing – measured by items related to exposure to a Japanese milieu in childhood; 2. cultural assimilation – measured principally by Japanese language use in various contexts; and 3. social assimilation – the degree of maintenance of social and occupational contacts with fellow Japanese-Americans. Using univariate and bivariate frequency distributions, Marmot and Syme found that the gradient in CHD prevalence was associated with the degree of acculturation to Western (i.e. American) culture and could not be accounted for by differences in the major coronary risk factors or adherence to a Japanese diet. However, in a later study of the Hawaiian cohort, which investigated incidence of CHD as well as prevalence, and, crucially, employed multivariate analysis, these finding held up only partially, at best. Whereas bivariate analysis showed the same association of at least some of the indices with both CHD prevalence and incidence as had the previous study (though the significant indices differed), with multivariate techniques it was found that none of the acculturation scores had any association with the incidence of any single clinical group of coronary heart disease. A further study of this sample population extended the negative findings and found that elevated blood pressure was not associated with the stress of migration, acculturation, or status incongruity (between education and occupation) (Reed et al. 1982b).

What concerns us here is the study design rather than the negative or positive results. Was the concept of acculturation used to investigate the health consequences of the multiple dynamic factors of migration,

which alter over time and with duration of residence? Are these studies considering "the process of migration" as an independent influence on health?

Close examination leads to a negative answer to both questions. The definition of acculturation which Marmot and Syme use seems promising, since they define it very broadly as "all the facets of cultural and social change" which migrants undergo (p.226). They seem unaware that this definitional breadth was, in fact, a departure from Gordon's analytical scheme. Gordon's concept was more focused. He was concerned specifically with "assimilation" in the United States, which he recognized both as a programmatic ideology and a conceptual model, both descriptive and prescriptive (Gordon 1961). In the analytic conceptual scheme which he developed he distinguished seven dimensions of "assimilation", but chiefly among them what he called "behavioral" assimilation and "structural" assimilation. Behavioral assimilation was accomplished through "acculturation", which he defined in a narrower manner than Marmot and Syme. It is limited to the 'inevitable' (his word) adoption by the immigrant group of the "extrinsic" cultural patterns of the host society, including language, dress, emotional expression and personal values (but not necessarily such ingredients of group identity as religious identity or even musical tastes). Structural assimilation occurs later and is not inevitable; it involves the entry of the immigrant group into the intimate institutions, organizations, clubs, etc of the host society, eventually resulting in intermarriage and the gradual disappearance of the minority's separate identity. He did not anticipate that this last stage would be accomplished by the immigrants themselves, but by future generations (for a critical discussion see (Alba and Nee 1997)).

The Japanese-American study is unusual in the literature because it appears to rely on a developed theory of acculturation, rather than simply employing acculturation scales detached from an explanatory framework, as many future studies of migrant health were to do (Abraido-Lanza et al. 2006). In practice, however, it simplifies Gordon's theory and strips it of the elements which provide a complex temporal structure. The dimensions of assimilation that Gordon envisaged were conceived as contingent stages rather than as related parallel processes. He stressed that for many groups in America, "structural assimilation" had not been achieved because of religious and racial barriers. Nor is the "social assimilation" dimension which was developed in the CHD and blood pressure studies equivalent to the "structural assimilation" that Gordon envisages, because the former does not distinguish "primary" relations (clubs, friendships), which for Gordon was its true representation, from "instrumental" relations (work and professional relationships) which were a "lesser" form of assimilation. A faithful application of Gordon's theory would have addressed the temporal sequence he envisaged, and tested for an increasing effect on CHD beginning with culture of upbringing, through current cultural assimilation (as expressed by language use and personal values), and finally the strongest effect on CHD would have been with structural assimilation (creation of intimate social relationships and mutual acceptance between Japanese Americans and the wider American society, especially its elites).

In practice the Japanese-American study measured the effect of each scale separately, ignoring the sequence that Gordon envisaged. This may have led to its confusingly contradictory findings: the strongest effect in California was found for childhood influences, "culture of upbringing", while in Hawaii this had the least effect. The acculturation scales measured the degree to which "traditional Japanese culture" had given way to "western American culture" through indirect proxy variables, namely, increasing English language use and quantity of social interaction with non-Japanese, rather than through a direct examination of values and social practices. Loss of adherence to the presumed traditional Japanese values of group cohesion and adoption of the "American" values of individual achievement are not ever measured directly.

The idea that immigrants arrive with positive behavioural attributes and gradually succumb to the "toxicity" of western culture is an example of an old and perennial temporal theme in migration studies (Abraido-Lanza et al. 2005; Antecol and Bedard 2006; Reed et al. 1970; Rumbaut 1997). Japanese-Americans are depicted as having brought with them a protective traditional culture, and as this culture is lost through

"acculturation", they are progressively exposed to the greater health risks that life in "modern" western society brings – but, surprisingly, this depiction is not backed up by direct measurement.

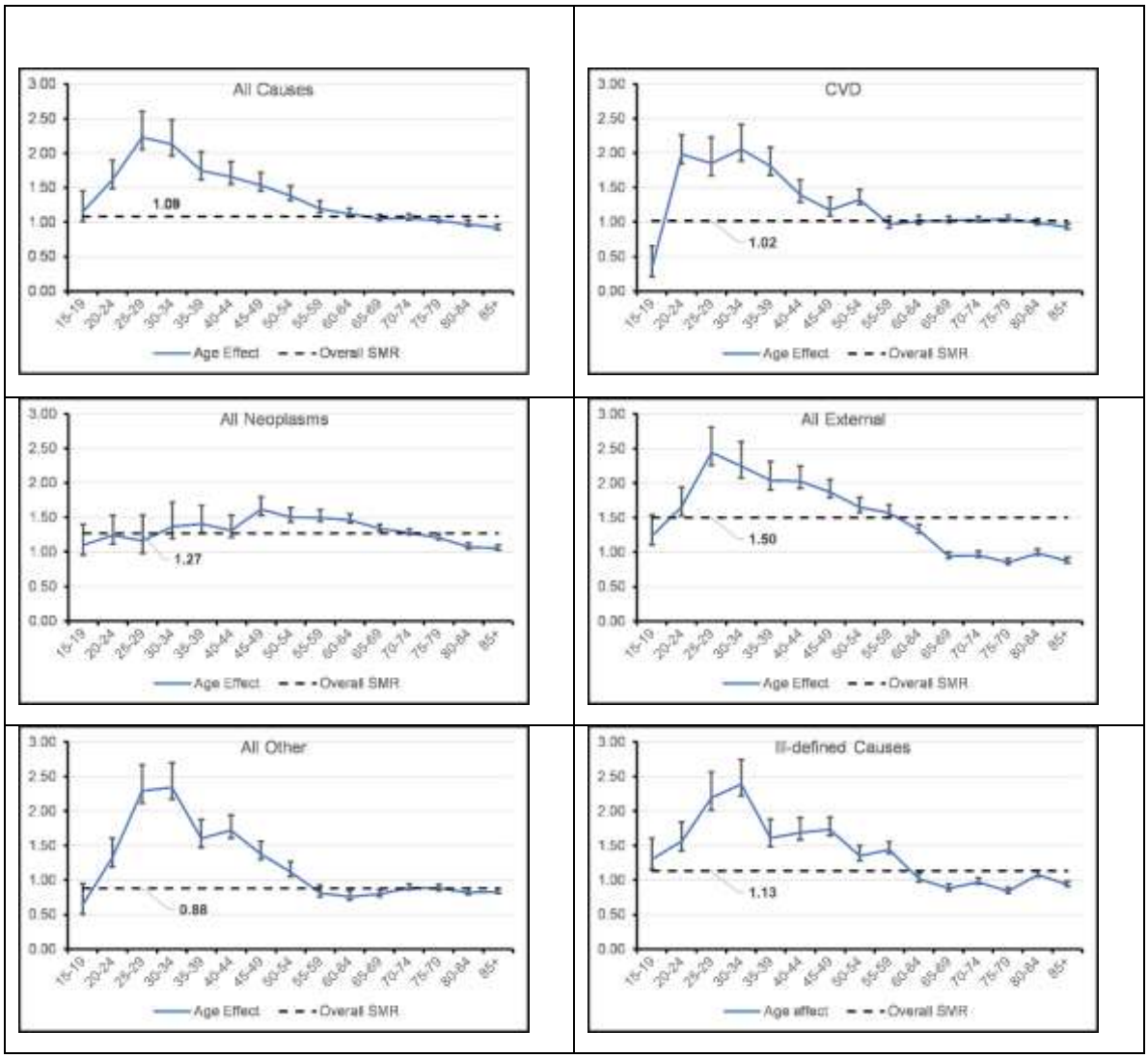
Despite the initial breath of the definition of "acculturation" these studies do not contain any real examination of the independent effect of "the process of migration", of how values and perspectives are altered through the need to adjust to life in a new social and economic context, and how this affects health. There is nothing about the travails of moving and adapting to a new society and culture, of finding employment and income. Instead, two states ("traditional", "western") are compared along a smooth continuum which can be measured by scales and, in the Hawaiian study, aggregated into one dimension of "total acculturation" (Reed et al. 1982a).

Even more remarkably, given its reputation as a classic "Migrant Study", this is not a study of the immediate consequences of migration – only 15% of the Californian cohort and an even smaller proportion of the Hawaiian cohort, 12%, were born in Japan. The overwhelming majority of these first generation migrants were over 65 years old when studied, and virtually all of them had been living in the United States for over 45 years – the latest date of migration was 1924, when regulations barred further migration by Japanese to the USA (Kagan et al. 1974). None of the migrants could display any but the most long-term consequences of the migration process. The effects of migration on blood pressure, proposed as "the effect of prolonged stress such as exposure to sociocultural change" (Reed et al. 1982b) were investigated 40 years after the process began! We are not provided with any information concerning possible attrition of the original migrants due to mortality and re-migration, those migrants for whom the stress of migration may have been greatest. And perhaps the most notorious source of "stress of acculturation" as migrants that Japanese-Americans were exposed to, an experience which one might expect to have had substantial health consequences, is never referred to at all: the consequences of the forced confinement by the United States government of Japanese immigrants on the west coast of the USA during World War II, and their loss of property (Robinson 2009). The importance of this omission is compounded since there are contrasting experiences in California and Hawaii, since there was no confinement in the latter!

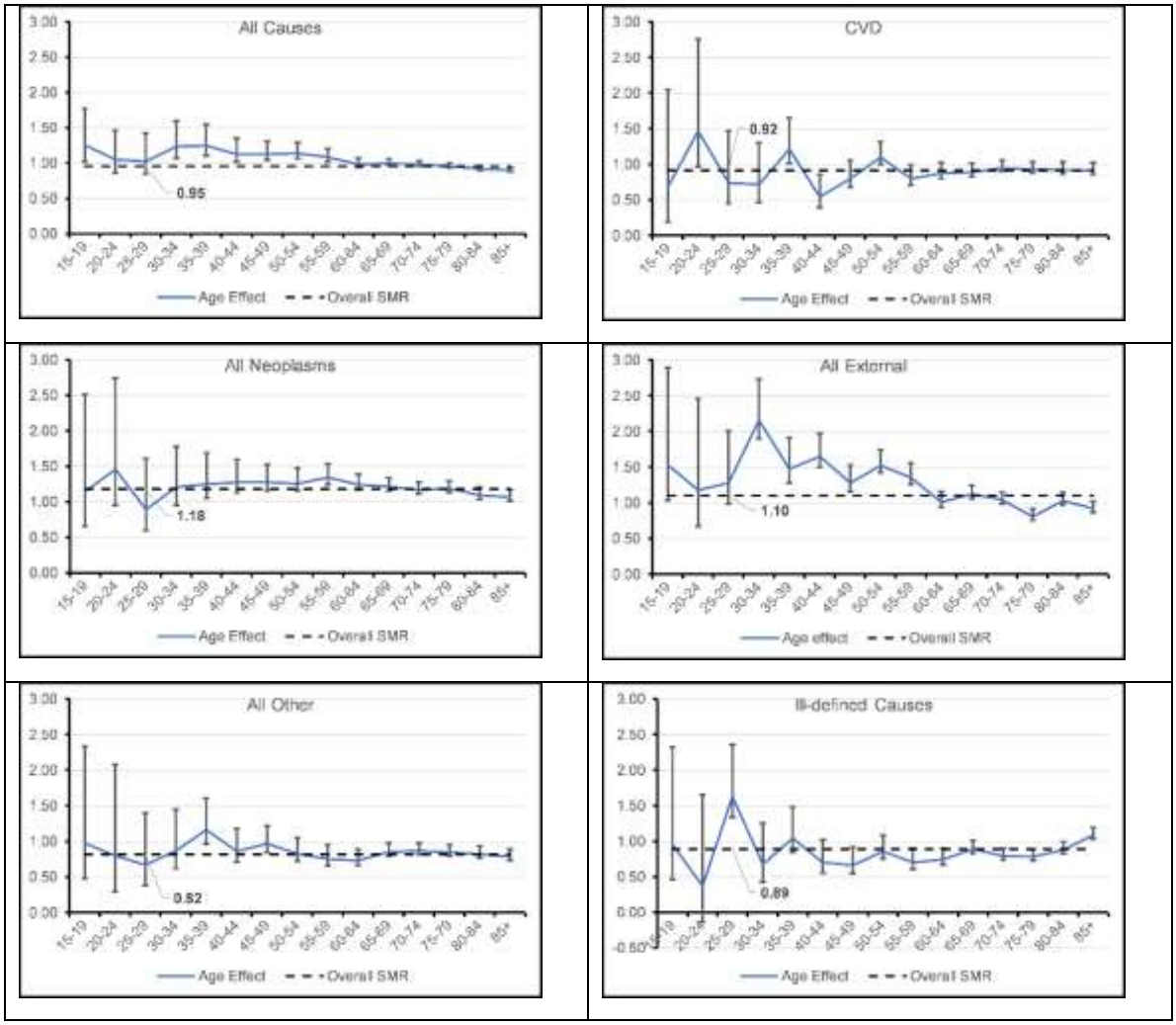
The concept of "acculturation" implies a process and change over time, but the Japanese-American study, typically of studies in this tradition, does not investigate the process itself but relies on assumptions about the direction of change towards a predetermined cultural end-state. In practice this study is essentially atemporal and ahistorical. Although clinical data were gathered longitudinally, "acculturation" data was collected in cross-section, at the initiation of the study. The only time-dependent variables that enter into the study are current age and exposure to Japanese culture in childhood. The historical context was not considered, including changes in immigration regulations and the upheavals of World War II – potentially highly significant "period" effects. Other potentially important temporal factors – such as age at migration, duration in the United States, or period of arrival in the USA – were not examined. This study is essentially an investigation of the contrasting effects of Japanese and Western culture on the aetiology of CHD, using migration as an investigative device, but ignoring essential characteristics of migration in general and distinctive characteristics of this migration in particular. Insofar as this study was influential, it's methodology appears to have supressed a direct interest in how the concrete circumstances of migration affect health outcomes for migrants in favour of a timeless study comparing origins and outcomes, with assumptions concerning the intervening processes.

## 11.2 Appendix Figures

Appendix Figure A3.1a Males, SMR and Age effects by Cause of Death Group, Model 1



Appendix Figure 3.1b Females, SMR and Age effects by Cause of Death Group, Model 1.



## 11.3 Appendix Tables

Table A3.1 Predictors of 13+ years of Education, by sex.

| | Odds Ratio | Lower confidence limit | Upper confidence limit |
|---|---|---|---|
| **Males** | | | |
| **Age** | | | |
| 15-34 | 1.000 | | |
| 35-59 | 2.510 *** | 2.471 | 2.550 |
| 60-74 | 1.642 *** | 1.608 | 1.677 |
| 75+ | 0.863 *** | 0.829 | 0.897 |
| **Region of FSU** | | | |
| Russian Federation and Baltic States | 1.000 | | |
| Ukraine, Belarus, Moldova | 0.854 *** | 0.839 | 0.869 |
| Asian Republics | 0.689 *** | 0.672 | 0.706 |
| Caucasian Republics | 0.549 *** | 0.534 | 0.566 |
| other | 0.619 *** | 0.585 | 0.655 |
| **Moscow St Petersburg (**Ref. all others**)** | 1.939 *** | 1.885 | 1.994 |
| **Non Jews (**ref. Jews**)** | 0.792 *** | 0.779 | 0.805 |
| **Emigrants (**Ref. Non emigrants**)** | 1.341 *** | 1.310 | 1.373 |
| **Females** | | | |
| **Age** | | | |
| 15-34 | 1.000 | | |
| 35-59 | 2.105*** | 2.074 | 2.136 |
| 60-74 | 0.912 | 0.896 | 0.929 |
| 75+ | 0.357 *** | 0.346 | 0.369 |
| **Region of FSU** | | | |
| Russian Federation and Baltic States | 1.000 | | |
| Ukraine, Belarus, Moldova | 0.824 *** | 0.811 | 0.838 |
| Asian Republics | 0.737 *** | 0.720 | 0.754 |
| Caucasian Republics | 0.494 *** | 0.481 | 0.507 |
| other | 0.514 *** | 0.487 | 0.544 |
| **Moscow St Petersburg (**Ref. all others**)** | 1.862 *** | 1.814 | 1.910 |
| **Non Jews (**ref. Jews**)** | 0.914 *** | 0.900 | 0.929 |
| **Emigrants (**Ref. Non emigrants**)** | 1.220 *** | 1.191 | 1.250 |

p *** p<0.001, ** 0.001<p<0.01, * 0.01<p<0.05

Table A3.2 Predictors of emigration.

| | Odds Ratio | Lower | Upper |
|---|---|---|---|
| **Female sex** | 0.760 *** | 0.748 | 0.772 |
| **Age** | | | |
| 15-34 | 4.076 *** | 3.839 | 4.327 |
| 35-59 | 2.177 *** | 2.049 | 2.313 |
| 60-74 | 1.371 *** | 1.286 | 1.462 |
| 75+ | 1.00 | | |
| **Region of FSU** | | | |
| Russian Federation and Baltic States | 1.000 | | |
| Ukraine, Belarus, Moldova | 0.704 *** | 0.690 | 0.719 |
| Asian Republics | 0.524 *** | 0.507 | 0.541 |
| Caucasian Republics | 0.643 *** | 0.621 | 0.667 |
| other | 2.088 *** | 1.989 | 2.191 |
| **Moscow St Petersburg (**ref. all | 1.966 *** | 1.916 | 2.017 |
| **Non Jews (**ref. Jews**)** | 1.451 *** | 1.426 | 1.477 |
| **Education 13+ years (**ref. all others**)** | 1.271 *** | 1.250 | 1.292 |

p *** p<0.001, ** 0.001<p<0.01, * 0.01<p<0.05

Table A3.3 ICD classification codes and cause of death group.

| ***WHO List 2 80 Selected grouped causes of Death*** | ***ICD 10 3 digit code*** | ***ICD9 4 digit code*** | ***ICBS 55 Selected grouped causes of death*** | ***ICBS code*** |
|---|---|---|---|---|
| 2-001 Cholera | A00 | 001.0-009.9 | Intestinal Infectious Diseases | 1 |
| 2-002 Diarrhoea and gastroenteritis of presumed infectious origin | A09 | | | |
| 2-003 Other intestinal infectious diseases | A01-A08 | | | |
| 2-004 Respiratory tuberculosis | A15-A16 | 010.0-018.9 | Tuberculosis (respiratory and other) | 2 |
| 2-005 Other tuberculosis | A17-A19 | | | |
| 2-011 Septicaemia | A40-A41 | 038.0-038.9 | Septicaemia | 3 |
| 2-018 Viral hepatitis | B15-B19 | 070.0-070.9 | Viral hepatitis | 4 |
| 2-019Human immunodeficiency virus [HIV] disease | B20-B24 | 042.0-044.9 | HIV | 5 |
| 2-006 Plague | A20 | 020.0-020.9, 037.0-037.9, 032.0-032.9, 033.0-033.9, 036.0-036.9, 090.0-099.9 131.0-131.9, 054.1, 078.1 045.0-045.9, 071.0-071.9 060.0-060.9, 061.0-066.9 055.0-055.9, 084.0-086.9 120.0-120.9, 021.0-031.9 034.0-034.9, 035.0-035.9 039.0-041.9, 046.0-053.9 054.0, 054.2-054.9, 056.0-056.9, 057.0-057.9 072.0-077.9, 078.0 078.2-078.8, 079.0-083.9 087.0-087.9, 088.0-088.9 100.0-119.9, 121.0-130.9 132.0-139.9 | Remainder of Infectious and Parasitic diseases | 6 |
| 2-007 Tetanus | A33-A35 | | | |
| 2-008 Diphtheria | A36 | | | |
| 2-009 Whooping cough | A37 | | | |
| 2-010 Meningococcal infection | A39 | | | |
| 2-012 Infections with a predominantly sexual mode of transmission | A50-A64 | | | |
| 2-013 Acute poliomyelitis | A80 | | | |
| 2-014 Rabies | A82 | | | |
| 2-015 Yellow fever | A95 | | | |
| 2-016 Other arthropod-borne viral fevers and viral haemorrhagic fevers | A90-A94, A96-A99 | | | |
| 2-017 Measles | B05 | | | |
| 2-020 Malaria | B50-B54 | | | |
| 2-021 Leishmaniasis | B55 | | | |
| 2-022 Trypanosomiasis | B56-B57 | | | |
| 2-023 Schistosomiasis | B65 | | | |
| 2-024 Remainder of certain infectious and parasitic diseases | A21-A32, A38, A42-A49, A65-A79, A81, A83-A89, B00-B04, B06-B09, B25-B49, B58-B64, B66-B94, B99 | | | |
| 2-025 Malignant neoplasm of lip, oral cavity and pharynx | C00-C14 | 140.0-149.9 | Malignant neoplasm of lip, oral cavity and pharynx | 7 |
| 2-026 Malignant neoplasm of oesophagus | C15 | 150.0-150.9 | Malignant neoplasm of oesophagus | 8 |
| 2-027 Malignant neoplasm of stomach | C16 | 151.0-151.9 | Malignant neoplasm of stomach | 9 |
| 2-028 Malignant neoplasm of colon, rectum and anus | C18-C21 | 153.0-154.9 | Malignant neoplasm of colon, rectum and anus | 10 |
| 2-029 Malignant neoplasm of liver and intrahepatic bile ducts | C22 | 155.0-155.9 | Malignant neoplasm of liver and intrahepatic bile ducts | 11 |
| 2-030 Malignant neoplasm of pancreas | C25 | 157.0-157.9 | Malignant neoplasm of pancreas | 12 |

| | | | | |
|---|---|---|---|---|
| 2-031 Malignant neoplasm of larynx | C32 | 161.0-161.9 | Malignant neoplasm of larynx | 13 |
| 2-032 Malignant neoplasm of trachea, bronchus and lung | C33-C34 | 162.0-162.9 | Malignant neoplasm of trachea, bronchus and lung | 14 |
| 2-033 Malignant neoplasm of skin | C43 | 172.0-172.9 | Malignant neoplasm of skin | 15 |
| 2-034 Malignant neoplasm of breast | C50 | 174.0-175.9 | Malignant neoplasm of breast | 16 |
| 2-035 Malignant neoplasm of cervix uteri | C53 | 180.0-180.9 | Malignant neoplasm of cervix uteri | 17 |
| 2-036 Malignant neoplasm of other and unspecified parts of uterus | C54-C55 | 179.0-179.9, 182.0-182.9 | Malignant neoplasm of other and unspecified parts of uterus | 18 |
| 2-037 Malignant neoplasm of ovary | C56 | 183.0 | Malignant neoplasm of ovary | 19 |
| 2-038 Malignant neoplasm of prostate | C61 | 185.0-185.9 | Malignant neoplasm of prostate | 20 |
| 2-039 Malignant neoplasm of bladder | C67 | 188.0-188.9 | Malignant neoplasm of bladder | 21 |
| 2-040 Malignant neoplasm of meninges, brain and other parts of central nervous system | C70-C72 | 191.0-192.9 | Malignant neoplasm of meninges, brain and other parts of central nervous system | 22 |
| 2-041 Non-Hodgkin's lymphoma | C82-C85 | 200.0-200.9, 202.0-202.9 | Non-Hodgkin's lymphoma | 23 |
| 2-042 Multiple myeloma and malignant plasma cell neoplasms | C90 | 203.0-203.9 | Multiple myeloma and malignant plasma cell neoplasms | 24 |
| 2-043 Leukaemia | C91-C95 | 204.0-208.9 | Leukaemia | 25 |
| 2-044 Remainder of malignant neoplasms | C17, C23-C24, C26-C31, C37-C41, C44-C49, C51-C52, C57-C60, C62-C66, C68-C69, C73-C81, C88, C96-C97 | 152.0-152.9, 156.0-156.9 158.0-160.9, 163.0-171.9 173.0-173.9, 176.0-176.9 181.0-181.9, 184.0-184.9 186.0-186.9, 187.0-187.9 189.0-189.9, 183.1-183.9 190.0-190.9, 193.0-199.9 201.0-201.9 | Remainder of malignant neoplasms | 26 |
| 2-045 Anaemias | D50-D64 | 280.0-285.9 | Anaemias | 27 |
| 2-046 Diabetes mellitus | E10-E14 | 250.0-250.9 | Diabetes mellitus | 28 |
| 2-048 Mental and behavioural disorders due to psychoactive substance use | F10-F19 | 291.0-292.9, 303.0-304.9 | Mental and behavioural disorders due to psychoactive substance use | 29 |
| 2-049 Meningitis | G00,G03 | 320.0-322.9 | Meningitis | 30 |
| 2-050 Alzheimer's disease | G30 | 331.0 | Alzheimer's disease | 31 |
| 2-051 Acute rheumatic fever and chronic rheumatic heart diseases | I00-I09 | 390.0-398.9 | Acute rheumatic fever and chronic rheumatic heart diseases | 32 |
| 2-052 Hypertensive diseases | I10-I14 | 401.0-405.9 | Hypertensive diseases | 33 |
| 2-053 Ischaemic heart diseases | I21 | 410.0-410.9 | Acute Myocardial Infarction | 34 |
| | I20-I25 | 411.0-414.9 | Other Ischaemic heart diseases | 35 |
| 2-054 Other heart diseases | I26-I51 | 415.0-429.9 | Other heart diseases | 36 |

| | | | | |
|---|---|---|---|---|
| 2-055 Cerebrovascular diseases | I60-I69 | 430.0-434.9, 436.0-438.9 | Cerebrovascular diseases | 37 |
| 2-056 Atherosclerosis | I70 | 440.0-440.9 | Atherosclerosis and Remainder of diseases of the circulatory system | 38 |
| 2-057 Remainder of diseases of the circulatory system | I71-I99 | 441.0-459.9 | | |
| 2-058 Influenza | J10-J11 | 487.0-487.9 | Influenza | 39 |
| 2-059 Pneumonia | J12-J18 | 480.0-486.9 | Pneumonia | 40 |
| 2-061 Chronic lower respiratory diseases | J40-J47 | 490.0-494.9, 496.0-496.9 | Chronic lower respiratory diseases | 41 |
| 2-060 Other acute lower respiratory infections | J20-J22 | 460.0-465.9, 466.0-466.9, 470.0-478.9, 495.0-495.9, 500.0-519.9 | Remainder diseases of the respiratory system | 42 |
| 2-062 Remainder of diseases of the respiratory system | J00-J06, J30-J39, J60-J98 | | | |
| 2-063 Gastric and duodenal ulcer | K25-K27 | 531.0-533.9 | Gastric and duodenal ulcer | 43 |
| 2-064 Diseases of the liver | K70-K76 | 570.0-573.9 | Diseases of the liver | 44 |
| 2-065 Glomerular and renal tubulo-interstitial diseases | N00-N15 | 580.0-583.9, 584.0-585.9 587.0-589.9, 590.0-590.9 591.0-591.9, 592.0-592.9 593.0-593.9, 594.0-594.9 599.6 | Kidney Diseases (including (N17-N29) | 45 |
| 2-066 Pregnancy with abortive outcome | O00-O07 | 630.0-639.9, 640.0-676.9 | Obstetric Causes (including O95 – unspecified) | 46 |
| 2-067 Other direct obstetric deaths | O10-O92 | | | |
| 2-068 Indirect obstetric deaths | O98-O99 | | | |
| 2-069 Certain conditions originating in the perinatal period | P00-P96 | 760.0-779.9 | Perinatal Conditions | 47 |
| 2-070 Congenital malformations, deformations and chromosomal abnormalities | Q00-Q99 | 740.0-759.9 | Congenital Anomalies | 48 |
| 2-071 Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified | R00-R99 | 780.0-799.9 | Signs symptoms and ill-defined causes | 49 |
| 2-047 Malnutrition | E40-E46 | 210.0-249.9, 251.0-259.9 264.0-279.9, 286.0-290.9 293.0-302.9, 305.0-319.9 332.0-389.9, 520.0-530.9 534.0-569.9, 574.0-579.9 586.0-586.9, 595.0-598.9 331.1-331.9, 600.0-629.9 435.0-435.9, 599.7-599.9 680.0-739.9, 599.0-599.5 323.0-330.9, 260.0-263.9 | Other diseases | 50 |
| 2-072 All other diseases | D00-D48, D65-D89, E00-E07, E15-E34, E50-E88, F01-F09, F20-F99, G04-G25, G31-G98, H00-H93, K00-K22, K28-K66, K80-K92, L00-L98, M00-M99, N17-N98, O95-O97 | | | |
| 2-073 Transport accidents | V01-V99 | 800.0-848.9, 929.0-929.1 | Transport accidents | 51 |

| | | | | |
|---|---|---|---|---|
| 2-074 Falls | W00-W19 | 880.0-888.9 | Falls | 52 |
| 2-075 Accidental drowning and submersion | W65-W74 | 850.0-869.9, 890.0-899.9 900.0-928.9, 929.2-929.9 | Other Accidents | 53 |
| 2-076 Exposure to smoke, fire and flames | X00-X09 | | | |
| 2-077 Accidental poisoning by and exposure to noxious substances | X40-X49 | | | |
| 2-078 Intentional self-harm | X60-X84 | 950.0-959.9 | Intentional self-harm | 54 |
| 2-079 Assault | X85-Y09 | 960.0-969.9, 870.0-879.9, 930.0-949.9, 970.0-999.9, 849.0-849.9 | Other External Causes | 55 |
| 2-080 All other external causes | W20-W64, W75-W99, X10-X39, X50-X59, Y10-Y89 | | | |

Table A3.4 Characteristics by calendar year: person-years, age, geographic origin, ethnicity, education

| | Calendar Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1990-2004 | 1990-1991 | 1992-1993 | 1994-1995 | 1996-1997 | 1998-1999 | 2000-2001 | 2002-2004 |
| **All immigrants – person years** | 7,383,331 | 251,092 | 612,113 | 816,362 | 1,011,954 | 1,178,117 | 1,354,406 | 2,159,287 |
| | | | | *Percentages* | | | | |
| **Female** | 54.5 | 54.2 | 54.3 | 54.4 | 54.5 | 54.5 | 54.5 | 54.5 |
| **Age** | | | | | | | | |
| 15-34 | 36.1 | 37.0 | 35.8 | 35.5 | 35.3 | 35.8 | 36.5 | 36.4 |
| 35-59 | 39.0 | 39.8 | 40.0 | 39.9 | 39.7 | 38.7 | 38.0 | 38.7 |
| 60-74 | 12.4 | 13.9 | 13.7 | 12.8 | 12.4 | 12.6 | 12.5 | 11.7 |
| 75+ | 12.5 | 9.3 | 10.5 | 11.7 | 12.5 | 12.9 | 13.0 | 13.1 |
| **Region of FSU** | | | | | | | | |
| Russia and Baltic Republics | 30.4 | 28.8 | 30.8 | 30.5 | 29.4 | 29.6 | 30.9 | 30.9 |
| *Thereof*: Moscow, St. Petersburg | 9.9 | 13.9 | 13.7 | 12.1 | 10.5 | 9.4 | 8.7 | 8.3 |
| Ukraine, Belarus Moldova | 46.1 | 52.0 | 47.8 | 44.7 | 45.4 | 46.1 | 45.9 | 46.0 |
| Caucasian and Asian Republics | 21.8 | 18.2 | 19.8 | 22.6 | 23.2 | 22.5 | 21.6 | 21.7 |
| Unspecified | 1.7 | 0.9 | 1.6 | 2.1 | 2.0 | 1.8 | 1.6 | 1.4 |
| **Education: 13 years and over** | 44.9 | 55.5 | 52.1 | 48.3 | 45.7 | 44.0 | 43.0 | 41.6 |
| **Ethnic Group** | | | | | | | | |
| Jews | 82.1 | 95.1 | 92.4 | 89.5 | 86.1 | 82.2 | 78.0 | 75.7 |
| Non-Jews | 17.9 | 4.9 | 7.6 | 10.5 | 13.9 | 17.8 | 22.0 | 24.3 |

Table A3.5a SMRs and 95% confidence intervals by Arrival Cohort and Duration of Residence, by Cause of Death Group

Males All Ages

| All causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.13** (1.1-1.16) | **1.12** (1.1-1.15) | **1.12** (1.09-1.15) | **1.08** (1.05-1.11) | **1.06** (1.03-1.09) | **1.02** (0.99-1.06) | **0.98** (0.95-1.02) |
| N | 6563 | 6516 | 6089 | 5329 | 4501 | 3444 | 2471 |
| 1990-91 | **0.97** (0.93-1.01) | **0.97** (0.93-1.01) | **1.02** (0.98-1.06) | **0.98** (0.94-1.02) | **0.99** (0.95-1.03) | **1.01** (0.97-1.05) | **0.98** (0.94-1.02) |
| N | 2248 | 2309 | 2446 | 2368 | 2417 | 2457 | 2353 |
| 1992-93 | **1.11** (1.04-1.18) | **1.16** (1.09-1.23) | **1.11** (1.04-1.17) | **1.14** (1.07-1.21) | **1.09** (1.02-1.16) | **1.04** (0.97-1.11) | |
| N | 1035 | 1083 | 1034 | 1073 | 1021 | 863 | |
| 1994-95 | **1.16** (1.09-1.23) | **1.17** (1.1-1.24) | **1.18** (1.11-1.25) | **1.21** (1.14-1.28) | **1.19** (1.12-1.27) | | |
| N | 1013 | 1047 | 1069 | 1097 | 942 | | |
| 1996-97 | **1.21** (1.13-1.3) | **1.15** (1.07-1.23) | **1.21** (1.13-1.3) | **1.20** (1.12-1.3) | | | |
| N | 778 | 763 | 823 | 730 | | | |
| 1998-99 | **1.37** (1.27-1.47) | **1.44** (1.34-1.55) | **1.40** (1.29-1.51) | | | | |
| N | 764 | 810 | 651 | | | | |
| 2000-01 | **1.44** (1.32-1.56) | **1.39** (1.27-1.53) | | | | | |
| N | 538 | 477 | | | | | |
| 2002-03 | **1.68** (1.44-1.93) | | | | | | |
| N | 187 | | | | | | |

| CVD | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **0.98** (0.94-1.03) | **0.99** (0.95-1.04) | **1.08** (1.03-1.12) | **1.03** (0.98-1.08) | **1.01** (0.95-1.06) | **1.03** (0.96-1.09) | **1.01** (0.94-1.09) |
| N | 2234 | 2190 | 2071 | 1658 | 1320 | 1044 | 744 |
| 1990-91 | **0.94** (0.88-1) | **0.90** (0.84-0.96) | **1.06** (0.99-1.12) | **0.98** (0.91-1.05) | **0.96** (0.9-1.04) | **1.02** (0.95-1.1) | **1.01** (0.94-1.09) |
| N | 931 | 946 | 1024 | 835 | 741 | 758 | 713 |
| 1992-93 | **0.96** (0.86-1.05) | **1.03** (0.93-1.14) | **1.08** (0.97-1.2) | **1.07** (0.96-1.2) | **1.00** (0.89-1.12) | **1.01** (0.89-1.15) | |
| N | 393 | 390 | 355 | 319 | 286 | 248 | |
| 1994-95 | **1.02** (0.92-1.13) | **1.06** (0.95-1.18) | **1.09** (0.97-1.22) | **1.11** (0.99-1.25) | **1.08** (0.95-1.22) | | |
| N | 356 | 331 | 308 | 305 | 248 | | |
| 1996-97 | **1.01** (0.88-1.15) | **1.10** (0.96-1.25) | **1.07** (0.93-1.23) | **1.06** (0.92-1.23) | | | |
| N | 219 | 223 | 214 | 185 | | | |
| 1998-99 | **1.03** (0.88-1.2) | **1.20** (1.04-1.39) | **1.18** (1-1.39) | | | | |
| N | 171 | 193 | 153 | | | | |
| 2000-01 | **1.16** (0.96-1.38) | **1.10** (0.89-1.33) | | | | | |
| N | 121 | 102 | | | | | |
| 2002-03 | **1.46** (1.06-1.97) | | | | | | |
| N | 43 | | | | | | |

Table A3.5a Males All Ages (cont.)

| All neoplasms | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.45** (1.39-1.52) | **1.25** (1.2-1.32) | **1.22** (1.16-1.28) | **1.27** (1.2-1.33) | **1.01** (0.95-1.06) | **1.03** (0.96-1.09) | **1.01** (0.94-1.09) |
| N | 1933 | 1743 | 1605 | 1513 | 1320 | 1044 | 744 |
| 1990-91 | **1.20** (1.11-1.31) | **1.10** (1.01-1.19) | **1.13** (1.05-1.23) | **1.19** (1.1-1.28) | **0.96** (0.9-1.04) | **1.02** (0.95-1.1) | **1.01** (0.94-1.09) |
| N | 581 | 603 | 647 | 695 | 741 | 758 | 713 |
| 1992-93 | **1.39** (1.24-1.56) | **1.26** (1.12-1.42) | **1.14** (1.01-1.29) | **1.31** (1.17-1.48) | **1.00** (0.89-1.12) | **1.01** (0.89-1.15) | |
| N | 300 | 281 | 259 | 287 | 286 | 248 | |
| 1994-95 | **1.35** (1.2-1.51) | **1.26** (1.11-1.41) | **1.24** (1.1-1.4) | **1.36** (1.21-1.52) | **1.08** (0.95-1.22) | | |
| N | 286 | 278 | 266 | 304 | 248 | | |
| 1996-97 | **1.58** (1.39-1.79) | **1.34** (1.17-1.54) | **1.32** (1.15-1.5) | **1.37** (1.19-1.56) | | | |
| N | 255 | 215 | 222 | 211 | | | |
| 1998-99 | **1.84** (1.62-2.09) | **1.45** (1.26-1.66) | **1.56** (1.35-1.8) | | | | |
| N | 249 | 206 | 189 | | | | |
| 2000-01 | **2.09** (1.81-2.41) | **1.67** (1.42-1.97) | | | | | |
| N | 199 | 150 | | | | | |
| 2002-03 | **2.11** (1.63-2.71) | | | | | | |
| N | 63 | | | | | | |

| All external causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.76** (1.63-1.89) | **1.66** (1.54-1.8) | **1.58** (1.45-1.72) | **1.42** (1.29-1.56) | **1.34** (1.2-1.49) | **1.23** (1.09-1.39) | **0.98** (0.82-1.15) |
| N | 714 | 646 | 545 | 427 | 339 | 253 | 142 |
| 1990-91 | **1.23** (1.06-1.41) | **1.09** (0.93-1.27) | **1.06** (0.9-1.24) | **0.92** (0.77-1.09) | **1.13** (0.97-1.32) | **1.16** (1-1.35) | **0.95** (0.8-1.13) |
| N | 188 | 165 | 154 | 133 | 163 | 177 | 133 |
| 1992-93 | **1.54** (1.25-1.89) | **1.32** (1.04-1.65) | **1.22** (0.95-1.55) | **1.70** (1.37-2.07) | **1.52** (1.22-1.87) | **1.39** (1.08-1.77) | |
| N | 95 | 77 | 70 | 95 | 89 | 66 | |
| 1994-95 | **1.87** (1.54-2.26) | **1.83** (1.5-2.22) | **2.07** (1.71-2.49) | **1.90** (1.56-2.29) | **1.67** (1.32-2.09) | | |
| N | 107 | 104 | 114 | 109 | 77 | | |
| 1996-97 | **1.93** (1.55-2.37) | **2.03** (1.64-2.49) | **1.95** (1.57-2.38) | **2.16** (1.72-2.67) | | | |
| N | 89 | 94 | 95 | 84 | | | |
| 1998-99 | **2.87** (2.39-3.42) | **2.76** (2.3-3.28) | **3.03** (2.47-3.67) | | | | |
| N | 125 | 127 | 103 | | | | |
| 2000-01 | **2.38** (1.89-2.96) | **2.69** (2.12-3.38) | | | | | |
| N | 81 | 75 | | | | | |
| 2002-03 | **2.85** (1.91-4.1) | | | | | | |
| N | 29 | | | | | | |

Table A3.5a Males All Ages (cont.)

| All other causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **0.76** (0.72-0.81) | **0.91** (0.86-0.96) | **0.92** (0.87-0.97) | **0.90** (0.85-0.95) | **0.91** (0.86-0.97) | **0.86** (0.8-0.92) | **0.88** (0.82-0.95) |
| N | 992 | 1190 | 1242 | 1211 | 1138 | 867 | 680 |
| 1990-91 | **0.72** (0.65-0.8) | **0.82** (0.74-0.91) | **0.81** (0.73-0.89) | **0.79** (0.72-0.87) | **0.88** (0.81-0.95) | **0.85** (0.78-0.92) | **0.89** (0.82-0.96) |
| N | 362 | 364 | 412 | 488 | 620 | 612 | 654 |
| 1992-93 | **0.68** (0.56-0.81) | **1.03** (0.89-1.18) | **0.96** (0.84-1.09) | **0.99** (0.87-1.11) | **0.88** (0.77-1) | **0.84** (0.74-0.97) | |
| N | 118 | 203 | 228 | 267 | 244 | 215 | |
| 1994-95 | **0.77** (0.65-0.91) | **0.87** (0.75-1) | **1.04** (0.91-1.17) | **1.05** (0.93-1.18) | **1.02** (0.89-1.15) | | |
| N | 140 | 195 | 265 | 278 | 243 | | |
| 1996-97 | **0.73** (0.61-0.88) | **0.86** (0.73-1) | **0.98** (0.85-1.13) | **0.91** (0.77-1.06) | | | |
| N | 114 | 156 | 190 | 164 | | | |
| 1998-99 | **0.95** (0.81-1.12) | **1.18** (1.01-1.36) | **0.98** (0.82-1.16) | | | | |
| N | 144 | 184 | 133 | | | | |
| 2000-01 | **0.83** (0.66-1.03) | **0.87** (0.69-1.07) | | | | | |
| N | 84 | 84 | | | | | |
| 2002-03 | **0.98** (0.66-1.4) | | | | | | |
| N | 30 | | | | | | |

| Ill-defined causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.42** (1.31-1.54) | **1.49** (1.37-1.62) | **1.21** (1.11-1.33) | **1.06** (0.96-1.17) | **0.82** (0.73-0.93) | **0.83** (0.72-0.96) | **0.62** (0.51-0.74) |
| N | 565 | 587 | 468 | 383 | 269 | 198 | 109 |
| 1990-91 | **1.03** (0.87-1.21) | **1.34** (1.15-1.54) | **1.11** (0.95-1.29) | **1.03** (0.88-1.19) | **0.68** (0.57-0.8) | **0.68** (0.57-0.82) | **0.60** (0.49-0.73) |
| N | 149 | 189 | 172 | 176 | 135 | 119 | 102 |
| 1992-93 | **2.15** (1.78-2.57) | **1.79** (1.47-2.16) | **1.55** (1.26-1.88) | **1.05** (0.83-1.31) | **0.87** (0.66-1.12) | **1.22** (0.95-1.54) | |
| N | 120 | 109 | 102 | 80 | 58 | 69 | |
| 1994-95 | **1.70** (1.38-2.07) | **1.73** (1.43-2.08) | **0.96** (0.75-1.21) | **1.01** (0.78-1.28) | **1.23** (0.95-1.56) | | |
| N | 100 | 113 | 71 | 66 | 67 | | |
| 1996-97 | **1.80** (1.45-2.22) | **0.97** (0.73-1.27) | **1.29** (1-1.64) | **1.25** (0.94-1.64) | | | |
| N | 89 | 54 | 66 | 54 | | | |
| 1998-99 | **1.11** (0.84-1.45) | **1.56** (1.21-1.98) | **1.46** (1.09-1.92) | | | | |
| N | 55 | 67 | 51 | | | | |
| 2000-01 | **1.34** (0.96-1.81) | **1.94** (1.44-2.55) | | | | | |
| N | 41 | 51 | | | | | |
| 2002-03 | **1.23** (0.61-2.2) | | | | | | |
| N | 11 | | | | | | |

Table A3.5b Females All Ages

| All causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **0.92** | **0.94** | **0.99** | **0.99** | **0.95** | **0.96** | **0.98** |
| | (0.9-0.94) | (0.92-0.97) | (0.96-1.01) | (0.97-1.02) | (0.93-0.98) | (0.93-0.99) | (0.95-1.02) |
| N | 6755 | 6973 | 6887 | 6254 | 5227 | 4084 | 2471 |
| 1990-91 | **0.90** | **0.93** | **0.99** | **0.96** | **0.93** | **0.95** | **0.98** |
| | (0.87-0.94) | (0.9-0.97) | (0.95-1.02) | (0.93-1) | (0.89-0.96) | (0.92-0.99) | (0.94-1.02) |
| N | 2551 | 2708 | 2922 | 2863 | 2836 | 2896 | 2353 |
| 1992-93 | **0.91** | **0.97** | **0.98** | **1.01** | **1.02** | **0.98** | |
| | (0.86-0.96) | (0.92-1.03) | (0.93-1.04) | (0.95-1.06) | (0.96-1.08) | (0.92-1.04) | |
| N | 1104 | 1202 | 1214 | 1263 | 1246 | 1059 | |
| 1994-95 | **0.93** | **0.95** | **1.00** | **1.06** | **0.96** | | |
| | (0.87-0.99) | (0.89-1) | (0.94-1.05) | (1-1.12) | (0.9-1.02) | | |
| N | 1100 | 1142 | 1223 | 1281 | 1032 | | |
| 1996-97 | **0.92** | **0.93** | **0.98** | **0.97** | | | |
| | (0.86-0.99) | (0.87-1) | (0.92-1.05) | (0.91-1.04) | | | |
| N | 776 | 830 | 870 | 782 | | | |
| 1998-99 | **0.92** | **0.92** | **1.00** | | | | |
| | (0.85-1) | (0.85-0.99) | (0.92-1.08) | | | | |
| N | 632 | 644 | 592 | | | | |
| 2000-01 | **0.98** | **1.01** | | | | | |
| | (0.89-1.08) | (0.92-1.12) | | | | | |
| N | 440 | 424 | | | | | |
| 2002-03 | **1.19** | | | | | | |
| | (1.01-1.39) | | | | | | |
| N | 152 | | | | | | |

| CVD | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **0.85** | **0.88** | **0.98** | **0.97** | **0.95** | **0.93** | **0.88** |
| | (0.82-0.89) | (0.85-0.91) | (0.94-1.01) | (0.93-1.01) | (0.91-1) | (0.88-0.98) | (0.82-0.94) |
| N | 2538 | 2604 | 2541 | 2122 | 1692 | 1281 | 892 |
| 1990-91 | **0.85** | **0.88** | **0.98** | **0.94** | **0.96** | **0.92** | **0.88** |
| | (0.8-0.91) | (0.83-0.93) | (0.93-1.04) | (0.89-1) | (0.9-1.02) | (0.86-0.98) | (0.82-0.94) |
| N | 1051 | 1187 | 1232 | 1053 | 967 | 912 | 853 |
| 1992-93 | **0.84** | **0.90** | **1.01** | **1.02** | **0.95** | **0.96** | |
| | (0.77-0.92) | (0.82-0.99) | (0.92-1.1) | (0.92-1.12) | (0.86-1.06) | (0.86-1.06) | |
| N | 474 | 479 | 471 | 426 | 380 | 329 | |
| 1994-95 | **0.88** | **0.89** | **0.93** | **1.01** | **0.89** | | |
| | (0.8-0.96) | (0.81-0.98) | (0.84-1.03) | (0.92-1.12) | (0.79-1) | | |
| N | 439 | 401 | 378 | 393 | 299 | | |
| 1996-97 | **0.81** | **0.82** | **0.96** | **0.96** | | | |
| | (0.72-0.92) | (0.71-0.93) | (0.85-1.08) | (0.84-1.09) | | | |
| N | 249 | 236 | 269 | 237 | | | |
| 1998-99 | **0.84** | **0.90** | **0.98** | | | | |
| | (0.72-0.97) | (0.77-1.03) | (0.84-1.14) | | | | |
| N | 178 | 191 | 173 | | | | |
| 2000-01 | **0.92** | **0.86** | | | | | |
| | (0.76-1.1) | (0.7-1.04) | | | | | |
| N | 122 | 104 | | | | | |
| 2002-03 | **0.70** | | | | | | |
| | (0.45-1.04) | | | | | | |
| N | 25 | | | | | | |

Table A3.5b Females All Ages (cont.)

| All neoplasms | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.18** | **1.20** | **1.17** | **1.21** | **1.19** | **1.16** | **1.10** |
| | (1.13-1.23) | (1.15-1.25) | (1.11-1.22) | (1.16-1.27) | (1.13-1.25) | (1.09-1.23) | (1.03-1.18) |
| N | 2024 | 2086 | 1929 | 1777 | 1466 | 1126 | 804 |
| 1990-91 | **1.14** | **1.15** | **1.13** | **1.20** | **1.15** | **1.17** | **1.11** |
| | (1.06-1.23) | (1.07-1.23) | (1.05-1.21) | (1.12-1.29) | (1.08-1.24) | (1.09-1.25) | (1.03-1.19) |
| N | 708 | 763 | 806 | 841 | 788 | 818 | 771 |
| 1992-93 | **1.08** | **1.22** | **1.06** | **1.21** | **1.21** | **1.13** | |
| | (0.96-1.21) | (1.1-1.36) | (0.94-1.18) | (1.08-1.35) | (1.09-1.35) | (1-1.27) | |
| N | 295 | 356 | 301 | 333 | 336 | 275 | |
| 1994-95 | **1.19** | **1.18** | **1.26** | **1.25** | **1.26** | | |
| | (1.06-1.32) | (1.05-1.31) | (1.13-1.4) | (1.12-1.39) | (1.12-1.4) | | |
| N | 342 | 335 | 350 | 352 | 312 | | |
| 1996-97 | **1.17** | **1.27** | **1.25** | **1.17** | | | |
| | (1.03-1.33) | (1.12-1.44) | (1.1-1.4) | (1.03-1.34) | | | |
| N | 244 | 265 | 265 | 225 | | | |
| 1998-99 | **1.24** | **1.20** | **1.22** | | | | |
| | (1.07-1.41) | (1.05-1.37) | (1.05-1.41) | | | | |
| N | 211 | 214 | 183 | | | | |
| 2000-01 | **1.31** | **1.34** | | | | | |
| | (1.11-1.54) | (1.14-1.58) | | | | | |
| N | 156 | 148 | | | | | |
| 2002-03 | **1.89** | | | | | | |
| | (1.47-2.39) | | | | | | |
| N | 68 | | | | | | |

| All external causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.19** | **1.13** | **1.10** | **1.14** | **0.94** | **1.06** | **1.02** |
| | (1.06-1.33) | (1-1.27) | (0.97-1.25) | (0.99-1.3) | (0.8-1.1) | (0.89-1.26) | (0.82-1.25) |
| N | 317 | 292 | 248 | 213 | 150 | 128 | 92 |
| 1990-91 | **1.24** | **1.06** | **0.95** | **1.02** | **0.84** | **1.03** | **1.03** |
| | (1.04-1.47) | (0.88-1.27) | (0.77-1.15) | (0.82-1.25) | (0.66-1.05) | (0.83-1.27) | (0.83-1.27) |
| N | 132 | 119 | 98 | 92 | 77 | 89 | 89 |
| 1992-93 | **1.20** | **1.16** | **1.08** | **1.02** | **1.29** | **1.06** | |
| | (0.91-1.56) | (0.86-1.52) | (0.77-1.46) | (0.72-1.41) | (0.94-1.74) | (0.72-1.5) | |
| N | 56 | 50 | 40 | 38 | 44 | 32 | |
| 1994-95 | **1.01** | **1.08** | **1.33** | **1.32** | **0.89** | | |
| | (0.73-1.37) | (0.77-1.48) | (0.99-1.76) | (0.96-1.77) | (0.59-1.3) | | |
| N | 43 | 40 | 49 | 45 | 27 | | |
| 1996-97 | **0.80** | **1.38** | **1.24** | **1.51** | | | |
| | (0.5-1.21) | (0.98-1.89) | (0.85-1.74) | (1.06-2.09) | | | |
| N | 22 | 39 | 33 | 36 | | | |
| 1998-99 | **1.35** | **0.87** | **1.01** | | | | |
| | (0.92-1.92) | (0.53-1.35) | (0.61-1.58) | | | | |
| N | 31 | 20 | 19 | | | | |
| 2000-01 | **1.53** | **1.49** | | | | | |
| | (0.98-2.28) | (0.92-2.28) | | | | | |
| N | 24 | 21 | | | | | |
| 2002-03 | **1.90** | | | | | | |
| | (0.87-3.61) | | | | | | |
| N | 9 | | | | | | |

Table A3.5b Females All Ages (cont.)

| All other causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **0.71** | **0.76** | **0.86** | **0.86** | **0.85** | **0.87** | **0.83** |
| | (0.67-0.74) | (0.72-0.8) | (0.82-0.9) | (0.82-0.9) | (0.81-0.89) | (0.82-0.92) | (0.78-0.88) |
| N | 1295 | 1437 | 1687 | 1684 | 1528 | 1240 | 920 |
| 1990-91 | **0.66** | **0.69** | **0.85** | **0.78** | **0.82** | **0.86** | **0.82** |
| | (0.6-0.73) | (0.63-0.76) | (0.78-0.92) | (0.72-0.84) | (0.77-0.88) | (0.8-0.92) | (0.77-0.88) |
| N | 447 | 417 | 590 | 668 | 805 | 865 | 872 |
| 1992-93 | **0.73** | **0.75** | **0.84** | **0.93** | **0.93** | **0.90** | |
| | (0.62-0.84) | (0.65-0.86) | (0.75-0.94) | (0.84-1.03) | (0.84-1.03) | (0.81-1) | |
| N | 185 | 219 | 302 | 375 | 379 | 338 | |
| 1994-95 | **0.64** | **0.80** | **0.92** | **1.00** | **0.85** | | |
| | (0.55-0.74) | (0.71-0.9) | (0.83-1.02) | (0.9-1.1) | (0.76-0.95) | | |
| N | 176 | 278 | 362 | 396 | 315 | | |
| 1996-97 | **0.79** | **0.81** | **0.82** | **0.83** | | | |
| | (0.68-0.91) | (0.71-0.93) | (0.71-0.93) | (0.73-0.94) | | | |
| N | 187 | 228 | 236 | 227 | | | |
| 1998-99 | **0.73** | **0.77** | **0.93** | | | | |
| | (0.62-0.85) | (0.66-0.89) | (0.8-1.07) | | | | |
| N | 155 | 173 | 183 | | | | |
| 2000-01 | **0.75** | **0.84** | | | | | |
| | (0.62-0.91) | (0.7-1.01) | | | | | |
| N | 106 | 116 | | | | | |
| 2002-03 | **0.95** | | | | | | |
| | (0.68-1.3) | | | | | | |
| N | 39 | | | | | | |

| Ill-defined causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.22** | **1.11** | **0.96** | **0.83** | **0.63** | **0.60** | **0.66** |
| | (1.11-1.33) | (1-1.22) | (0.86-1.06) | (0.74-0.93) | (0.54-0.72) | (0.51-0.71) | (0.54-0.79) |
| N | 457 | 411 | 352 | 290 | 211 | 143 | 112 |
| 1990-91 | **1.15** | **1.33** | **1.16** | **1.04** | **0.57** | **0.52** | **0.66** |
| | (0.98-1.34) | (1.14-1.55) | (0.98-1.35) | (0.88-1.21) | (0.47-0.68) | (0.41-0.64) | (0.54-0.8) |
| N | 163 | 175 | 159 | 158 | 116 | 89 | 107 |
| 1992-93 | **1.32** | **1.25** | **1.27** | **0.60** | **0.75** | **0.84** | |
| | (1.04-1.66) | (0.98-1.58) | (1-1.58) | (0.45-0.8) | (0.56-0.98) | (0.62-1.11) | |
| N | 73 | 72 | 79 | 49 | 53 | 48 | |
| 1994-95 | **1.48** | **1.09** | **0.73** | **0.69** | **0.67** | | |
| | (1.18-1.84) | (0.85-1.39) | (0.55-0.94) | (0.51-0.91) | (0.48-0.92) | | |
| N | 82 | 67 | 58 | 48 | 38 | | |
| 1996-97 | **1.41** | **0.74** | **0.73** | **0.77** | | | |
| | (1.08-1.81) | (0.53-0.99) | (0.51-1) | (0.53-1.09) | | | |
| N | 61 | 42 | 38 | 33 | | | |
| 1998-99 | **1.06** | **0.80** | **0.54** | | | | |
| | (0.78-1.4) | (0.55-1.13) | (0.31-0.86) | | | | |
| N | 49 | 32 | 17 | | | | |
| 2000-01 | **0.66** | **0.93** | | | | | |
| | (0.39-1.05) | (0.58-1.42) | | | | | |
| N | 18 | 21 | | | | | |
| 2002-03 | **1.58** | | | | | | |
| | (0.79-2.82) | | | | | | |
| N | 11 | | | | | | |

Table A3.6a SMRs and 95% confidence intervals by Arrival Cohort and Duration of Residence, by Cause of Death Group
Males Under age 60

| All causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.74** | **1.71** | **1.57** | **1.46** | **1.33** | **1.16** | **0.91** |
| | (1.66-1.82) | (1.63-1.8) | (1.48-1.65) | (1.37-1.55) | (1.24-1.43) | (1.07-1.26) | (0.82-1.01) |
| N | 1767 | 1637 | 1328 | 1059 | 804 | 572 | 358 |
| 1990-91 | **1.13** | **1.16** | **1.05** | **1.01** | **1.07** | **1.06** | **0.90** |
| | (1.03-1.24) | (1.06-1.27) | (0.95-1.16) | (0.91-1.11) | (0.97-1.19) | (0.96-1.18) | (0.81-1.01) |
| N | 441 | 455 | 407 | 381 | 388 | 392 | 343 |
| 1992-93 | **1.81** | **1.68** | **1.57** | **1.82** | **1.48** | **1.42** | |
| | (1.59-2.04) | (1.47-1.91) | (1.36-1.79) | (1.59-2.07) | (1.27-1.7) | (1.21-1.66) | |
| N | 259 | 236 | 212 | 231 | 188 | 158 | |
| 1994-95 | **1.89** | **2.01** | **2.06** | **2.09** | **1.96** | | |
| | (1.67-2.13) | (1.77-2.26) | (1.81-2.33) | (1.84-2.37) | (1.7-2.25) | | |
| N | 273 | 268 | 250 | 250 | 201 | | |
| 1996-97 | **2.11** | **1.93** | **2.18** | **2.01** | | | |
| | (1.85-2.38) | (1.68-2.21) | (1.91-2.48) | (1.73-2.32) | | | |
| N | 251 | 210 | 233 | 183 | | | |
| 1998-99 | **2.46** | **2.52** | **2.46** | | | | |
| | (2.17-2.77) | (2.22-2.84) | (2.14-2.82) | | | | |
| N | 271 | 268 | 209 | | | | |
| 2000-01 | **2.53** | **2.70** | | | | | |
| | (2.2-2.9) | (2.33-3.11) | | | | | |
| N | 209 | 190 | | | | | |
| 2002-03 | **2.33** | | | | | | |
| | (1.79-2.98) | | | | | | |
| N | 63 | | | | | | |

| CVD | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.30** | **1.28** | **1.23** | **1.20** | **1.15** | **1.01** | **0.86** |
| | (1.16-1.45) | (1.13-1.44) | (1.08-1.41) | (1.03-1.4) | (0.96-1.37) | (0.81-1.25) | (0.65-1.1) |
| N | 318 | 278 | 222 | 173 | 129 | 85 | 59 |
| 1990-91 | **0.95** | **0.95** | **0.96** | **0.91** | **0.92** | **1.01** | **0.88** |
| | (0.77-1.15) | (0.78-1.16) | (0.77-1.18) | (0.72-1.14) | (0.72-1.17) | (0.78-1.29) | (0.66-1.13) |
| N | 104 | 103 | 93 | 77 | 67 | 64 | 58 |
| 1992-93 | **1.57** | **1.05** | **1.25** | **1.57** | **1.45** | **1.04** | |
| | (1.2-2.03) | (0.73-1.46) | (0.88-1.74) | (1.11-2.15) | (0.98-2.07) | (0.63-1.62) | |
| N | 59 | 35 | 36 | 38 | 30 | 19 | |
| 1994-95 | **1.49** | **1.53** | **1.28** | **1.69** | **1.41** | | |
| | (1.11-1.96) | (1.11-2.06) | (0.86-1.84) | (1.16-2.39) | (0.89-2.12) | | |
| N | 52 | 43 | 29 | 32 | 23 | | |
| 1996-97 | **1.51** | **1.48** | **1.91** | **1.60** | | | |
| | (1.07-2.08) | (1-2.12) | (1.31-2.7) | (1.01-2.4) | | | |
| N | 38 | 30 | 32 | 23 | | | |
| 1998-99 | **1.54** | **2.37** | **2.26** | | | | |
| | (1.05-2.19) | (1.69-3.24) | (1.53-3.23) | | | | |
| N | 31 | 39 | 30 | | | | |
| 2000-01 | **1.95** | **2.48** | | | | | |
| | (1.26-2.87) | (1.64-3.61) | | | | | |
| N | 25 | 27 | | | | | |
| 2002-03 | **2.14** | | | | | | |
| | (0.98-4.06) | | | | | | |
| N | 9 | | | | | | |

Table A3.6a Males under age 60 (cont.)

| All Neoplasms | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **2.03** (1.85-2.22) | **1.44** (1.29-1.61) | **1.47** (1.31-1.65) | **1.41** (1.24-1.6) | **1.22** (1.05-1.42) | **1.20** (1.01-1.42) | **1.04** (0.85-1.26) |
| N | 467 | 318 | 294 | 240 | 173 | 143 | 105 |
| 1990-91 | **1.32** (1.09-1.58) | **1.29** (1.07-1.54) | **1.22** (1.01-1.47) | **1.31** (1.09-1.57) | **1.18** (0.96-1.44) | **1.25** (1.03-1.51) | **1.02** (0.83-1.24) |
| N | 115 | 119 | 116 | 119 | 100 | 111 | 99 |
| 1992-93 | **2.03** (1.57-2.58) | **1.25** (0.89-1.69) | **1.60** (1.18-2.1) | **1.39** (0.99-1.89) | **0.89** (0.58-1.31) | **1.04** (0.69-1.5) | |
| N | 66 | 41 | 50 | 40 | 26 | 28 | |
| 1994-95 | **2.10** (1.65-2.65) | **1.49** (1.09-1.99) | **1.59** (1.15-2.14) | **1.72** (1.26-2.29) | **1.81** (1.32-2.44) | | |
| N | 72 | 46 | 43 | 46 | 44 | | |
| 1996-97 | **2.48** (1.92-3.14) | **1.57** (1.11-2.16) | **1.98** (1.46-2.64) | **1.50** (1.02-2.11) | | | |
| N | 68 | 38 | 47 | 32 | | | |
| 1998-99 | **2.80** (2.17-3.55) | **1.49** (1.04-2.07) | **1.67** (1.15-2.34) | | | | |
| N | 68 | 35 | 33 | | | | |
| 2000-01 | **3.54** (2.73-4.52) | **2.16** (1.51-3.01) | | | | | |
| N | 64 | 35 | | | | | |
| 2002-03 | **2.23** (1.22-3.74) | | | | | | |
| N | 14 | | | | | | |

| All External Causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **2.14** (1.96-2.33) | **2.20** (2.02-2.4) | **1.95** (1.76-2.15) | **1.83** (1.63-2.04) | **1.65** (1.45-1.87) | **1.42** (1.23-1.65) | **1.08** (0.88-1.32) |
| N | 510 | 511 | 388 | 320 | 249 | 183 | 96 |
| 1990-91 | **1.34** (1.1-1.61) | **1.30** (1.07-1.57) | **1.11** (0.89-1.37) | **1.03** (0.82-1.28) | **1.40** (1.16-1.68) | **1.29** (1.08-1.54) | **1.06** (0.86-1.31) |
| N | 108 | 112 | 85 | 82 | 117 | 125 | 91 |
| 1992-93 | **1.85** (1.43-2.36) | **1.94** (1.48-2.5) | **1.46** (1.07-1.95) | **2.44** (1.93-3.04) | **1.77** (1.37-2.26) | **1.75** (1.3-2.31) | |
| N | 65 | 60 | 46 | 79 | 65 | 50 | |
| 1994-95 | **2.22** (1.73-2.81) | **2.36** (1.85-2.97) | **2.85** (2.3-3.5) | **2.42** (1.94-2.99) | **2.18** (1.66-2.8) | | |
| N | 69 | 74 | 91 | 87 | 60 | | |
| 1996-97 | **2.38** (1.84-3.02) | **2.86** (2.28-3.55) | **2.21** (1.73-2.77) | **2.68** (2.08-3.41) | | | |
| N | 67 | 84 | 73 | 67 | | | |
| 1998-99 | **3.52** (2.88-4.27) | **3.31** (2.72-3.99) | **3.67** (2.94-4.53) | | | | |
| N | 105 | 110 | 86 | | | | |
| 2000-01 | **2.80** (2.19-3.53) | **3.38** (2.63-4.29) | | | | | |
| N | 72 | 68 | | | | | |
| 2002-03 | **3.12** (2.00-4.64) | | | | | | |
| N | 24 | | | | | | |

Table A3.6a Males under age 60 (cont.)

| All other causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.27** (1.1-1.46) | **1.55** (1.36-1.77) | **1.38** (1.2-1.59) | **1.21** (1.03-1.42) | **1.22** (1.02-1.44) | **0.89** (0.7-1.1) | **0.67** (0.5-0.87) |
| N | 205 | 232 | 192 | 153 | 136 | 81 | 53 |
| 1990-91 | **0.86** (0.65-1.13) | **0.89** (0.66-1.17) | **0.71** (0.51-0.96) | **0.69** (0.5-0.93) | **0.84** (0.63-1.09) | **0.73** (0.54-0.97) | **0.67** (0.5-0.88) |
| N | 53 | 49 | 41 | 44 | 56 | 49 | 51 |
| 1992-93 | **1.26** (0.82-1.86) | **2.35** (1.73-3.11) | **1.53** (1.06-2.14) | **1.44** (0.99-2.03) | **1.60** (1.12-2.21) | **1.33** (0.89-1.91) | |
| N | 25 | 48 | 34 | 33 | 36 | 29 | |
| 1994-95 | **1.26** (0.83-1.84) | **1.82** (1.3-2.48) | **2.08** (1.52-2.78) | **2.25** (1.66-3) | **2.08** (1.49-2.82) | | |
| N | 27 | 40 | 45 | 47 | 41 | | |
| 1996-97 | **1.38** (0.91-2.01) | **1.46** (0.97-2.11) | **2.39** (1.73-3.2) | **1.61** (1.07-2.33) | | | |
| N | 27 | 28 | 44 | 28 | | | |
| 1998-99 | **2.05** (1.46-2.79) | **2.28** (1.64-3.09) | **1.72** (1.15-2.49) | | | | |
| N | 40 | 42 | 28 | | | | |
| 2000-01 | **1.68** (1.08-2.5) | **1.81** (1.16-2.7) | | | | | |
| N | 24 | 24 | | | | | |
| 2002-03 | **1.77** (0.81-3.35) | | | | | | |
| N | 9 | | | | | | |

| Ill-defined | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.87** (1.64-2.13) | **2.22** (1.96-2.51) | **1.76** (1.52-2.03) | **1.48** (1.25-1.75) | **1.24** (1.00-1.52) | **1.09** (0.85-1.39) | **0.62** (0.51-0.74) |
| N | 231 | 256 | 194 | 141 | 94 | 67 | 109 |
| 1990-91 | **1.23** (0.93-1.6) | **1.53** (1.18-1.96) | **1.31** (1.02-1.67) | **1.02** (0.77-1.34) | **0.93** (0.67-1.25) | **0.70** (0.48-0.99) | **0.60** (0.49-0.73) |
| N | 55 | 64 | 67 | 53 | 42 | 32 | 102 |
| 1992-93 | **2.72** (1.96-3.67) | **2.38** (1.74-3.18) | **2.25** (1.62-3.05) | **2.08** (1.43-2.92) | **1.45** (0.92-2.17) | **2.16** (1.46-3.09) | |
| N | 42 | 46 | 42 | 33 | 23 | 30 | |
| 1994-95 | **2.31** (1.68-3.09) | **3.07** (2.33-3.98) | **1.99** (1.34-2.84) | **2.16** (1.48-3.05) | **1.95** (1.26-2.88) | | |
| N | 45 | 57 | 30 | 32 | 25 | | |
| 1996-97 | **2.75** (2.01-3.68) | **1.87** (1.21-2.76) | **2.05** (1.35-2.98) | **1.87** (1.15-2.85) | | | |
| N | 45 | 25 | 27 | 21 | | | |
| 1998-99 | **1.44** (0.88-2.22) | **2.46** (1.68-3.47) | **2.36** (1.52-3.48) | | | | |
| N | 20 | 32 | 25 | | | | |
| 2000-01 | **1.87** (1.13-2.92) | **3.57** (2.42-5.06) | | | | | |
| N | 19 | 31 | | | | | |
| 2002-03 | **1.53** (0.50-3.56) | | | | | | |
| N | 5 | | | | | | |

Table A3.6b Females under age 60

| All | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.26** (1.18-1.34) | **1.27** (1.18-1.36) | **1.10** (1.02-1.19) | **1.14** (1.05-1.24) | **0.97** (0.87-1.07) | **0.96** (0.93-0.99) | **0.98** (0.95-1.02) |
| N | 906 | 817 | 618 | 532 | 372 | 4084 | 2471 |
| 1990-91 | **1.08** (0.96-1.21) | **1.10** (0.98-1.24) | **0.95** (0.83-1.08) | **1.04** (0.91-1.18) | **0.85** (0.73-0.98) | **0.95** (0.92-0.99) | **0.98** (0.94-1.02) |
| N | 289 | 280 | 239 | 245 | 192 | 2896 | 2353 |
| 1992-93 | **1.43** (1.21-1.68) | **1.36** (1.14-1.62) | **1.17** (0.95-1.43) | **1.16** (0.94-1.42) | **1.06** (0.85-1.32) | **0.98** (0.92-1.04) | |
| N | 144 | 129 | 100 | 93 | 83 | 1059 | |
| 1994-95 | **1.25** (1.05-1.48) | **1.25** (1.03-1.5) | **1.27** (1.04-1.54) | **1.34** (1.1-1.62) | **1.24** (1-1.53) | | |
| N | 137 | 116 | 106 | 107 | 88 | | |
| 1996-97 | **1.11** (0.9-1.35) | **1.37** (1.13-1.66) | **1.32** (1.06-1.61) | **1.29** (1.02-1.6) | | | |
| N | 96 | 106 | 95 | 81 | | | |
| 1998-99 | **1.33** (1.09-1.62) | **1.31** (1.06-1.6) | **1.08** (0.83-1.38) | | | | |
| N | 104 | 95 | 64 | | | | |
| 2000-01 | **1.74** (1.41-2.11) | **1.72** (1.38-2.13) | | | | | |
| N | 99 | 86 | | | | | |
| 2002-03 | **1.84** (1.3-2.54) | | | | | | |
| N | 37 | | | | | | |

| CVD | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.01** (0.84-1.21) | **0.78** (0.62-0.98) | **0.88** (0.68-1.11) | **0.94** (0.7-1.22) | **0.69** (0.46-0.98) | **0.85** (0.56-1.24) | **0.61** (0.34-1) |
| N | 120 | 79 | 69 | 54 | 30 | 27 | 15 |
| 1990-91 | **0.87** (0.63-1.17) | **0.67** (0.46-0.94) | **0.73** (0.5-1.04) | **0.70** (0.45-1.06) | **0.72** (0.44-1.12) | **0.80** (0.48-1.25) | **0.50** (0.26-0.88) |
| N | 43 | 33 | 31 | 23 | 20 | 19 | 12 |
| 1992-93 | **1.20** (0.77-1.78) | **0.62** (0.3-1.13) | **1.18** (0.65-1.98) | **0.92** (0.42-1.74) | **0.74** (0.27-1.61) | **0.99** (0.4-2.04) | |
| N | 24 | 10 | 14 | 9 | 6 | 7 | |
| 1994-95 | **0.93** (0.55-1.46) | **0.92** (0.48-1.61) | **1.08** (0.54-1.93) | **1.57** (0.83-2.68) | **0.56** (0.15-1.44) | | |
| N | 18 | 12 | 11 | 13 | 4 | | |
| 1996-97 | **0.73** (0.33-1.39) | **1.05** (0.5-1.93) | **0.80** (0.29-1.73) | **1.42** (0.65-2.7) | | | |
| N | 9 | 10 | 6 | 9 | | | |
| 1998-99 | **1.47** (0.8-2.47) | **1.46** (0.73-2.61) | **1.02** (0.38-2.23) | | | | |
| N | 14 | 11 | 6 | | | | |
| 2000-01 | **1.83** (0.91-3.28) | **0.59** (0.12-1.74) | | | | | |
| N | 11 | 3 | | | | | |
| 2002-03 | **0.48** (0.01-2.69) | | | | | | |
| N | 1 | | | | | | |

Table A3.6b Females under age 60 (cont.)

| All | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.47** (1.34-1.6) | **1.54** (1.41-1.69) | **1.21** (1.08-1.34) | **1.30** (1.15-1.45) | **1.10** (0.96-1.26) | **1.00** (0.85-1.18) | **0.89** (0.74-1.07) |
| N | 500 | 478 | 332 | 299 | 214 | 153 | 114 |
| 1990-91 | **1.21** (1.03-1.42) | **1.46** (1.25-1.69) | **1.18** (1-1.39) | **1.26** (1.07-1.49) | **1.01** (0.83-1.21) | **1.00** (0.83-1.21) | **0.91** (0.75-1.09) |
| N | 151 | 175 | 146 | 147 | 116 | 112 | 111 |
| 1992-93 | **1.71** (1.36-2.13) | **1.80** (1.43-2.23) | **1.23** (0.92-1.62) | **1.32** (0.99-1.73) | **1.18** (0.86-1.57) | **1.05** (0.74-1.44) | |
| N | 80 | 82 | 51 | 53 | 45 | 38 | |
| 1994-95 | **1.44** (1.13-1.8) | **1.70** (1.34-2.13) | **1.16** (0.86-1.54) | **1.33** (1-1.75) | **1.30** (0.95-1.72) | | |
| N | 75 | 76 | 48 | 52 | 47 | | |
| 1996-97 | **1.54** (1.19-1.97) | **1.34** (1-1.77) | **1.43** (1.06-1.89) | **1.34** (0.97-1.81) | | | |
| N | 64 | 51 | 50 | 43 | | | |
| 1998-99 | **1.18** (0.86-1.58) | **1.40** (1.03-1.85) | **1.03** (0.7-1.47) | | | | |
| N | 45 | 49 | 31 | | | | |
| 2000-01 | **2.12** (1.61-2.74) | **1.75** (1.27-2.34) | | | | | |
| N | 58 | 44 | | | | | |
| 2002-03 | **2.67** (1.76-3.88) | | | | | | |
| N | 27 | | | | | | |

| All External causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.68** (1.4-2) | **1.50** (1.22-1.82) | **1.60** (1.29-1.96) | **1.55** (1.21-1.94) | **1.27** (0.94-1.67) | **1.12** (0.79-1.54) | **1.29** (0.87-1.84) |
| N | 127 | 102 | 93 | 73 | 51 | 38 | 30 |
| 1990-91 | **1.60** (1.17-2.14) | **1.21** (0.83-1.71) | **1.09** (0.72-1.59) | **1.44** (0.98-2.04) | **0.85** (0.51-1.32) | **1.13** (0.75-1.62) | **1.26** (0.83-1.81) |
| N | 45 | 32 | 27 | 31 | 19 | 29 | 28 |
| 1992-93 | **1.89** (1.15-2.91) | **1.56** (0.87-2.58) | **1.57** (0.84-2.69) | **1.07** (0.49-2.03) | **1.61** (0.9-2.65) | **1.25** (0.57-2.37) | |
| N | 20 | 15 | 13 | 9 | 15 | 9 | |
| 1994-95 | **1.58** (0.92-2.53) | **0.56** (0.18-1.3) | **2.49** (1.56-3.76) | **1.96** (1.18-3.06) | **2.14** (1.22-3.47) | | |
| N | 17 | 5 | 22 | 19 | 16 | | |
| 1996-97 | **0.59** (0.19-1.38) | **2.31** (1.39-3.6) | **1.67** (0.94-2.76) | **2.05** (1.12-3.43) | | | |
| N | 5 | 19 | 15 | 14 | | | |
| 1998-99 | **2.36** (1.44-3.64) | **1.54** (0.84-2.59) | **1.54** (0.74-2.82) | | | | |
| N | 20 | 14 | 10 | | | | |
| 2000-01 | **1.82** (0.97-3.11) | **2.51** (1.37-4.22) | | | | | |
| N | 13 | 14 | | | | | |
| 2002-03 | **3.15** (1.27-6.50) | | | | | | |
| N | 7 | | | | | | |

Table A3.6b Females under age 60 (cont.)

| All other causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **0.85** (0.69-1.02) | **0.97** (0.8-1.18) | **0.87** (0.7-1.07) | **0.85** (0.67-1.07) | **0.68** (0.51-0.9) | **0.74** (0.54-1) | **0.83** (0.78-0.88) |
| N | 105 | 108 | 87 | 75 | 49 | 44 | 920 |
| 1990-91 | **0.67** (0.45-0.96) | **0.68** (0.44-1) | **0.48** (0.29-0.75) | **0.68** (0.46-0.96) | **0.58** (0.37-0.86) | **0.66** (0.44-0.94) | **0.82** (0.77-0.88) |
| N | 29 | 26 | 20 | 30 | 24 | 29 | 872 |
| 1992-93 | **0.90** (0.49-1.52) | **1.27** (0.78-1.97) | **0.92** (0.52-1.52) | **1.15** (0.67-1.84) | **0.72** (0.36-1.29) | **1.06** (0.58-1.77) | |
| N | 14 | 20 | 15 | 17 | 11 | 14 | |
| 1994-95 | **0.82** (0.46-1.35) | **0.83** (0.47-1.38) | **1.42** (0.89-2.15) | **0.89** (0.49-1.5) | **0.90** (0.46-1.57) | | |
| N | 15 | 15 | 22 | 14 | 12 | | |
| 1996-97 | **0.89** (0.5-1.47) | **1.03** (0.58-1.7) | **1.13** (0.64-1.83) | **1.09** (0.58-1.87) | | | |
| N | 15 | 15 | 16 | 13 | | | |
| 1998-99 | **1.15** (0.67-1.85) | **0.98** (0.53-1.64) | **1.17** (0.62-2) | | | | |
| N | 17 | 14 | 13 | | | | |
| 2000-01 | **1.15** (0.61-1.97) | **1.90** (1.12-3) | | | | | |
| N | 13 | 18 | | | | | |
| 2002-03 | **0.52** (0.06-1.88) | | | | | | |
| N | 2 | | | | | | |

| Ill-defined causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.04** (0.77-1.37) | **0.91** (0.64-1.25) | **0.76** (0.5-1.1) | **0.80** (0.52-1.17) | **0.52** (0.28-0.87) | **0.67** (0.37-1.13) | **0.35** (0.13-0.75) |
| N | 49 | 37 | 28 | 26 | 14 | 14 | 6 |
| 1990-91 | **1.13** (0.69-1.75) | **0.76** (0.38-1.35) | **0.85** (0.45-1.45) | **0.79** (0.42-1.36) | **0.50** (0.22-0.98) | **0.66** (0.32-1.21) | **0.24** (0.07-0.62) |
| N | 20 | 11 | 13 | 13 | 8 | 10 | 4 |
| 1992-93 | **0.85** (0.28-1.98) | **0.17** (0.0-0.96) | **1.20** (0.48-2.47) | **0.88** (0.29-2.06) | **0.37** (0.04-1.34) | **0.82** (0.22-2.09) | |
| N | 5 | 1 | 7 | 5 | 2 | 4 | |
| 1994-95 | **1.67** (0.83-2.98) | **0.95** (0.35-2.06) | **0.34** (0.04-1.22) | **0.91** (0.29-2.12) | **0.81** (0.22-2.06) | | |
| N | 11 | 6 | 2 | 5 | 4 | | |
| 1996-97 | **0.50** (0.1-1.47) | **1.64** (0.75-3.11) | **0.79** (0.22-2.03) | **0.45** (0.05-1.63) | | | |
| N | 3 | 9 | 4 | 2 | | | |
| 1998-99 | **1.05** (0.38-2.28) | **1.00** (0.33-2.34) | **0.48** (0.06-1.72) | | | | |
| N | 6 | 5 | 2 | | | | |
| 2000-01 | **0.75** (0.15-2.18) | **1.15** (0.31-2.94) | | | | | |
| N | 3 | 4 | | | | | |
| 2002-03 | **0.72** (0.02-4.02) | | | | | | |
| N | 1 | | | | | | |

Table A3.7a SMRs and 95% confidence intervals by Arrival Cohort and Duration of Residence, by Cause of Death Group

Males age 60 and over

| All causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.00** (0.97-1.03) | **1.01** (0.98-1.04) | **1.04** (1.01-1.07) | **1.02** (0.99-1.05) | **1.01** (0.98-1.04) | **1.00** (0.96-1.04) | **1.00** (0.96-1.04) |
| N | 4796 | 4879 | 4761 | 4270 | 3697 | 2872 | 2113 |
| 1990-91 | **0.94** (0.89-0.98) | **0.93** (0.89-0.98) | **1.02** (0.97-1.06) | **0.97** (0.93-1.02) | **0.98** (0.93-1.02) | **1.00** (0.96-1.04) | **0.99** (0.95-1.04) |
| N | 1807 | 1854 | 2039 | 1987 | 2029 | 2065 | 2010 |
| 1992-93 | **0.98** (0.91-1.05) | **1.07** (1-1.15) | **1.03** (0.96-1.1) | **1.03** (0.96-1.1) | **1.03** (0.96-1.1) | **0.98** (0.91-1.06) | |
| N | 776 | 847 | 822 | 842 | 833 | 705 | |
| 1994-95 | **1.01** (0.94-1.09) | **1.02** (0.95-1.09) | **1.04** (0.97-1.12) | **1.07** (1-1.15) | **1.08** (1-1.16) | | |
| N | 740 | 779 | 819 | 847 | 741 | | |
| 1996-97 | **1.01** (0.92-1.1) | **1.00** (0.91-1.08) | **1.03** (0.95-1.12) | **1.06** (0.98-1.16) | | | |
| N | 527 | 553 | 590 | 547 | | | |
| 1998-99 | **1.10** (1-1.2) | **1.19** (1.09-1.3) | **1.16** (1.05-1.27) | | | | |
| N | 493 | 542 | 442 | | | | |
| 2000-01 | **1.13** (1.01-1.26) | **1.06** (0.94-1.19) | | | | | |
| N | 329 | 287 | | | | | |
| 2002-03 | **1.47** (1.22-1.75) | | | | | | |
| N | 124 | | | | | | |

| CVD | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **0.95** (0.9-0.99) | **0.96** (0.92-1.01) | **1.06** (1.01-1.11) | **1.01** (0.96-1.06) | **0.99** (0.94-1.05) | **1.03** (0.96-1.09) | **1.03** (0.95-1.11) |
| N | 1916 | 1912 | 1849 | 1485 | 1191 | 959 | 685 |
| 1990-91 | **0.94** (0.87-1) | **0.89** (0.83-0.95) | **1.07** (1-1.14) | **0.99** (0.92-1.06) | **0.97** (0.9-1.04) | **1.02** (0.95-1.1) | **1.02** (0.95-1.11) |
| N | 827 | 843 | 931 | 758 | 674 | 694 | 655 |
| 1992-93 | **0.89** (0.8-0.99) | **1.03** (0.93-1.15) | **1.06** (0.95-1.19) | **1.03** (0.91-1.16) | **0.97** (0.85-1.09) | **1.01** (0.88-1.15) | |
| N | 334 | 355 | 319 | 281 | 256 | 229 | |
| 1994-95 | **0.97** (0.86-1.08) | **1.02** (0.9-1.14) | **1.07** (0.95-1.21) | **1.07** (0.95-1.21) | **1.05** (0.92-1.2) | | |
| N | 304 | 288 | 279 | 273 | 225 | | |
| 1996-97 | **0.94** (0.81-1.09) | **1.06** (0.91-1.22) | **1.00** (0.86-1.15) | **1.02** (0.87-1.19) | | | |
| N | 181 | 193 | 182 | 162 | | | |
| 1998-99 | **0.96** (0.81-1.13) | **1.07** (0.91-1.25) | **1.06** (0.88-1.26) | | | | |
| N | 140 | 154 | 123 | | | | |
| 2000-01 | **1.04** (0.85-1.28) | **0.91** (0.72-1.14) | | | | | |
| N | 96 | 75 | | | | | |
| 2002-03 | **1.35** (0.93-1.88) | | | | | | |
| N | 34 | | | | | | |

Table A3.7a Males age 60 and over (cont.)

| All neoplasms | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.33** (1.26-1.4) | **1.22** (1.16-1.29) | **1.17** (1.11-1.24) | **1.24** (1.17-1.31) | **1.25** (1.18-1.33) | **1.18** (1.11-1.27) | **1.18** (1.09-1.27) |
| N | 1466 | 1425 | 1311 | 1273 | 1084 | 826 | 611 |
| 1990-91 | **1.18** (1.07-1.29) | **1.06** (0.97-1.16) | **1.12** (1.02-1.22) | **1.16** (1.07-1.26) | **1.23** (1.14-1.34) | **1.19** (1.09-1.29) | **1.17** (1.08-1.27) |
| N | 466 | 484 | 531 | 576 | 586 | 591 | 580 |
| 1992-93 | **1.28** (1.12-1.45) | **1.27** (1.11-1.44) | **1.07** (0.93-1.22) | **1.30** (1.15-1.48) | **1.32** (1.16-1.49) | **1.21** (1.05-1.39) | |
| N | 234 | 240 | 209 | 247 | 259 | 214 | |
| 1994-95 | **1.20** (1.05-1.38) | **1.22** (1.07-1.39) | **1.19** (1.04-1.36) | **1.31** (1.16-1.48) | **1.26** (1.1-1.44) | | |
| N | 214 | 232 | 223 | 258 | 221 | | |
| 1996-97 | **1.40** (1.21-1.61) | **1.30** (1.12-1.51) | **1.21** (1.04-1.4) | **1.35** (1.16-1.56) | | | |
| N | 187 | 177 | 175 | 179 | | | |
| 1998-99 | **1.63** (1.4-1.89) | **1.44** (1.23-1.67) | **1.54** (1.31-1.8) | | | | |
| N | 181 | 171 | 156 | | | | |
| 2000-01 | **1.76** (1.47-2.08) | **1.57** (1.29-1.88) | | | | | |
| N | 135 | 115 | | | | | |
| 2002-03 | **2.08** (1.54-2.76) | | | | | | |
| N | 49 | | | | | | |

| All external causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.22** (1.05-1.39) | **0.86** (0.72-1.02) | **1.08** (0.91-1.26) | **0.85** (0.7-1.03) | **0.88** (0.7-1.08) | **0.91** (0.71-1.15) | **0.81** (0.6-1.09) |
| N | 204 | 135 | 157 | 107 | 90 | 70 | 46 |
| 1990-91 | **1.10** (0.87-1.37) | **0.81** (0.61-1.06) | **1.00** (0.77-1.26) | **0.78** (0.58-1.02) | **0.76** (0.56-1.02) | **0.94** (0.7-1.23) | **0.78** (0.56-1.05) |
| N | 80 | 53 | 69 | 51 | 46 | 52 | 42 |
| 1992-93 | **1.13** (0.77-1.62) | **0.62** (0.36-0.99) | **0.93** (0.6-1.39) | **0.68** (0.39-1.1) | **1.10** (0.71-1.64) | **0.85** (0.48-1.37) | |
| N | 30 | 17 | 24 | 16 | 24 | 16 | |
| 1994-95 | **1.46** (1.03-2) | **1.18** (0.79-1.68) | **0.99** (0.63-1.49) | **1.02** (0.64-1.55) | **0.92** (0.54-1.48) | | |
| N | 38 | 30 | 23 | 22 | 17 | | |
| 1996-97 | **1.22** (0.77-1.85) | **0.59** (0.28-1.09) | **1.40** (0.88-2.12) | **1.22** (0.71-1.95) | | | |
| N | 22 | 10 | 22 | 17 | | | |
| 1998-99 | **1.46** (0.89-2.25) | **1.33** (0.77-2.13) | **1.61** (0.94-2.57) | | | | |
| N | 20 | 17 | 17 | | | | |
| 2000-01 | **1.08** (0.49-2.05) | **0.90** (0.36-1.86) | | | | | |
| N | 9 | 7 | | | | | |
| 2002-03 | **2.02** (0.66-4.71) | | | | | | |
| N | 5 | | | | | | |

Table A3.7a Males age 60 and over (cont.)

| All other causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **0.69** (0.64-0.74) | **0.83** (0.78-0.88) | **0.87** (0.82-0.92) | **0.87** (0.81-0.92) | **0.88** (0.83-0.94) | **0.86** (0.8-0.92) | **0.91** (0.84-0.98) |
| N | 787 | 958 | 1050 | 1058 | 1002 | 786 | 627 |
| 1990-91 | **0.70** (0.62-0.78) | **0.81** (0.72-0.9) | **0.82** (0.74-0.91) | **0.80** (0.73-0.88) | **0.89** (0.82-0.96) | **0.86** (0.79-0.94) | **0.92** (0.84-0.99) |
| N | 309 | 315 | 371 | 444 | 564 | 563 | 603 |
| 1992-93 | **0.60** (0.48-0.74) | **0.88** (0.75-1.03) | **0.90** (0.78-1.03) | **0.95** (0.83-1.08) | **0.81** (0.71-0.93) | **0.80** (0.69-0.92) | |
| N | 93 | 155 | 194 | 234 | 208 | 186 | |
| 1994-95 | **0.70** (0.58-0.85) | **0.76** (0.65-0.89) | **0.94** (0.82-1.07) | **0.94** (0.83-1.07) | **0.92** (0.8-1.06) | | |
| N | 113 | 155 | 220 | 231 | 202 | | |
| 1996-97 | **0.64** (0.51-0.79) | **0.79** (0.66-0.94) | **0.84** (0.71-0.98) | **0.83** (0.7-0.98) | | | |
| N | 87 | 128 | 146 | 136 | | | |
| 1998-99 | **0.79** (0.65-0.96) | **1.03** (0.87-1.21) | **0.88** (0.72-1.07) | | | | |
| N | 104 | 142 | 105 | | | | |
| 2000-01 | **0.69** (0.53-0.89) | **0.72** (0.55-0.92) | | | | | |
| N | 60 | 60 | | | | | |
| 2002-03 | **0.82** (0.51-1.26) | | | | | | |
| N | 21 | | | | | | |

| Ill-defined causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.87** (1.64-2.13) | **2.22** (1.96-2.51) | **1.76** (1.52-2.03) | **1.48** (1.25-1.75) | **1.24** (1.00-1.52) | **1.09** (0.85-1.39) | **0.62** (0.51-0.74) |
| N | 231 | 256 | 194 | 141 | 94 | 67 | 109 |
| 1990-91 | **1.23** (0.93-1.6) | **1.53** (1.18-1.96) | **1.31** (1.02-1.67) | **1.02** (0.77-1.34) | **0.93** (0.67-1.25) | **0.70** (0.48-0.99) | **0.60** (0.49-0.73) |
| N | 55 | 64 | 67 | 53 | 42 | 32 | 102 |
| 1992-93 | **2.72** (1.96-3.67) | **2.38** (1.74-3.18) | **2.25** (1.62-3.05) | **2.08** (1.43-2.92) | **1.45** (0.92-2.17) | **2.16** (1.46-3.09) | |
| N | 42 | 46 | 42 | 33 | 23 | 30 | |
| 1994-95 | **2.31** (1.68-3.09) | **3.07** (2.33-3.98) | **1.99** (1.34-2.84) | **2.16** (1.48-3.05) | **1.95** (1.26-2.88) | | |
| N | 45 | 57 | 30 | 32 | 25 | | |
| 1996-97 | **2.75** (2.01-3.68) | **1.87** (1.21-2.76) | **2.05** (1.35-2.98) | **1.87** (1.15-2.85) | | | |
| N | 45 | 25 | 27 | 21 | | | |
| 1998-99 | **1.44** (0.88-2.22) | **2.46** (1.68-3.47) | **2.36** (1.52-3.48) | | | | |
| N | 20 | 32 | 25 | | | | |
| 2000-01 | **1.87** (1.13-2.92) | **3.57** (2.42-5.06) | | | | | |
| N | 19 | 31 | | | | | |
| 2002-03 | **1.53** (0.50-3.56) | | | | | | |
| N | 5 | | | | | | |

Table A3.7b Females age 60 and over

| All causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **0.88** (0.86-0.91) | **0.91** (0.89-0.94) | **0.98** (0.95-1) | **0.98** (0.95-1) | **0.95** (0.93-0.98) | **0.96** (0.93-0.99) | **0.92** (0.89-0.95) |
| N | 5849 | 6156 | 6269 | 5722 | 4855 | 3795 | 2726 |
| 1990-91 | **0.88** (0.85-0.92) | **0.91** (0.88-0.95) | **0.99** (0.95-1.03) | **0.98** (0.92-0.99) | **0.93** (0.9-0.97) | **0.95** (0.92-0.99) | **0.92** (0.89-0.96) |
| N | 2262 | 2428 | 2683 | 2618 | 2644 | 2689 | 2609 |
| 1992-93 | **0.86** (0.81-0.92) | **0.94** (0.88-1) | **0.97** (0.91-1.02) | **0.95** (0.94-1.05) | **1.02** (0.96-1.08) | **0.97** (0.91-1.03) | |
| N | 960 | 1073 | 1114 | 1170 | 1163 | 983 | |
| 1994-95 | **0.90** (0.84-0.95) | **0.92** (0.87-0.98) | **0.98** (0.92-1.04) | **1.00** (0.98-1.1) | **0.94** (0.88-1) | | |
| N | 963 | 1026 | 1117 | 1174 | 944 | | |
| 1996-97 | **0.90** (0.83-0.97) | **0.89** (0.83-0.96) | **0.95** (0.88-1.02) | **1.04** (0.88-1.02) | | | |
| N | 680 | 724 | 775 | 701 | | | |
| 1998-99 | **0.87** (0.8-0.95) | **0.87** (0.8-0.95) | **0.99** (0.91-1.08) | | | | |
| N | 528 | 549 | 528 | | | | |
| 2000-01 | **0.87** (0.78-0.97) | **0.92** (0.82-1.02) | | | | | |
| N | 341 | 338 | | | | | |
| 2002-03 | **1.06** (0.88-1.28) | | | | | | |
| N | 115 | | | | | | |

| CVD | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **0.85** (0.81-0.88) | **0.88** (0.85-0.92) | **0.98** (0.94-1.02) | **0.97** (0.93-1.01) | **0.96** (0.91-1) | **0.93** (0.88-0.98) | **0.89** (0.83-0.95) |
| N | 2418 | 2525 | 2472 | 2068 | 1662 | 1254 | 877 |
| 1990-91 | **0.85** (0.8-0.91) | **0.89** (0.84-0.94) | **0.99** (0.93-1.05) | **0.97** (0.89-1.01) | **0.97** (0.9-1.03) | **0.92** (0.87-0.99) | **0.89** (0.83-0.95) |
| N | 1008 | 1154 | 1201 | 1030 | 947 | 893 | 841 |
| 1992-93 | **0.83** (0.75-0.91) | **0.91** (0.83-1) | **1.00** (0.91-1.1) | **0.95** (0.92-1.12) | **0.96** (0.86-1.06) | **0.96** (0.85-1.07) | |
| N | 450 | 469 | 457 | 417 | 374 | 322 | |
| 1994-95 | **0.88** (0.79-0.96) | **0.89** (0.8-0.98) | **0.93** (0.84-1.03) | **1.02** (0.9-1.11) | **0.90** (0.8-1.01) | | |
| N | 421 | 389 | 367 | 380 | 295 | | |
| 1996-97 | **0.82** (0.72-0.93) | **0.81** (0.71-0.92) | **0.97** (0.85-1.09) | **1.00** (0.83-1.08) | | | |
| N | 240 | 226 | 263 | 228 | | | |
| 1998-99 | **0.81** (0.69-0.94) | **0.87** (0.75-1.01) | **0.98** (0.84-1.14) | | | | |
| N | 164 | 180 | 167 | | | | |
| 2000-01 | **0.87** (0.72-1.05) | **0.87** (0.71-1.05) | | | | | |
| N | 111 | 101 | | | | | |
| 2002-03 | **0.72** (0.46-1.06) | | | | | | |
| N | 24 | | | | | | |

Table A3.7b Females age 60 and over (cont.)

| All neoplasms | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.11** (1.05-1.17) | **1.12** (1.07-1.18) | **1.16** (1.1-1.22) | **1.20** (1.14-1.26) | **1.20** (1.14-1.27) | **1.18** (1.11-1.26) | **1.15** (1.06-1.24) |
| N | 1524 | 1608 | 1597 | 1478 | 1252 | 973 | 690 |
| 1990-91 | **1.13** (1.03-1.22) | **1.08** (0.99-1.17) | **1.12** (1.04-1.21) | **1.20** (1.1-1.28) | **1.18** (1.1-1.28) | **1.20** (1.12-1.3) | **1.15** (1.06-1.24) |
| N | 557 | 588 | 660 | 694 | 672 | 706 | 660 |
| 1992-93 | **0.95** (0.83-1.09) | **1.12** (0.99-1.26) | **1.03** (0.9-1.16) | **1.19** (1.05-1.34) | **1.22** (1.08-1.37) | **1.14** (1-1.29) | |
| N | 215 | 274 | 250 | 280 | 291 | 237 | |
| 1994-95 | **1.13** (1-1.28) | **1.08** (0.95-1.22) | **1.28** (1.14-1.43) | **1.19** (1.1-1.39) | **1.25** (1.1-1.41) | | |
| N | 267 | 259 | 302 | 300 | 265 | | |
| 1996-97 | **1.08** (0.93-1.25) | **1.26** (1.1-1.44) | **1.21** (1.05-1.38) | **1.24** (0.98-1.32) | | | |
| N | 180 | 214 | 215 | 182 | | | |
| 1998-99 | **1.25** (1.07-1.46) | **1.15** (0.98-1.34) | **1.27** (1.08-1.49) | | | | |
| N | 166 | 165 | 152 | | | | |
| 2000-01 | **1.07** (0.87-1.31) | **1.22** (1-1.48) | | | | | |
| N | 98 | 104 | | | | | |
| 2002-03 | **1.58** (1.14-2.15) | | | | | | |
| N | 41 | | | | | | |

| All external causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.00** (0.86-1.15) | **1.00** (0.86-1.15) | **0.93** (0.79-1.09) | **1.00** (0.84-1.18) | **0.83** (0.68-1.01) | **1.04** (0.83-1.28) | **0.92** (0.71-1.18) |
| N | 190 | 190 | 155 | 140 | 99 | 90 | 62 |
| 1990-91 | **1.11** (0.89-1.37) | **1.01** (0.81-1.25) | **0.90** (0.7-1.14) | **1.00** (0.68-1.15) | **0.84** (0.64-1.08) | **0.99** (0.75-1.27) | **0.95** (0.73-1.22) |
| N | 87 | 87 | 71 | 61 | 58 | 60 | 61 |
| 1992-93 | **1.00** (0.7-1.38) | **1.04** (0.72-1.45) | **0.93** (0.62-1.36) | **0.89** (0.68-1.45) | **1.18** (0.79-1.69) | **1.00** (0.63-1.5) | |
| N | 36 | 35 | 27 | 29 | 29 | 23 | |
| 1994-95 | **0.82** (0.54-1.2) | **1.25** (0.87-1.74) | **0.97** (0.64-1.41) | **1.01** (0.7-1.56) | **0.48** (0.24-0.86) | | |
| N | 26 | 35 | 27 | 26 | 11 | | |
| 1996-97 | **0.90** (0.52-1.43) | **1.00** (0.61-1.54) | **1.02** (0.6-1.61) | **1.07** (0.81-1.96) | | | |
| N | 17 | 20 | 18 | 22 | | | |
| 1998-99 | **0.76** (0.38-1.36) | **0.43** (0.16-0.94) | **0.74** (0.34-1.4) | | | | |
| N | 11 | 6 | 9 | | | | |
| 2000-01 | **1.29** (0.64-2.31) | **0.82** (0.33-1.7) | | | | | |
| N | 11 | 7 | | | | | |
| 2002-03 | **0.80** (0.1-2.88) | | | | | | |
| N | 2 | | | | | | |

Table A3.7b Females age 60 and over (cont.)

| All other causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **0.70** (0.66-0.74) | **0.75** (0.71-0.79) | **0.86** (0.82-0.91) | **0.86** (0.82-0.91) | **0.86** (0.81-0.9) | **0.87** (0.82-0.92) | **0.83** (0.78-0.89) |
| N | 1190 | 1329 | 1600 | 1609 | 1479 | 1196 | 884 |
| 1990-91 | **0.66** (0.6-0.73) | **0.69** (0.62-0.76) | **0.87** (0.8-0.95) | **0.86** (0.73-0.85) | **0.83** (0.77-0.89) | **0.87** (0.81-0.93) | **0.83** (0.77-0.89) |
| N | 418 | 391 | 570 | 638 | 781 | 836 | 840 |
| 1992-93 | **0.71** (0.61-0.83) | **0.72** (0.62-0.83) | **0.84** (0.74-0.94) | **0.79** (0.83-1.02) | **0.94** (0.85-1.04) | **0.89** (0.8-1) | |
| N | 171 | 199 | 287 | 358 | 368 | 324 | |
| 1994-95 | **0.62** (0.53-0.73) | **0.80** (0.71-0.9) | **0.90** (0.81-1.01) | **0.92** (0.9-1.11) | **0.85** (0.76-0.95) | | |
| N | 161 | 263 | 340 | 382 | 303 | | |
| 1996-97 | **0.78** (0.67-0.9) | **0.80** (0.7-0.92) | **0.80** (0.7-0.91) | **1.00** (0.71-0.93) | | | |
| N | 172 | 213 | 220 | 214 | | | |
| 1998-99 | **0.70** (0.59-0.83) | **0.75** (0.64-0.88) | **0.91** (0.78-1.06) | | | | |
| N | 138 | 159 | 170 | | | | |
| 2000-01 | **0.72** (0.58-0.88) | **0.77** (0.62-0.93) | | | | | |
| N | 93 | 98 | | | | | |
| 2002-03 | **0.99** (0.7-1.37) | | | | | | |
| N | 37 | | | | | | |

| Ill-defined causes | 0.0-1.9 | 2.0-3.9 | 4.0-5.9 | 6.0-7.9 | 8.0-8.9 | 10.0-11.9 | 12.0-14.9 |
|---|---|---|---|---|---|---|---|
| All | **1.24** (1.12-1.37) | **1.13** (1.02-1.25) | **0.98** (0.88-1.09) | **0.83** (0.73-0.94) | **0.63** (0.55-0.73) | **0.60** (0.5-0.71) | **0.70** (0.57-0.84) |
| N | 408 | 374 | 324 | 264 | 197 | 129 | 106 |
| 1990-91 | **1.15** (0.97-1.36) | **1.40** (1.2-1.64) | **1.20** (1.01-1.41) | **0.83** (0.9-1.25) | **0.58** (0.47-0.7) | **0.50** (0.4-0.63) | **0.71** (0.58-0.86) |
| N | 143 | 164 | 146 | 145 | 108 | 79 | 103 |
| 1992-93 | **1.38** (1.07-1.75) | **1.37** (1.07-1.73) | **1.27** (1-1.6) | **1.07** (0.42-0.78) | **0.78** (0.58-1.02) | **0.84** (0.61-1.13) | |
| N | 68 | 71 | 72 | 44 | 51 | 44 | |
| 1994-95 | **1.46** (1.14-1.84) | **1.11** (0.85-1.43) | **0.76** (0.57-0.99) | **0.58** (0.48-0.9) | **0.66** (0.46-0.92) | | |
| N | 71 | 61 | 56 | 43 | 34 | | |
| 1996-97 | **1.56** (1.18-2.01) | **0.64** (0.44-0.9) | **0.72** (0.5-1) | **0.67** (0.55-1.15) | | | |
| N | 58 | 33 | 34 | 31 | | | |
| 1998-99 | **1.06** (0.77-1.43) | **0.77** (0.51-1.12) | **0.55** (0.31-0.9) | | | | |
| N | 43 | 27 | 15 | | | | |
| 2000-01 | **0.65** (0.36-1.07) | **0.89** (0.52-1.43) | | | | | |
| N | 15 | 17 | | | | | |
| 2002-03 | **1.79** (0.86-3.29) | | | | | | |
| N | 10 | | | | | | |

## Section 12.0 Curriculum Vitae

| | |
|---|---|
| **Name** | Ari Meir Paltiel |
| **Date of Birth** | 10 May, 1950 |
| **Place of Birth** | Montreal, Québec, Canada |
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| **Marital Status** | Married, two adult children |

**Elementary and Secondary Education**

| | |
|---|---|
| **1967-1968** | Preliminary Year, Carleton University |
| **June 1967** | Grade 12 Graduation. Laurentian High School |
| **1963-1967** | Laurentian High School, Ottawa Ont., Canada |
| **1960-1963** | Gymnasia Rehavia Elementary School, Jerusalem, Israel |
| **1958-1960** | Usischkin Elementary School, Jerusalem, Israel |
| **1956-1958** | Glenwood Public School, Windsor Ont., Canada |

**Higher Education**

| | |
|---|---|
| **November 2005 – December 2008** | Doctoral Studies in the Graduiertenkolleg 793/2 "Epidemiology of communicable and chronic non-communicable diseases and their interrelationships", sponsored by the Deutschen Forschungsgemeinschaft, Institute of Public Health, the University of Heidelberg |
| **March 1997** | M.A. Demography, Hebrew University of Jerusalem, Magna Cum Laude. |
| **1984-1987, 1992-1996** | Studies in Demography, Hebrew University of Jerusalem, Israel |
| **1987-1988** | Studies in Demography, Department of Demography, University of California, Berkeley, USA |
| **1973-1981** | B. Phil – D.Phil studies in Political Theory, University of Oxford, U.K. |
| **November 1972** | B.A. (Hons) Political Science First Class Honours, Carleton University, Ottawa Canada. |
| **1968-1972** | B.A. studies in Sociology and Political Science, Carleton University, Ottawa Canada |

**Teaching Experience**

| | |
|---|---|
| **1999-2007, 2009-2023** | Lecturer, Braun School of Public Health and Community Medicine, Hebrew University of Jerusalem |
| **2008** | Lecturer, Module on Demography, Institute of Public Health, University of Heidelberg |
| **1998-2003** | Lecturer, Department of Demography, Hebrew University of Jerusalem |

**Professional Experience**

| | |
|---|---|
| **2013-2018** | Director, Statistical Quality Control Department, Central Bureau of Statistics, Israel |
| **2000-2013** | Deputy Senior Director, Department of Social and Welfare Statistics, Central Bureau of Statistics, Israel |
| **1995-2000** | Head, Department of Demography and Population Statistics, Central Bureau of Statistics, Israel |
| **1983-1995** | Head, Migration Statistics Branch, Central Bureau of Statistics, Israel |
| **1981-1983** | Researcher, Brookdale Institute of Gerontology and Adult Human Development, Jerusalem, Israel |
| **May-Sept 1971-1973** | Researcher, Medical Services Branch, Department of Health and Welfare, Ottawa, Canada |

**Signature: _____**

## Section 13.0 Acknowledgements

The debt I owe to my supervisor, Prof Dr, Heiko Becher is much greater than that commonly owed by doctorands to their teacher. The German language specifies the relationship between a doctoral student and his supervisor. The duties of a Doktormutter/vater are parental: they guide, instruct, support, and hold up the standards of scientific tradition, responsibility, and excellence. The student's obligations are filial: they are dutiful and respectful, and without being subservient they strive to live up to the expectations placed on them, and the standards they have been set.

My relationship with Prof. Dr Becher was all this and more. With understanding, trust and patience, he provided me with the unusual and surprising opportunity to pursue a doctorate at a relatively advanced age, and in unusual circumstances. At every stage of the work he encouraged and challenged, and tolerated the difficulties of a long-distance apprenticeship. His innate generosity expressed itself both professionally and personally. He welcomed me into a warm and friendly and, at the same time, stimulating group of young minds who were investigating epidemiological problems in general and migrant health in particular, each from his own perspective. Very soon we became more than colleagues and collaborators, we became friends. His home became my home in Germany. If the relationship to Prof. Dr Becher remained familial it was no longer hierarchical. Rather than a Vater, he became (chronology notwithstanding) an älterer Bruder.

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Many years ago, my colleagues and superiors at the Israel Central Bureau of Statistics, Dr. Eitan Sabatello, Prof. Moshe Sicron, and Prof. Yossi Yahav (all three of whom have passed away) and Prof. Zvi Eisenbach, gave me the responsibility to analyse, compile and publish officially Israeli migration statistics during a very exciting period. They opened the door which allowed me to make Demography my chosen profession. This study is an outcome of the trust they placed in me. Ms. Pnina Zadka, Dr. Charles Kamen and others at the Bureau, too many to mention personally, provided me with assistance, access and permission to use and share the data on which this study is based. They provided me with leaves to devote time to this study, as well as collegial encouragement. But I would like to single out Ms. Naama Rotem, Head of the Health Statistics Department, without whom I would not have been able to compile the data. Her support, expertise, and previous research on FSU mortality enriched this study, and her friendship was just as important to its completion.

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## Section 14.0 Eidesstattliche Versicherung

1. Bei der eingereichten Dissertation zu dem Thema

**Migration, Risk of Death, and Time: Mortality among Immigrants from the Former Soviet Union in Israel 1990-2004**

handelt es sich um meine eigenständig erbrachte Leistung.

2. Ich habe nur die angegebenen Quellen und Hilfsmittel benutzt und mich keiner unzulässigen Hilfe Dritter bedient. Insbesondere habe ich wörtlich oder sinngemäß aus anderen Werken übernommene Inhalte als solche kenntlich gemacht.

3. Die Arbeit oder Teile davon habe ich bislang nicht an einer Hochschule des In- oder Auslands als Bestandteil einer Prüfungs- oder Qualifikationsleistung vorgelegt.*

4. Die Richtigkeit der vorstehenden Erklärungen bestätige ich.

5. Die Bedeutung der eidesstattlichen Versicherung und die strafrechtlichen Folgen einer unrichtigen oder unvollständigen eidesstattlichen Versicherung sind mir bekannt. Ich versichere an Eides statt, dass ich nach bestem Wissen die reine Wahrheit erklärt und nichts verschwiegen habe.

Mevasseret Zion, Israel, 31.01.2023 _____