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Heidelberg Institut für Global Health

(Direktor: Prof. Dr. med. Till Bärnighausen)

# A Cross-sectional study on prevalence and association between developmental impairment and BMI among preschool children aged 4-6 years in Rhine-Neckar County and the City of Heidelberg, Germany

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Weina Liu

aus

Xinjiang, China

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**Dekan:** **Prof. Dr. med. Hans Georg Kräusslich**

**Doktorvater:** **Prof. Dr. med. Michael Marx**

**Dedicated to my family!**

## CONTENTS

# ABBREVIATIONS

| Abbreviation | Full name |
|---|---|
| ECD | Early Childhood Development |
| DD | Developmental Disorder |
| DI | Developmental Impairment |
| DD | Developmental Delay |
| SEHE | School Entry Health Examination |
| VI | Vision impairment |
| HI | Hearing impairment |
| MI | Motor impairment |
| CI | Cognition impairment |
| SES | Socioeconomic status |
| PCBs | Polychlorinated biphenyls |
| $PC_1$ | pro-hor-mone convertase 1 |
| KIGGS | German Health Interview and Examination Survey for Children and Adolescents |
| QOPE | The quality of outdoor environment |
| BDNF | Brain Derived Neurotrophic Factor |

# 1. INTRODUCTION

Early childhood is a critical stage of life, marked by significant physical and neural development. Early Childhood Development (ECD) includes physical growth, language, psychosocial, cognitive and motor development among children aged 0 to 8 years (World Health Organisation 2020). From individual perspective, ECD provides the foundation for achieving developmental potential and wellbeing in adult life. From national perspective ECD has profound impact on social productivity and socioeconomic burden in the long term. Moreover, early childhood is a critical period that children can aquire life skills and academic compentencies. Therefore, the issue of ECD has been gradually concerned by more and more countries over the past two decades. Although mortality of children aged under 5 years decreased by 53% from 1990 to 2015 (United Nations 2015), about 250 million children were still facing the threats of developmental impairment in developing countries (Black et al. 2017). Some industrialised countries such as England, the United States, Canada, Germany, have established the relevant laws and regulations to promote the service for ECD assessment. Therefore, School Entry Health Examination (SEHE) was advocated as a screening tool of basic public health services for ECD evaluation at the end of the 18th century, and established in the 19th century (Reiser 1978; Rosen 2015; Wald 1905). Before developmental impairment occurres and developes, SEHE could detect infectious diseases and development related to academic performance among preschool children and screen children who need further examination and special support.

In Germany SEHE was established for all children entering primary school at the end of 19$^{th}$ century (Wattjes et al. 2018). Nowadays, SEHE is varied in different federal states, but mandatory in many federal states. It mainly includes disease history, vaccination status, physical and developmental functions test. Of all health assessment achievement of developmental function is the basic and critical requirement for children entering school. In Germany, School Entry Health Examination (SEHE) as the mandatory surveillance is to detect developmental impairment and the potential risk factors and provide a reasonable reference for effective advice and intervention measures in time. Because SEHE is mandatory by law in most of federal states, more and more pediatricians and health care personnel are committed to SEHE. SEHE takes up considerable resources of public health service in Germany, therefore, the contradictions between growing health needs and provision of health service are gradually prominent with the

increase of migrations. It is an imperative issue to use public health service effectively and rationally in recent years. In order to appropriately focus public health service, it is urgent to answer the following questions: what is major problem of children development and which group is suspectiable?

To explore these questions in the following chapter the classification and prevalence of developmental delay will be described and the prevalence and determinants of developmental delay (visual, hearing, motor, language, cognitive functions) will be outlined. As the derterminants are varied from different kinds of developmental delay, BMI and migirant background are easily measurable and identifiable. Therefore, the prevalence of BMI and the developmental delay among migrants will be described, the relathionship between BMI and developmental delay will be summarized and the relationship between migrant background and developmental delay will be explained.

### 1.1 Classification and prevalance of Developmental impairment

Developmental Delay (DD) is a term used to describe a child who does not reach developmental milestones at the expected age, even after allowing for the broad variety of normality (Rydz et al. 2005), which is also called Developmental Disorder(DD) or Developmental Impairment(DI). The child development usually involves vision, hearing, motor skills, language, cognition, and social skills, according to the developmental trajectories of brain and central nervous system. The methodologies and standards of DI assessment are different, the prevalence of DI showed an increase trend (Flender 2005) and varied from different countries. Before the 21th century, few studies of the prevalence of DI were conducted among preschoolers (Karch 1990; Wohlfeil 1991b). Since then more and more research focuses on the prevalence of impairments in single specific areas of development among children (Boyle 2011; Flender 2005; Najman et al. 1992; Stich et al. 2012), while co-occurrence developmental delays were studied by some researchers (Gaines and Missiuna 2007; Najman et al. 1992; Tirosh et al. 1998). The prevalence of global DI is around 1-3% among children (Rydz et al. 2006), and 5-10% children have a specific learning disability in a single domain (Blanchard et al. 2006). Findings from the United States suggested that 13.2% of children had 1 or more developmental disabilities during 1997–2005 and 1.6% had 3 or more developmental disabilities in (Boyle et al. 2011). A recently cross-sectional survey was conducted in poverty-stricken areas of China that showed 39.7% (children aged 1-35 months)

had DD or DI problems (Wei et al. 2015). In Izmir, Turkey the prevalence of DI was 6.4% (children aged 3-60 months) (Demirci and Kartal 2016), in Iranian children aged from 4 to 60 months it ranged from 3.69% to 4.31% (Sajedi et al. 2014). In Germany, school entry examinations of Mecklenburg-Western Pomerania indicated a high prevalence of motor developmental delays (13.7 %) (Gottschling-Lang et al. 2016). An investigation conducted among 13876 preschoolers in Bavaria from 1997 to 2010 shows that four domains (motor, speech, cognition, psyche) showed increasing trends for the whole period, the most significant increase was psychosocial DI(3.8% in 1997 versus 13.8 % in 2010), others are speech ( 11.2% in 1997 versus 19.4 % in 2010), cognition ( 7.2% in 1997 versus 11.4 % in 2010), motor ( 5.4% in 1997 versus 28.6 % in 2010) respectively (Stich et al. 2017).

### 1.1.1 Prevalance and determinants of vision impairment

Vision impairment (VI) is also regarded as a growing population health concern, VI may negatively affect school performance and even health as well as quality in later life. Globally 1.4 billion people were estimated to be affected in 2000 (Holden et al. 2016). Prevalence estimates of visual impairment among preschool children in the US range from 1% to 6% (Donahue et al. 2006; Friedman et al. 2009; Group 2009; McKean-Cowdin et al. 2013; Ying et al. 2014). The prevalence of myopia was higher in Asia (60%) than in Europe (40%) among school children (Grzybowski et al. 2020a). In Germany a previous study in Saarland found that the prevalence of visual acuity was 31.1% and color blindness was 1.3% among preschool children (Käsmann-Kellner and Ruprecht 2000). Another investagiton showed that the prevalence of vision impairment was ranged from 2.7% to 4.4% (Snowdon and Stewart-Brown 1997).
Previous studies showed that visual impairment was related to sex (Nucci et al. 2016), age (Nangia et al. 2011), ethnicity (Nangia et al. 2011), education (Nangia et al. 2011; Soler et al. 2016), socioeconomic status (Grzybowski et al. 2020a; Nangia et al. 2011), outdoor time and availability of a TV in children's rooms (Adhikari et al. 2018). Some studies showed a positive relationship between obesity and visual impairment (Peng et al. 2016a; Zhang et al. 2018) among school-aged children. Available studies on the association of visual impairment and body mass index (BMI) are yet limited (Bergman et al. 2004; Holbrook et al. 2009; Nangia et al. 2011; Rosner et al. 1995; Wrzesińska et al. 2017; Yang et al. 2016). There are a few studies on school-aged children showing a positive relationship with obesity, but none on preschool children (Peng

et al. 2016a; Zhang et al. 2018), which raises the question of whether the association with school-aged children's BMI emerges from visual impairment among preschool children.

### 1.1.2 Prevalance and determinants of hearing impairment

Hearing impairment (HI) is one of the most common chronic physical conditions globally. HI easily leads to poor academic performance and social psychosocial problems. Estimated Prevalence of HI in a meta-analyse showed an upword trend from 1990 to 2010 (Wang et al. 2019). Globally 32 million children suffered from HI according WHO report (World Health Organization 2014). In Africa the prevalence of HI was 10% among children and adolescents (Desalew et al. 2020). In the United states showed that 0.11% of infants and 3.1% of children and adolescents have hearing loss problems (Mehra et al. 2009). In Germany the prevalence of HI among children and adolescent was from 1.0% to 4.0% (Schmucker et al. 2019). Data from SEHE demonstrated estimated prevalence of HI ranged from 3.9% to 5.2% (Robert-Koch-Institute， 2006) among preschool children.

The risk factors which affect HI Evidence are various. Biological factors include genetic disease (Mehra et al. 2009), household smoking (Taha et al. 2010), perinatal infections, birth status, ototoxic infection and treatment (World Health Organization), age and and other infectious diseases such as HIV, tuberculosis (Desalew et al. 2020). Environmental risk factors are low income of family (Taha et al. 2010; Zakzouk 1997), use of earphones (Desalew et al. 2020), and ethinic background (Mehra et al. 2009). One cross-sectional study demonstrated hispanic Americans had a higher prevalence of HI than other children (Mehra et al. 2009).

In adults, obesity has been examined as a risk factor for Hearing Loss (Barrenäs et al. 2005; Fransen et al. 2008; Gates et al. 1993). Some previous studies showed that nutritional deficiencies increased the Risk of Hearing Loss in infants (Olusanya 2010; Olusanya 2011; Valeix et al. 1994), but there was a lack of evidence among preschool children.

### 1.1.3 Prevalance and determinants of motor impairment

The motor impairment (MI) may affect the achievement in education, socialization and mental health (Nikolić and Ilić-Stošović 2009). Moreover, MI is often accompanied by other diseases such as ADHD (Dewey et al. 2002), language developmental delay(Alloway and Archibald 2008; Gaines and Missiuna 2007; Webster et al. 2005). Because of different criteria, prevalence of MI was varied, aproximately 5-6% of children had MI problems in Canada(Spitzer et al. 2002; Zwicker et al. 2012) . The prevalence of MI in England was 1.8% (Lingam et al. 2009), in Greece was 19.0% (Tsiotra et al. 2006), in Spain was 9.9% (Amador-Ruiz et al. 2018). The Previous research from Germany showed that the trend of MI decreased in some domains over last decades among preschool children (Roth et al. 2010).

Individual fators such as gender (Chow and Chan 2011; Cliff et al. 2009), ethnicity (Chow et al. 2001), preterm birth (Holsti et al. 2002), age (Chow et al. 2001; Iivonen et al. 2011; Krombholz 2006) were found to be associated with MI. Lifestyle factor like lack of physical activity (Bürgi et al. 2011) was risk factor for MI. Environmental factors such as family structure (Cools et al. 2011), kindergarden area (Chow and Chan 2011), community density (Cools et al. 2011), and socioeconomic status (Roth et al. 2010) of family were considered to be risk factors (Iivonen and Sääkslahti 2014). Some results suggested a direct relationship between MI and BMI among preschool children, whereas other studies showed no relationship between BMI and MI (Castetbon and Andreyeva 2012). This raises the question of whether the association with school-aged children's BMI emerges from motor impairment among preschool children.

### 1.1.4 Prevalance and determinants of cognition impairment

Few studies on the prevalence of cognition impairment (CI) have been conducted. One cross-sectional study from Germany showed that the prevalence of CI was 11.3% (Stich et al. 2012). More and more research focused on the risk factors, such as parental education (Parisi et al. 2010), smoking history, family environment, polychlorinated biphenyls (PCBs), socioeconomic status (SES) (Stewart et al. 2003), psychosocial stimulation, nutritional status, early childhood education (Warsito et al. 2012), educational mobile games (Ni and Yu 2015), race/ethnicity (Mollborn et al. 2012), physical exercise (Niederer et al. 2011). The relathionship between BMI

and CI remains controversial. Some researches showed no association between weight and cognitive function (Krombholz 2012), whereas other studies suggested that BMI affect CI in mid-low SES (Galván et al. 2014).

### 1.1.5 Prevalance and determinants of Language impairment

Language impairment (LI) is one of most prevalent DD among preschool children, often lead to cognition disorder, behavior problems, mental health and academic achievement (Shetty 2012). Because of different measurement and assessment standards the estimatied prevalence of LI was from 0.4%(Paul et al. 1992) to 19% (Beitchman et al. 1986). More boys than girls have LI problems (Silva et al. 1987; Stevenson and Richman 1976; Wong et al. 1995). Among toddlers the prevalence of LI was around 15% in children aged 2 years old (Desmarais et al. 2008), 13.5% in children aged 18-23 months, 17.5% in children aged 30-36 month (Horwitz et al. 2003). In Bavaria, southern Germany, the prevalence of pronounciation impairment was 13.8%, and the impairment of rhythm was 3.1% (Stich et al. 2012). Around 70-80% of children with language delay will catch up growth and recover the language skills over the following years (Whitehouse et al. 2011).

The genic factor such as family history (Lyytinen et al. 2001; Zubrick et al. 2007) is considered to be a risk factor for LI. The extrinsic facors include parenting environment (Vigil et al. 2005), daily TV watching (Byeon and Hong 2015; Lyytinen et al. 2001), family socioeconomic status (Domsch et al. 2012), parental occupation (Zubrick et al. 2007), gender, birth weight, birth order (Reilly et al. 2009),and ethnicity (Galvin et al. 2020). A study of relationship between with BMI and language impairment couldn't be found.

## 1.2 Prevalance of BMI

With the development of the economy obesity has become a global public health concern among the general population in the 21$^{st}$ century. The prevalence of overweight and obese children has increased in recent decades and shown an increasing trend at younger age (De Onis et al. 2010). Globally, its prevalence among preschool children increased from 4.2% in 1990 to 6.7% in 2010 (De Onis et al. 2010). The prevalence of overweight and obese children has

increased in recent decades and shown an increasing trend at a younger age (De Onis et al. 2010). The prevalence of obesity in preschool children varies from different countries, with a significantly higher prevalence in the United States (13.9%) (Volger et al. 2018) than in European countries (5.3%)(Garrido-Miguel et al. 2019). In Europe according to recent estimates for preschool children 5.3% are obese (Garrido-Miguel et al. 2019). According to a large Pan-European Cohort of preschool children in 2012 the prevalence of overweight and obesity was higher in Southern and Eastern European countries than Central and Northern European countries (Manios et al. 2018). Previous research such as KiGGS Wave 2 in Germany indicated current trends in overweight and obesity among preschool children had no significant change from 2014 to 2017 (Schienkiewitz et al. 2019), national investigation from 2005 to 2015 showed significant decreased trends of overweight and obesity among German children (Keß et al. 2017). Although the general prevalence is declining, the prevalence at a regional level is still unknown and not timely updated. Few previous studies such as the prevalence of overweight and obesity in Bavarian children demonstrated an increasing trend of overweight from 8.5% to12.3% and for obesity from 1.8% and 2.8% between 1982 and 1997 (von Kries 2004). Most recent prevalence data and trends among preschool children in Germany are lacking.

Except for genetic risk factors, such as parental obesity (Padez et al. 2005), congenital peptin deficiency (Herrmann et al. 2002), mutations of pro-hor-mone convertase 1(PC1) gene (Jackson et al. 1997), SES is found to be associated with obesity among preschool children (Veugelers and Fitzgerald 2005). A further risk factor for BMI is ethnic background (Toselli et al. 2015). Previous studies found that the TV viewing and low physical activity increased the risk for fat gain. Parental ecucation and family size were protective factors for overweight and obesity among preschool children (Padez et al. 2005) and children (Keane et al. 2012).

### 1.3 Migrant children's health

Definition of migration is *"The movement of a person or a group of persons, either across an international border, or within a State. It is a population movement, encompassing any kind of movement of people, whatever its length, composition and causes; it includes migration of refugees, displaced persons, economic migrants, and persons moving for other purposes, including family reunification"* (International Organization for Migration 2018).

With development of globalisation, migration waves started after world war II. Millions of workers from other European countries moved to Germany. From 1950 to 1985, about 4.4 million people migrated to Germany (Schmidt 1997). During the Cold War about 15 million refugees settled down in Germany from 1945 to 1990. Approximately 2.7 million German repatriated from the former Soviet Union (Heckmann 1995). Until 2005, the figure of migrants was 15.3 million, accounting for 18.6% of the total population. People with migration background in Baden-Württemberg accounts for 12% of the whole states' population. The number of migrants is still increasing because of family unification. With development of economy and health care German population is ageing. Birth rate decreased because of low marriage rates. However, the structure of people with migration background is relatively younger than german average. Among migrants, people aged from 0 to 20 accounts for 29.3%. Among migrant children, about 60% of children are aged from 0 to 9 years old, becoming the main labor force in the future. Therefore, migrant children health has been a concern in recent years.

Migration background is considered to be a risk factor for children's health. Many studies demonstrated percentage of overweight and obesity were different among migrant children and non-migrant children (El-Sayed et al. 2011; Menigoz et al. 2016). One study showed that the prevalence of overweight and obedisy were 14.7% and 3.1% respectively among migrant prescool children from Bielefeld, Germany, which was much higher than among German children (9.1% and 1.9%)(Will et al. 2005). Another investigation from Hannover demonstrated migrant children had higher (12.7%) prevalence of overweight than non-migrant children (6.9%) (Zhou et al. 2018). German Health Interview and Examination Survey for Children and Adolescents (KIGGS) demonstrated that overweight prevalence among migrant children (10%) was higher than non-migrant children (6.4%)(Brettschneider et al. 2017).

Migration background impacts on the preschool children development. SEE in Bavaria, Germany suggested that migrant children had more risk to face language impairment and overweight (Le Thi et al. 2019). First-generation migrant children had worse SEE results than others in Halle, Germany(Führer et al. 2020). KiGGS study also showed difference beween migrants and non-migrant in oral health behavior (Schenk and Knopf 2007). A study in Sweden

suggested that children with migrant background were more likely to have poorer motor skills (Hilpert et al. 2017).

### 1.4 Aim

The current study was designed to to describe the prevalence and the six-year trends of overweight and obesity, developmental delay on vision acuity, hearing loss, motor impairment, language retardation, cognitive disorder, to test associations between BMI and comprehensive developmental delay (vision, hearing, motor, speech, and cognition impairment), and to explore the potential role of BMI to predict developmental disorder among preschool children, which can inform health policy and effective intervention targeting on young obese children. This research hypothesizes that BMI was associated with developmental delay on vision acuity, hearing loss, motor impairment, language retardation, cognitive disorder.

# 2. MATERIALS AND METHODOLOGY

### 2.1 SEHE data sources

According to the law and regulation in Baden-Württemberg (Ministry of Education and cultural affairs in Baden-Württemberg 2010; Ministry of Social Affairs in Baden-Württemberg 2011) (Ministry of Social Affairs in Baden-Württemberg 2015), all preschool children of Baden-Württemberg are examined annually by the Public Health Service before entering school. From 2013 to 2018, 454 kindergarten of 54 district towns and municipalities in Rhine-Neckar County and the City of Heidelberg participated in the SEE. Since the SEE is compulsory in Rhine-Neckar County and the City of Heidelberg, all children's data was obtained from that area in this cross-sectional study. The dataset includes the 17 variables. Table 1 showed the definition and type of each variable in the analysis.

#### 2.1.1 Anthropometric method and criteria

Before the examination, parents receive a formal written consent from the public health office. The information including age, migration background, parents' education and occupation, usage of electronic equipment was obtained from the parents' questionnaire. Data includes measurements of physical examination and children development, and health examimation for

children and questionair for parents are showed in Appendix1.The criteria and methodology to identify developmental impairment during the examination follows the Work Guideline for School Entry Examination (WGSE) of the Ministry of Social Affairs and Integration, Baden-Württemberg (Ministry of Social Affairs and Integration Baden-Württemberg 2017). If the any of this information like age, gender, weight, height was missing the participant was excluded from the study.

### 2.1.2 BMI measurement

Data includes height and weight measurements required to wear light clothes and to take off shoes. Body height was accurate to 1 cm, and body weight to the nearest 100 g.

$$BMI = \frac{Weight(kg)}{Height^2(m^2)}$$

BMI was categorized as underweight, normal weight, overweight, or obese according to BMI-for-age z-scores from the World Health Organization child growth standards (World Health Organization 2020).

For children age ≤ 5 years, Underweight <-2SD, Overweight: >+2SD, Obesity: > +3SD; For children age > 5 years, Underweight <-2SD, Overweight: >+1SD, Obesity: > +2SD.

### 2.1.3 Visual test

Visual test is according to scoring visual acuity measured with a refractometer in at least two out of three measurements, and the final result is the highest value. The child is asked to look away from the device for several seconds to relax the Ciliary Muscles. The test is checked whether the child now correctly recognizes the next higher level of vision in at least 2 out of 3 rounds. If visual acuity values are below 0.7 (one or both sides), the child will be regarded as visual impairment according to the Work guidelines for the enrollment examination(Ministry of Social Affairs and Integration Baden-Württemberg 2017).

### 2.1.4 Hearing test

Hearing test is carried out with an audiometer in a quiet room, and all frequencies (500, 1000, 2000, 4000, 6000 Hz) must be checked for the right and left ear. Adjust the sound of headphones protection caps exactly over the ear cups before measuring. The tone should be given clearly

above the threshold that the child can notice. To determine the hearing threshold, the examiner offers the sound subliminally and then increases the volume until the child hears the sound. The test should be conducted twice. The child should show as soon as he hears the sound. A side differentiation according to the right or left ear can be omitted, unless there is a large difference in the hearing threshold between the right and left ear (hearing threshold from the poorly hearing side to the good hearing from about 45 dB difference). If the hearing threshold is permanently above 20 dB, hearing is seen as impairment according to the Work guidelines for the enrollment examination(Ministry of Social Affairs and Integration Baden-Württemberg 2017).

### 2.1.5 Motor skills test

Motor skills test includes gross motor skills, fine motor skills, and visual-motor skills. As to gross motor skills, the examiner asks the participant to jump ten times at a time with one leg alternatively. For children aged 4 years old, if the hops number is less than 4 on one or both sides; For children aged more than and equal to 5 years old, if the hops number is less than 7 on one or both sides, the children will be seen as gross motor impairment. Concerning fine motor skills, the capability of holding a pen is tested by professionals. Evaluation index includes handedness (unclear), pressure (too strong or weak), mastery (trembling, spatial inappropriateness of the target movements, moving movement impulses), and posture (Thumb and index finger grip the pen like a pair of pliers; Lies on the middle finger. The end of the pen does not point steeply upwards, but rests in the thumb recess; The ring finger and little finger are slightly bent and the forearm and wrist rest slightly on the table). If an index is inappropriate, the result is regarded as fine motor impairment. The participant draws the characters based on a template (Appendix 2). If the number of correctly reproduced characters is more than 3, the result will be seen as inappropriate. In general, any subcategory of motor skill is inappropriate, the result will be seen as motor impairment according to the Work guidelines for the enrollment examination(Ministry of Social Affairs and Integration Baden-Württemberg 2017).

### 2.1.6 Cognition skills test

Cognition skills are divided into two parts which include painting development and mathematical competence. If a child draws a human without structure and figurative painting, the result of painting development will be inappropriate. If the child can't figure out the quantity of folding card block according to the SOPESS test booklet, the result of mathematical will be not appropriate. In general, if any subcategory of cognition skills is inappropriate, the result will be not appropriate according to the Work guidelines for the enrollment examination (Ministry of Social Affairs and Integration Baden-Württemberg 2017).

### 2.1.7 Language skills test

Language skills include repeating sentences, playback of sequences of numbers, and repeating artificial words, which are carried out according to the HASE manual (Appedix3). For repeating sentences, the maximum point value is 10. When repeating sentences, correct pronunciation is not important, but if a sentence is grammatically incorrect due to added words, the sentence is counted as wrong. Furthermore, when repeating sentences, the prepositional phrases can be interchanged. Each correctly repeated sequence of numbers is rated with 1 point. If the first sequence of numbers of a pair of tasks is reproduced correctly, the second sequence of numbers is skipped. For playback of sequences of numbers, if the child repeats the sequence of numbers "6-3" correctly, he will receive 1 point. If children aged from 4.0 to 4.5 years old, point $\leq 1$ is inappropriate; If children aged from 4.6 to 4.11 years old, point $\leq 2$ is noticeable; If children aged more than and equal to 5 years, point $\leq 3$ is noticeable. For artificial words, if an artificial word is not pronounced correctly, the child does not receive a point. Among children aged from 4.0 to 4.5 years old, points $\leq 4$; Among children aged from 4.6 to 4.11 years old, 5 points and less are noticeable; Among children aged over 5 years old, 6 points and less are noticeable. For language comprehension, the order was given as follows, 1) Place the big red ball in front of the black teddy. Place the little blue ball behind the black teddy. 2) Place the little red ball next to the white teddy. 3) The child takes the required items out of the box himself. Everything that the child chose wrongly is to be regarded as a mistake: colors, sizes, and location modalities. The maximum total number is 3, and errors in 2 or 3 tasks are noticeable. For articulation, the child names the pictures from the sound test sheet (Appendix 3). If the child is unable to name a picture, the child will be asked to repeat it once. For example, if a child says roofs instead of

kites, the test term "kite" is marked as unremarkable. The result will be assessed according to standard (Appendix 4). Generally, if any of the subcategories of language skills is noticeable, the result will be regarded as inappropriate according to the Work guidelines for the enrollment examination(Ministry of Social Affairs and Integration Baden-Württemberg 2017). All subcategories of developmental impairment are shown in table 1.

Table 1. Subcategories of developmental impairment

| **Categories** | **Subcategories** | **Examination items** |
|---|---|---|
| **Vision** | Visual acuity | Visual acuity of the right eye |
| | | Visual acuity of the left eye |
| **Hearing** | Frequency | 500 /1000 /2000 /4000 /6000 Hz |
| **Motor** | Gross motor | One-leg hopping |
| | Graph motor | Drawing figures (dexterity, pressure, posture, guidance) |
| | Fine motor | Drawing a human (head, body, hands, legs) |
| **Speech** | Articulation | Articulation ‘L, N’ ‘Books’ ‘Dragon’ ‘G, K’ ‘S, Z’ ‘Sch’ ‘R’ ‘T, D’ and consonant clustering |
| | Grammar | Repetition of sentences (i.e. "Tina Singh") |
| | Coherence | Playback of number sequences (i.e. “2-4-9-1”) |
| | | Reproduction of artificial words (i.e. “LUFA”) |
| | Comprehension | Action according to orders: colors, sizes, and location modalities. |
| **Cognition** | Quantity detection | Distinction and designation of ball quantities in picture |
| | Painting development | The child should paint a human during the examination |

## 2.2 Methods

### 2.2.1 Definition for Weight status

BMI was categorized as underweight, normal weight, overweight, or obese according to BMI-for-age z-scores of the WHO child growth standards (World Health Organization 2020) are used as classification criteria for overweight and obesity. The cut-offs are as follows according to WHO standards: for children age ⩽ 5years : Underweight <-2SD, Overweight: >+2SD, Obesity: > +3SD; for children age > 5 years: Underweight <-2SD, Overweight: >+1SD, Obesity: > +2SD.

### 2.2.2 Definition for migration background

The definition was implemented when any indicators met the standard of migrant status introduced by Schenk et al.(Schenk et al. 2006) A child has a migration background, if
– both parents were born abroad or the child and at least one of the parents were born abroad;
– the language spoken at home is not German or it is German and another language.

### 2.2.3 Definition for developmental impairment and related variable

Table 2. Definition of key variables.

| **Variables** | Definition | Type |
|---|---|---|
| Visual impairment | Visual impairment according to scoring visual acuity measured with a refractometer in at least two out of three measurements ≤0.7. | Categorical |
| BMI category | Classification in normal weight, overweight, obesity and underweight by BMI-for-age z-scores of WHO child growth standards (For children age ≤ 5 years, Underweight <-2SD, Overweight: >+2SD, Obesity: > +3SD; For children age > 5 years, Underweight <-2SD, Overweight: >+1SD, Obesity: > +2SD) | Categorical |
| Age | Age at SEE, including children from 4 to 6 years | Categorical |
| Gender | Includes male and female children | Categorical |
| Survey circle | Every year of investigation from 2013 to 2018 coded as 'year-2013' | Continuous |
| Immigration background | Children with at least one of their parents being born abroad or the language spoken at home is not German or it is German together with another language | Categorical |
| Father's education | Education level as low (primary school), middle (high school) and high | Categorical |

| | | |
|---|---|---|
| | (college and above) | |
| Mother's education | Education level from low (primary school), middle (high school) and high (college and above) | Categorical |
| Father's occupation | Occupation type as full-time, part-time, unemployment | Categorical |
| Mother's occupation | Occupation type as full-time, part-time, unemployment | Categorical |
| TV in children's room | TV in children's room available, yes or no | Categorical |
| Screen time on weekends | The time of using electronic equipment such as smart phone, computer, tablet and TV on weekends (never, ≤30minutes per day, 1 to 2 hours per day, ≥3 hours per day) | Categorical |
| Screen time on weekday | The time of using electronic equipment such as smart phone, computer, tablet and TV on weekends (never, ≤30minutes per day, 1 to 2 hours per day, ≥3 hours per day) | Categorical |
| Quality of outdoor environment | Three dimensions measuring the environment of kindergartens are included in the survey: i) open areas, ii) green areas including number of trees, shrubberies and hilly terrains, and iii) the integration of open areas and green areas with a score ranging from 1 to 3. Here we define quality of outdoor environment =0 if total score≤2 and quality of outdoor environment=1 if total score >2. | Categorical |

### 2.2.4 Statistical analysis

We described the baseline characteristics of preschool children by each BMI category. We also analyzed the relationship between each independent variables and visual impairment with univariate logistic regression analysis, at the same time we tested the interaction between BMI category and each independent variable. Finally, we performed multiple logistic regression analyses to estimate the association of BMI category on developmental impairment (visual, hearing, motor, language, with and without adjusted covariables and multiple imputation of missing data. ModelIwas adjusted by age, gender, migration background, year circle. ModelIIwas adjusted by year circle, age, gender, migration background, fathers education, mother's education, father's occupation, mother occupation, TV in children's room, Screen time on a weekday, screen time at weekend and Quality of outdoor environment of preschool. The heterogeneous effect of BMI category was analyzed for nationality. The logistics regression was produced by the GLM

function, and multiple imputation was performed by the *mice* package in R software. Data was processed by R 3.6.3 software to analyze the data.

# 3. RESULTS

### 3.1 Characteristics of the study participants

In this survey, 37858 children aged 4 to 6 years old were enrolled from 2013 to 2018, 33407 children had valid information, including 17304 boys and 16103 girls. The response rate is 88.2%. The overall prevalence of overweight and obesity was 7.6% and 2.8% respectively. The overall prevalence of developmental impairment was 45.1% (vision), 23.5% (hearing), 52.3% (motor), 39. 6% (language), 34.7% (cognition).

The baseline characteristics of preschool children is shown in Table 1. The unadjusted prevalence of underweight, normal weight, overweight and obesity is displayed in Figure 1. The unadjusted trend of children with developmental impairment was shown in Figure 2. The percentage of age, gender, migration background, social-economic status of parents, and screen time were significantly different by BMI category.

Table 3.Baseline Characteristics of preschool children in Rhine-Neckar County and the City of Heidelberg, 2013-2018

| Characteristic | | Number | Percentage (%) |
|---|---|---|---|
| Survey Year | 2013 | 5665 | 17.0 |
| | 2014 | 5619 | 16.8 |
| | 2015 | 4557 | 13.6 |
| | 2016 | 5612 | 16.8 |
| | 2017 | 5956 | 17.8 |
| | 2018 | 5998 | 18.0 |
| Gender | Boys | 17304 | 51.8 |
| | Girls | 16103 | 48.2 |
| Age | 4 | 4062 | 12.2 |
| | 5 | 25078 | 75.0 |
| | 6 | 4267 | 12.8 |
| Migration background | Non-migrant | 16436 | 49.2 |
| | Migrant | 16971 | 50.8 |
| Nutrition status | | | |
| | Normal | 29605 | 88.6 |
| | Underweight | 2525 | 1.1 |
| | Overweight | 920 | 7.6 |
| | Obesity | 357 | 2.8 |
| Developmental impairment | | | |

| | | | |
|---|---|---|---|
| Vision | 15065 | 45.1 |
| Hearing | 7848 | 23.5 |
| Motor | 17473 | 52.3 |
| Language | 13231 | 39.6 |
| Cognition | 11603 | 34.7 |

### 3.2 Prevalence of overweight and obesity

The prevalence of overweight, obesity and developmental impairment by age, sex, migration background is displayed in Table 4. The prevalence of overweight and obesity in boys (7.9%, 3.2%) was more than girls (7.2%,2.3%), and in migration background (8.9%,3.7%) was higher than non-migrant background (6.3%,1.8%).

Table 4. Prevalence of overweight and obesity by migration background, by age, by gender, among preschool children in Rhine-Neckar County and the City of Heidelberg, 2013-2018

| Characteristic | Overweight prevalence (%) | | | Obesity prevalence (%) | | |
|---|---|---|---|---|---|---|
| | Total | Non-migrant background | Migration background | Total | Non-migrant background | Migration background |
| All, age, y | | | | | | |
| Total | 7.6 | 6.3 | 8.9 | 2.8 | 1.8 | 3.7 |
| 4 | 3.1 | 2.9 | 3.3 | 0.9 | 0.6 | 1.2 |
| 5 | 7.2 | 5.9 | 8.5 | 2.5 | 1.7 | 3.4 |
| 6 | 14.1 | 13.0 | 14.9 | 6.0 | 4.5 | 7.2 |
| Male, age, y | | | | | | |
| Total | 7.9 | 6.6 | 9.2 | 3.2 | 2.0 | 4.5 |
| 4 | 3.6 | 3.4 | 3.9 | 1.1 | 0.6 | 1.6 |
| 5 | 7.4 | 6.0 | 8.9 | 2.9 | 1.8 | 3.9 |
| 6 | 14.6 | 14.8 | 14.4 | 7.3 | 4.8 | 9.1 |
| Female, age, y | | | | | | |
| Total | 7.2 | 5.9 | 8.5 | 2.3 | 1.7 | 2.9 |
| 4 | 2.5 | 2.2 | 2.8 | 0.7 | 0.6 | 0.7 |
| 5 | 6.9 | 5.8 | 8.1 | 2.1 | 1.5 | 2.8 |
| 6 | 13.6 | 11.2 | 15.4 | 4.6 | 4.1 | 5.0 |

### 3.3 Prevalence of developmental impairment

The prevalence of developmental impairment from 2013 to 2018 was decreasing with age except for language impairment. Among five domains of developmental impairment, the prevalence of vision and hearing impairment in girls was higher than in boys, and the prevalence of motor, language and cognition impairment in boys was higher than in girls. Children with migration background had higher prevalence than non-migrant background in all developmental impairment.

Table 5. Prevalence of developmental impairment by migration background, by age, by gender, among preschool children in Rhine-Neckar County and the City of Heidelberg, 2013-2018

| Developmental | Total | | | | Male | | | | Female | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| impairment | Total | 4 | 5 | 6 | Total | 4 | 5 | 6 | Total | 4 | 5 | 6 |
| **Vision impairment** | | | | | | | | | | | | |
| Total | 45.1 | 55.5 | 45.0 | 35.8 | 44.3 | 54.4 | 44.3 | 35.2 | 45.9 | 56.7 | 45.7 | 36.4 |
| Non-migrant background | 43.4 | 54.0 | 43.0 | 34.0 | 42.7 | 52.2 | 42.5 | 32.6 | 44.2 | 56.0 | 43.5 | 35.5 |
| Migration background | 46.8 | 57.2 | 47.2 | 37.1 | 46.1 | 57.0 | 46.3 | 37.1 | 47.7 | 57.4 | 48.1 | 37.1 |
| **Hearing impairment** | | | | | | | | | | | | |
| Total | 23.5 | 31.0 | 23.7 | 15.4 | 22.9 | 30.3 | 23.1 | 15.3 | 24.1 | 31.7 | 24.3 | 15.5 |
| Non-migrant background | 21.2 | 28.2 | 21.4 | 11.7 | 20.8 | 27.4 | 21.0 | 11.6 | 21.6 | 29.2 | 21.8 | 11.8 |
| Migration background | 25.8 | 34.1 | 26.1 | 18.2 | 25.1 | 33.8 | 25.3 | 18.0 | 26.7 | 34.4 | 27.0 | 18.4 |
| **Motor impairment** | | | | | | | | | | | | |
| Total | 52.3 | 63.8 | 51.8 | 44.3 | 62.4 | 76.5 | 61.9 | 52.4 | 41.4 | 50.7 | 40.9 | 35.4 |
| Non-migrant background | 50.4 | 61.3 | 49.9 | 41.5 | 60.9 | 75.3 | 60.2 | 9.3 | 39.1 | 45.9 | 38.8 | 33.1 |
| Migration background | 54.3 | 66.7 | 53.9 | 46.5 | 64.0 | 77.9 | 63.8 | 4.7 | 43.8 | 55.8 | 43.1 | 37.1 |
| **Language impairment** | | | | | | | | | | | | |
| Total | 39.6 | 37.2 | 39.6 | 42.1 | 41.2 | 38.7 | 41.1 | 43.8 | 37.9 | 35.7 | 37.9 | 40.2 |
| Non-migrant background | 30.7 | 27.9 | 31.5 | 28.7 | 32.5 | 29.7 | 33.1 | 1.0 | 28.8 | 26.0 | 29.7 | 26.2 |
| Migration background | 48.8 | 47.9 | 48.2 | 52.4 | 50.2 | 49.7 | 49.7 | 3.3 | 47.3 | 46.3 | 46.7 | 51.2 |
| **Cognition impairment** | | | | | | | | | | | | |
| Total | 34.7 | 48.2 | 33.7 | 28.1 | 40.8 | 57.2 | 39.5 | 33.8 | 28.2 | 39.0 | 27.4 | 21.9 |
| Non-migrant background | 31.1 | 43.8 | 29.8 | 24.6 | 37.5 | 54.1 | 35.9 | 9.3 | 24.1 | 32.5 | 23.4 | 19.6 |
| Migration background | 38.5 | 53.3 | 37.8 | 30.8 | 44.3 | 60.9 | 43.3 | 7.1 | 32.3 | 45.9 | 31.8 | 23.7 |

### 3.4 Trends of overweight and obesity

The prevalence of overweight and obesity shows an ascending tendency with the increasing of year. The general trend of overweight and obesity is shown in Figure 1. The prevalence of overweight (from 6.7% to 7.3%) and obesity (from 2.3 to 3.0%) shows an increasing trend from 2013 to 2018. After adjusting by age, gender, migrant backgound, the trend of overweight

fluctuated, which was most significant among boys of migants aged 6 years—increasing from 11.8% to 16.3% before decreasing to 15.3 during in 2018. Meanwhile, the prevalence of obesity showed the similar trend of overweight among migrants aged 6 years—increasing to 11.6% before dropping to 9.8% then rising to 11.8%. Among girls, the trend of overweight fluctuated from 7.2% to 8.2% during six years. Girls with migrant aged 6 years had the highest prevalence of overweight and obesity.

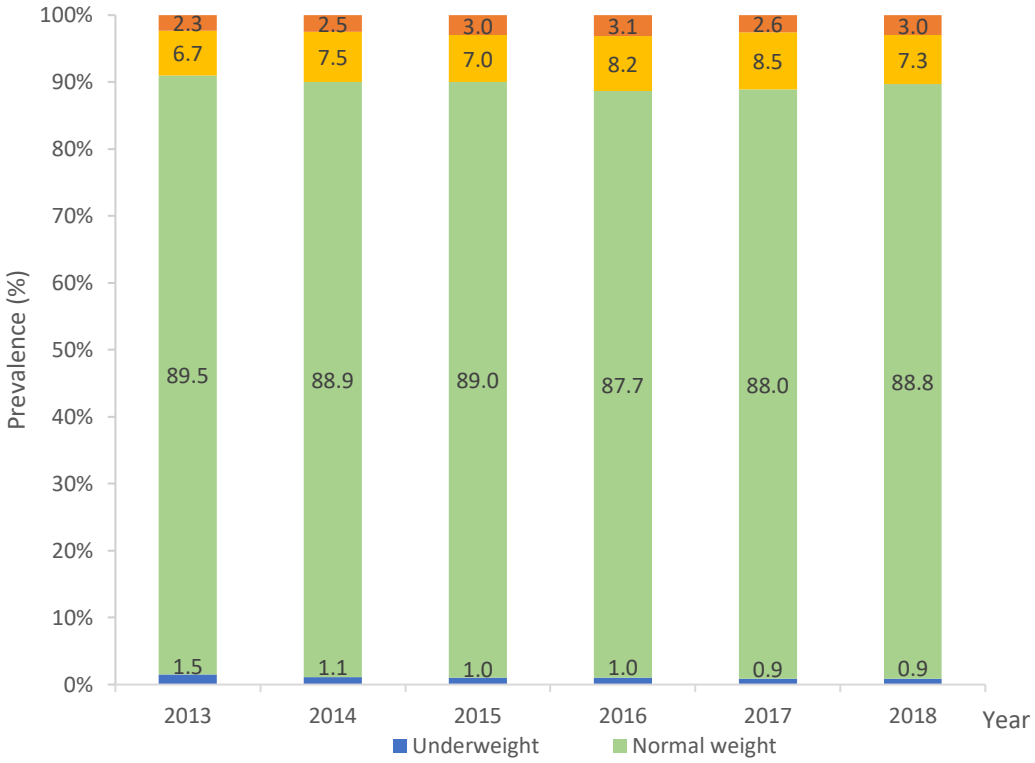


Figure 1 The unadjusted prevalence of BMI category (underweight, normal weight, overweight and obesity) from 2013 to 2018

Table 6.Trends in the prevalence of overweight in male children, 2013 to 2018

| | No. (%) of Male | | | |
|---|---|---|---|---|
| | Total | Aged 4 years | Aged 5 years | Aged 6 years |
| **Total** | 1363 (7.9) | 75 (3.6) | 961 (7.4) | 51 (14.6) |
| 2013 | 209 (7.1) | 13 (3.6) | 145 (6.5) | 55 (13.4) |
| 2014 | 226 (7.9) | 11 (3.3) | 160 (7.7) | 42 (13.2) |
| 2015 | 169 (7.1) | 9 (2.9) | 118 (6.6) | 65 (14.4) |
| 2016 | 232 (7.9) | 13 (4.7) | 154 (7.0) | 66 (14.7) |
| 2017 | 276 (8.9) | 11 (3.4) | 199 (8.4) | 48 (16.2) |
| 2018 | 251 (8.2) | 18 (4.0) | 185 (8.0) | 299 (15.6) |
| **Non-migrant background** | | | | |
| 2013 | 90 (6.0) | 5 (2.4) | 61 (5.4) | 24 (15.8) |
| 2014 | 91 (6.2) | 9 (4.4) | 55 (5.2) | 27 (14.2) |
| 2015 | 65 (5.5) | 5 (2.8) | 47 (5.3) | 13 (12.9) |

| | | | | |
|---|---|---|---|---|
| 2016 | 107 (7.0) | 10 (6.9) | 68 (5.8) | 29 (13.7) |
| 2017 | 119 (7.6) | 2 (1.3) | 91 (7.3) | 26 (16.1) |
| 2018 | 111 (7.0) | 8 (3.3) | 80 (6.7) | 23 (15.6) |
| **Migration background** | | | | |
| 2013 | 119 (8.1) | 8 (5.0) | 84 (7.7) | 27 (11.8) |
| 2014 | 135 (9.8) | 2 (1.6) | 105 (10.3) | 28 (12.3) |
| 2015 | 104 (8.6) | 4 (3.1) | 71 (8.0) | 29 (15.3) |
| 2016 | 125 (9.0) | 3 (2.2) | 86 (8.3) | 36 (15.6) |
| 2017 | 157 (10.1) | 9 (5.4) | 108 (9.5) | 40 (16.3) |
| 2018 | 140 (9.3) | 10 (4.8) | 105 (9.3) | 25 (15.5) |

Table 7.Trends in the prevalence of overweight in female children, 2013 to 2018

| | No. (%) of female | | | |
|---|---|---|---|---|
| | Total | Aged 4 years | Aged 5 years | Aged 6 years |
| **Total** | 1162 (7.2) | 50 (2.5) | 838 (6.9) | 274 (13.6) |
| 2013 | 8 (2.4) | 8 (2.4) | 124 (6.1) | 40 (12.1) |
| 2014 | 226 (7.9) | 10 (3.0) | 139 (6.7) | 45 (12.3) |
| 2015 | 169 (7.1) | 7 (2.3) | 99 (6.2) | 46 (16.8) |
| 2016 | 232 (7.9) | 7 (2.7) | 159 (7.9) | 60 (14.2) |
| 2017 | 276 (8.9) | 8 (2.5) | 173 (8.0) | 52 (14.4) |
| 2018 | 251 (8.2) | 10 (2.3) | 144 (6.5) | 31 (11.6) |
| **Non-migrant background** | | | | |
| 2013 | 67 (4.9) | 2 (1.2) | 50 (4.7) | 15 (10.9) |
| 2014 | 89 (6.2) | 5 (2.8) | 70 (6.4) | 14 (7.9) |
| 2015 | 51 (4.8) | 4 (2.4) | 33 (4.2) | 14 (12.7) |
| 2016 | 102 (7.4) | 4 (3.1) | 72 (6.8) | 26 (13.1) |
| 2017 | 82 (5.7) | 2 (1.2) | 65 (5.7) | 15 (10.5) |
| 2018 | 95 (6.4) | 6 (2.7) | 73 (6.4) | 16 (12.5) |
| **Migration background** | | | | |
| 2013 | 105 (7.9) | 6 (3.6) | 74 (7.7) | 25 (12.9) |
| 2014 | 105 (7.9) | 5 (3.2) | 69 (7.0) | 31 (16.3) |
| 2015 | 101 (9.0) | 3 (2.3) | 66 (8.0) | 32 (19.5) |
| 2016 | 124 (9.5) | 3 (2.3) | 87 (9.1) | 34 (17.1) |
| 2017 | 151 (10.8) | 6 (4.0) | 108 (10.5) | 37 (16.3) |
| 2018 | 90 (6.3) | 4 (1.8) | 71 (6.6) | 15 (10.8) |

Table 8.Trends in the prevalence of obesity in male children, 2013 to 2018

| | No. (%) of Male obesity | | | |
|---|---|---|---|---|
| | Total | Aged 4 years | Aged 5 years | Aged 6 years |
| **Total** | 556 (3.2) | 22 (1.1) | 371 (2.9) | 163 (7.3) |
| 2013 | 79 (2.7) | 7 (1.9) | 51 (2.3) | 21 (5.5) |
| 2014 | 87 (3.1) | 6 (1.8) | 62 (3.0) | 19 (4.5) |
| 2015 | 78 (3.3) | 3 (1.0) | 45 (2.5) | 30 (10.3) |
| 2016 | 108 (3.7) | 2 (0.7) | 71 (3.2) | 35 (7.9) |
| 2017 | 102 (3.3) | 3 (0.9) | 65 (2.7) | 34 (8.4) |
| 2018 | 102 (3.3) | 1 (0.2) | 77 (3.3) | 24 (7.8) |
| **Non-migrant background** | | | | |
| 2013 | 29 (1.9) | 3 (1.5) | 17 (1.5) | 9 (5.9) |
| 2014 | 25 (1.7) | 2 (1.0) | 19 (1.8) | 4 (2.1) |
| 2015 | 19 (1.6) | 1 (0.6) | 10 (1.1) | 8 (7.9) |
| 2016 | 33 (2.2) | 1 (0.7) | 22 (1.9) | 10 (4.7) |

| | | | | |
|---|---|---|---|---|
| 2017 | 29 (1.9) | 0 (0) | 19 (1.5) | 10 (6.2) |
| 2018 | 41 (2.6) | 0 (0) | 36 (3.0) | 5 (3.4) |
| **Migration background** | | | | |
| 2013 | 50 (3.4) | 4 (2.5) | 34 (3.1) | 12 (5.3) |
| 2014 | 62 (4.5) | 4 (3.1) | 43 (4.2) | 15 (6.6) |
| 2015 | 59 (4.9) | 2 (1.5) | 35 (3.9) | 22 (11.6) |
| 2016 | 75 (5.4) | 1 (0.7) | 49 (4.8) | 25 (10.8) |
| 2017 | 73 (4.7) | 3 (1.8) | 46 (4.1) | 24 (9.8) |
| 2018 | 61 (4.1) | 1 (0.5) | 41 (3.6) | 19 (11.8) |

Table 9.Trends in the prevalence of obesity in female children, 2013 to 2018

| | No. (%) of female obesity | | | |
|---|---|---|---|---|
| | Total | Aged 4 years | Aged 5 years | Aged 6 years |
| **Total** | 364 (2.3) | 13 (0.7) | 258 (2.1) | 93 (4.6) |
| 2013 | 50 (1.9) | 1 (0.3) | 33 (1.6) | 16 (4.8) |
| 2014 | 55 (2.0) | 3 (0.9) | 44 (2.1) | 8 (2.2) |
| 2015 | 59 (2.7) | 1 (0.3) | 46 (2.9) | 12 (4.4) |
| 2016 | 67 (2.5) | 5 (1.9) | 42 (2.1) | 20 (4.7) |
| 2017 | 53 (1.9) | 2 (0.6) | 34 (1.6) | 17 (4.7) |
| 2018 | 80 (2.7) | 1 (0.2) | 59 (2.7) | 20 (7.5) |
| **Non-migrant background** | | | | |
| 2013 | 19 (1.4) | 1 (0.6) | 13 (1.2) | 5 (3.6) |
| 2014 | 18 (1.3) | 2 (1.1) | 14 (1.3) | 2 (1.1) |
| 2015 | 22 (2.1) | 0 (0) | 17 (2.2) | 5 (4.5) |
| 2016 | 26 (1.9) | 3 (2.3) | 15 (1.4) | 8 (4.0) |
| 2017 | 25 (1.7) | 0 (0) | 16 (1.4) | 9 (6.3) |
| 2018 | 27 (1.8) | 0 (0) | 19 (1.7) | 8 (6.3) |
| **Migration background** | | | | |
| 2013 | 31 (2.3) | 0 (0) | 20 (2.1) | 11 (5.7) |
| 2014 | 37 (2.8) | 1 (0.6) | 30 (3.0) | 6 (3.2) |
| 2015 | 37 (3.3) | 1 (0.8) | 29 (3.5) | 7 (4.3) |
| 2016 | 41 (3.1) | 2 (1.5) | 27 (2.8) | 12 (5.4) |
| 2017 | 28 (2.0) | 2 (1.3) | 18 (1.7) | 8 (3.7) |
| 2018 | 53 (3.7) | 1 (0.4) | 40 (3.7) | 12 (8.6) |

### 3.5 Trends of developmental impairment

The general trend of developmental impairment is shown in Figure 2.The prevalence of motor impairment points at an increasing trend from 2013 to 2018. Meanwhile, the prevalence of visual impairment showed a trend of rising first and then falling. The rate of language showed the opposite trend, first decreasing and then increasing. The trend of cognition and hearing was similar, fluctuating steadily and slightly. The prevalence differed after adjusting by gender, age, migrant background.

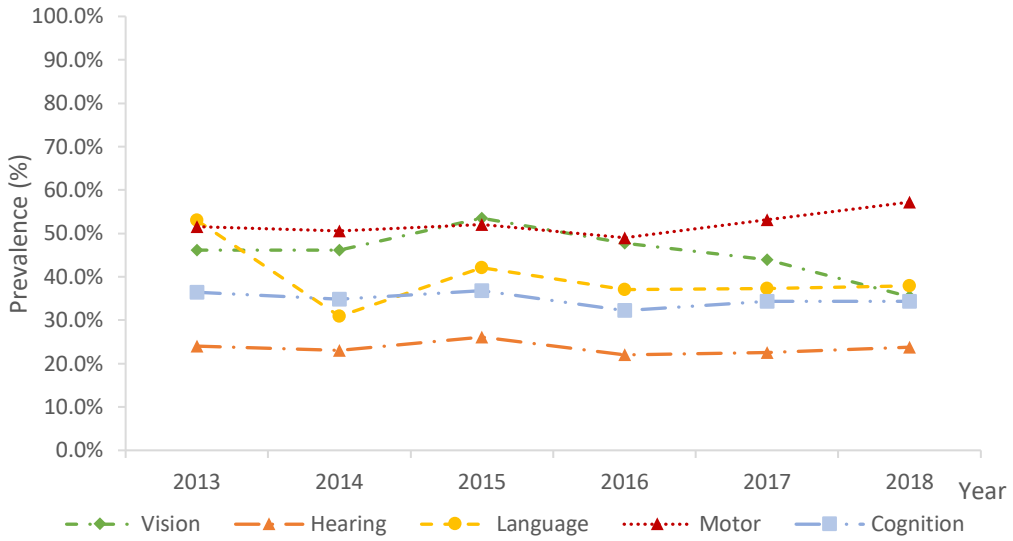


Figure 2 The unadjusted prevalence of developmental impairment (vision, hearing, language, motor, cognition) from 2013 to 2018

### 3.5.1 Trends of vision impairment

After adjusting by age, the trend of visual impairment fluctuated from 2013 to 2018, which was most significant among girls aged 4 years—increasing from 56.7% to 56.8% before decreasing to 47.1% during in 2018. Meanwhile, the prevalence of visual impairment among boys showed the similar trend of girls, which was highest among boys aged 4 years. After adjusting by gender, the prevalence among girls was higher than boys. After adjusting by migration background, for both of girls and boys, the prevalence of visual impairment among migrants was higher than that among non-migrant group but not significantly ($p$<0.001).

Table 10.Trends in the prevalence of visual impairment in female children, 2013 to 2018

| | No. (%) of Visual impairment | | | |
|---|---|---|---|---|
| | Total | Aged 4 years | Aged 5 years | Aged 6 years |
| **Total** | 7392 (45.9) | 1132 (56.7) | 5524 (45.7) | 736 (36.4) |
| 2013 | 1250 (46.3) | 198 (58.2) | 935 (46.1) | 117 (35.3) |
| 2014 | 1318 (47.5) | 187 (55.8) | 985 (47.5) | 146 (39.8) |
| 2015 | 1191 54.8) | 190 (63.8) | 881 (55.0) | 120 (43.8) |
| 2016 | 1334 (49.6) | 165 (63.7) | 1009 (50.2) | 160 (37.9) |
| 2017 | 1264 (44.4) | 183 (56.8) | 959 (44.3) | 122 (33.9) |
| 2018 | 1035 (35.5) | 209 (47.1) | 755 (34.2) | 71 (26.6) |
| **Non-migrant background** | | | | |
| 2013 | 628 (45.8) | 100 (58.5) | 478 (44.9) | 50 (36.5) |
| 2014 | 673 (46.7) | 104 (58.8) | 498 (45.9) | 71 (40.1) |
| 2015 | 555 (52.6) | 102 (61.1) | 403 (51.7) | 50 (45.5) |
| 2016 | 661 (47.9) | 83 (64.3) | 507 (48.1) | 71 (35.9) |
| 2017 | 626 (43.3) | 94 (55.0) | 479 (42.3) | 53 (37.1) |
| 2018 | 470 (31.7) | 97 (43.9) | 351 (31.0) | 22 (17.2) |
| **Migration background** | | | | |

| | | | | |
|---|---|---|---|---|
| 2013 | 622 (46.8) | 98 (58.0) | 457 (47.3) | 67 (34.5) |
| 2014 | 645 (48.3) | 83 (52.5) | 487(49.3) | 75 (39.5) |
| 2015 | 636 (56.9) | 88 (67.2) | 478 (58.2) | 70 (42.7) |
| 2016 | 673 (51.4) | 82 (63.1) | 502 (52.5) | 89 (39.7) |
| 2017 | 638 (45.6) | 89 (58.9) | 480 (46.6) | 69 (31.8) |
| 2018 | 565 (39.3) | 112 (50.2) | 404 (37.5) | 49 (35.3) |

Table 11.Trends in the prevalence of visual impairment in male children, 2013 to 2018

| | No. (%) of Visual impairment | | | |
|---|---|---|---|---|
| | Total | Aged 4 years | Aged 5 years | Aged 6 years |
| **Total** | 7673 (44.3) | 1122 (54.4) | 5760 (44.3) | 791 (35.2) |
| 2013 | 1363 (46.0) | 199 (54.5) | 1026 (46.2) | 138 (36.3) |
| 2014 | 1279 (45.0) | 170 (50.7) | 929 (44.4) | 180 (43.1) |
| 2015 | 1248 (52.3) | 201 (65.0) | 938 (52.6) | 109 (37.5) |
| 2016 | 1344 (46.0) | 160 (57.3) | 1041 (47.3) | 143 (32.4) |
| 2017 | 1353 (43.5) | 197 (60.4) | 1020 (42.9) | 136 (33.4) |
| 2018 | 1086 (35.3) | 195 (43.3) | 806 (34.7) | 85 (27.6) |
| **Non-migrant background** | | | | |
| 2013 | 701 (47.0) | 116 (56.3) | 528 (46.6) | 57 (37.5) |
| 2014 | 661 (45.2) | 102 (49.5) | 478 (44.8) | 81 (42.6) |
| 2015 | 584 (49.8) | 109 (61.2) | 438 (49.0) | 37 (36.6) |
| 2016 | 670 (43.9) | 83 (57.2) | 523 (44.7) | 64 (30.3) |
| 2017 | 637 (40.8) | 93 (58.5) | 497 (40.0) | 47 (29.2) |
| 2018 | 500 (31.6) | 90 (37.2) | 382 (32.1) | 28 (19.0) |
| **Migration background** | | | | |
| 2013 | 662 (44.9) | 83 (52.2) | 498 (45.8) | 81 (35.5) |
| 2014 | 618 (44.8) | 68 (52.7) | 451 (44.0) | 99 (43.4) |
| 2015 | 664 (54.8) | 92 (70.2) | 500 (56.1) | 72 (37.9) |
| 2016 | 674 (48.3) | 77 (57.5) | 518 (50.3) | 79 (34.2) |
| 2017 | 716 (46.3) | 104 (62.3) | 523 (46.1) | 89 (36.2) |
| 2018 | 586 (39.1) | 105 (50.5) | 424 (37.5) | 57 (35.4) |

### 3.5.2 Trends of hearing impairment

After adjusting by age, the trend of hearing impairment fluctuated from 2013 to 2018, which was most significant among girls and boys aged 4 years—fluctuated during six years among girls (from 34.7% to 27.5%) and boys (from 30.1% to 31.1%). After adjusting by gender, the prevalence among girls was higher than boys.

After adjusting by migration background, for both of girls and boys, the prevalence of visual impairment among migrants was higher than that among non-migrant group($p$<0.001).

Table 12.Trends in the prevalence of hearing impairment in female children, 2013 to 2018

| | No. (%) of Hearing impairment | | | |
|---|---|---|---|---|
| | Total | Aged 4 years | Aged 5 years | Aged 6 years |
| **Total** | 3883 (24.1) | 633 (31.7) | 2937 (24.3) | 313 (15.5) |
| 2013 | 654 (24.2) | 118 (34.7) | 483 (23.8) | 53 (16.0) |
| 2014 | 671 (24.2) | 110 (32.8) | 513 (24.7) | 48 (13.1) |
| 2015 | 597 (27.5) | 105 (35.2) | 444 (27.7) | 48 (17.5) |

| | | | | |
|---|---|---|---|---|
| 2016 | 642 (23.9) | 86 (33.2) | 487 (24.2) | 69 (16.4) |
| 2017 | 646 (22.7) | 92 (28.6) | 498 (23.0) | 56 (15.6) |
| 2018 | 673 (23.1) | 122 (27.5) | 512 (23.2) | 39 (14.6) |
| **Non-migrant background** | | | | |
| 2013 | 292 (21.3) | 51 (29.8) | 224 (21.1) | 17 (12.4) |
| 2014 | 316 (21.9) | 56 (31.6) | 241 (22.2) | 19 (10.7) |
| 2015 | 278 (26.3) | 60 (35.9) | 202 (25.9) | 16 (14.5) |
| 2016 | 275 (19.9) | 33 (25.6) | 217 (20.6) | 25 (12.6) |
| 2017 | 312 (21.6) | 48 (28.1) | 248 (21.9) | 16 (11.2) |
| 2018 | 297 (20.1) | 54 (24.4) | 231 (20.4) | 12 (9.4) |
| **Migration background** | | | | |
| 2013 | 622 (46.8) | 98 (58.0) | 457 (47.3) | 67 (34.5) |
| 2014 | 645 (48.3) | 83 (52.5) | 487 (49.3) | 75 (39.5) |
| 2015 | 636 (56.9) | 88 (67.2) | 478 (58.2) | 70 (42.7) |
| 2016 | 673 (51.4) | 82 (63.1) | 502 (52.5) | 89 (39.7) |
| 2017 | 638 (45.6) | 89 (58.9) | 480 (46.6) | 69 (31.8) |
| 2018 | 565 (39.3) | 112 (50.2) | 404 (37.5) | 49 (35.3) |

Table 13.Trends in the prevalence of hearing impairment in male children, 2013 to 2018

| | No. (%) of Hearing impairment | | | |
|---|---|---|---|---|
| | Total | Aged 4 years | Aged 5 years | Aged 6 years |
| **Total** | 3965 (22.9) | 625 (30.3) | 2997 (23.1) | 343 (15.3) |
| 2013 | 703 (23.7) | 110 (30.1) | 537 (24.2) | 56 (14.7) |
| 2014 | 622 (21.9) | 95 (28.4) | 462 (22.1) | 65 (15.6) |
| 2015 | 593 (24.9) | 100 (32.4) | 445 (24.9) | 48 (16.5) |
| 2016 | 592 (20.3) | 78 (28.0) | 448 (20.4) | 66 (14.9) |
| 2017 | 702 (22.6) | 102 (31.3) | 537 (22.6) | 63 (15.5) |
| 2018 | 753 (24.5) | 140 (31.1) | 568 (24.5) | 45 (14.6) |
| **Non-migrant background** | | | | |
| 2013 | 335 (22.5) | 67 (32.5) | 254 (22.4) | 14 (9.2) |
| 2014 | 299 (20.4) | 50 (24.3) | 224 (21.0) | 25 (13.2) |
| 2015 | 270 (23.0) | 50 (28.1) | 206 (23.1) | 14 (13.9) |
| 2016 | 267 (17.5) | 31 (21.4) | 209 (17.8) | 27 (12.8) |
| 2017 | 312 (20.0) | 49 (30.8) | 244 (19.6) | 19 (11.8) |
| 2018 | 347 (22.0) | 64 (26.4) | 270 (22.7) | 13 (8.8) |
| **Migration background** | | | | |
| 2013 | 662 (44.9) | 83 (52.2) | 498 (45.8) | 81 (35.5) |
| 2014 | 618 (44.8) | 68 (52.7) | 451 (44.0) | 99 (43.4) |
| 2015 | 664 (54.8) | 92 (70.2) | 500 (56.1) | 72 (37.9) |
| 2016 | 674 (48.3) | 77 (57.5) | 518 (50.3) | 79 (34.2) |
| 2017 | 716 (46.3) | 104 (62.3) | 523 (46.1) | 89 (36.2) |
| 2018 | 586 (39.1) | 105 (50.5) | 424 (37.5) | 57 (35.4) |

### 3.5.3 Trends of language impairment

After adjusting by age, the trend of language impairment fluctuated from 2013 to 2018, which was most significant among girls and boys aged 6 years—fluctuated during six years among girls (from 52.0% to 35.6%) and boys (from 46.6% to 44.2%). After adjusting by gender, the

prevalence among boys was higher than girls. After adjusting by migration background, for both of girls and boys, the prevalence of language impairment among migrants was higher than that among non-migrant group excepr for 2013 ($p$<0.001).

Table 14.Trends in the prevalence of language impairment in female children, 2013 to 2018

| | No. (%) of language impairment | | | |
|---|---|---|---|---|
| | Total | Aged 4 years | Aged 5 years | Aged 6 years |
| **Total** | 6103 (37.9) | 714 (35.7) | 4577 (37.9) | 812 (40.2) |
| 2013 | 1526 (56.5) | 174 (51.2) | 1180 (58.1) | 172 (52.0) |
| 2014 | 781 (28.1) | 113 (33.7) | 582 (28.1) | 86 (23.4) |
| 2015 | 868 (39.9) | 109 (36.6) | 630 (39.4) | 129 (47.1) |
| 2016 | 954 (35.5) | 100 (38.6) | 686 (34.1) | 168 (39.8) |
| 2017 | 985 (34.6) | 83 (25.8) | 740 (34.2) | 162 (45.0) |
| 2018 | 989 (33.9) | 135 (30.4) | 759 (34.4) | 95 (35.6) |
| **Non-migrant background** | | | | |
| 2013 | 929 (67.7) | 106 (62.0) | 730 (68.6) | 93 (67.9) |
| 2014 | 257 (17.8) | 45 (25.4) | 193 (17.8) | 19 (10.7) |
| 2015 | 264 (25.0) | 38 (22.8) | 194 (24.9) | 32 (29.1) |
| 2016 | 288 (20.9) | 30 (23.3) | 220 (20.9) | 38 (19.2) |
| 2017 | 304 (21.0) | 17 (9.9) | 254 (22.4) | 33 (23.1) |
| 2018 | 314 (21.2) | 33 (14.9) | 262 (23.1) | 19 (14.8) |
| **Migration background** | | | | |
| 2013 | 597 (44.9) | 68 (40.2) | 450 (46.6) | 79 (40.7) |
| 2014 | 524 (39.3) | 68 (43.0) | 389 (39.4) | 67 (35.3) |
| 2015 | 604 (54.1) | 71 (54.2) | 436 (53.0) | 97 (59.1) |
| 2016 | 666 (50.8) | 70 (53.8) | 466 (48.7) | 130 (58.0) |
| 2017 | 681 (48.7) | 66 (43.7) | 486 (47.2) | 129 (59.4) |
| 2018 | 675 (46.9) | 102 (45.7) | 497 (46.2) | 76 (54.7) |

Table 15.Trends in the prevalence of language impairment in male children, 2013 to 2018

| | No. (%) of Language impairment | | | |
|---|---|---|---|---|
| | Total | Aged 4 years | Aged 5 years | Aged 6 years |
| **Total** | 7128 (41.2) | 798 (38.7) | 5347 (41.1) | 983 (43.8) |
| 2013 | 1474 (49.7) | 157 (43.0) | 1140 (51.4) | 177 (46.6) |
| 2014 | 957 (33.6) | 126 (37.6) | 709 (33.9) | 122 (29.2) |
| 2015 | 1051 (44.1) | 123 (39.8) | 778 (43.6) | 150 (51.5) |
| 2016 | 1121 (38.4) | 113 (40.5) | 817 (37.1) | 191 (43.2) |
| 2017 | 1238 (39.8) | 116 (35.6) | 915 (38.5) | 207 (50.9) |
| 2018 | 1287 (41.8) | 163 (36.2) | 988 (42.6) | 136 (44.2) |
| **Non-migrant background** | | | | |
| 2013 | 893 (59.9) | 109 (52.9) | 692 (61.1) | 92 (60.5) |
| 2014 | 341 (23.3) | 57 (27.7) | 252 (23.6) | 32 (16.8) |
| 2015 | 352 (30.0) | 50 (28.1) | 277 (31.0) | 25 (24.8) |
| 2016 | 403 (26.4) | 36 (24.8) | 309 (26.4) | 58 (27.5) |
| 2017 | 435 (27.8) | 35 (22.0) | 344 (27.7) | 56 (34.8) |
| 2018 | 431 (27.3) | 50 (20.7) | 346 (29.1) | 35 (23.8) |
| **Migration background** | | | | |
| 2013 | 581 (39.4) | 48 (30.2) | 448 (41.2) | 85 (37.3) |
| 2014 | 616 (44.6) | 69 (53.5) | 457 (44.6) | 90 (39.5) |

| | | | | |
|---|---|---|---|---|
| 2015 | 699 (57.7) | 73 (55.7) | 501 (56.2) | 125 (65.8) |
| 2016 | 718 (51.5) | 77 (57.5) | 508 (49.3) | 133 (57.6) |
| 2017 | 803 (51.9) | 81 (48.5) | 571 (50.3) | 151 (61.4) |
| 2018 | 856 (57.1) | 113 (54.3) | 642 (56.8) | 101 (62.7) |

### 3.5.4 Trends of motor impairment

After adjusting by age, the trend of motor impairment increased from 2013 to 2018, which was most significant among girls and boys aged 4 years—fluctuated during six years among girls (from 60.0% to 50.2%) and boys (from 84.9% to71.1%). After adjusting by gender, the prevalence among boys was higher than girls. After adjusting by migration background, for both of girls and boys, the prevalence of motor impairment among migrants was higher than that among non-migrant group except for 2018 ($p$<0.001).

Table 16.Trends in the prevalence of motor impairment in female children, 2013 to 2018

| | No. (%) of motor impairment | | | |
|---|---|---|---|---|
| | Total | Aged 4 years | Aged 5 years | Aged 6 years |
| **Total** | 6670 (41.4) | 1013 (50.7) | 4942 (40.9) | 715 (35.4) |
| 2013 | 1045 (38.7) | 204 (60.0) | 752 (37.0) | 89 (26.9) |
| 2014 | 1065 (38.4) | 185 (55.2) | 769 (37.1) | 111 (30.2) |
| 2015 | 851 (39.2) | 151 (50.7) | 616 (38.5) | 84 (30.7) |
| 2016 | 1027 (38.2) | 110 (42.5) | 761 (37.9) | 156 (37.0) |
| 2017 | 1258 (44.2) | 140 (43.5) | 972 (44.9) | 146 (40.6) |
| 2018 | 1424 (48.8) | 223 (50.2) | 1072 (48.6) | 129 (48.3) |
| **Non-migrant background** | | | | |
| 2013 | 496 (36.2) | 101 (59.1) | 359 (33.7) | 36 (26.3) |
| 2014 | 497 (34.5) | 84 (47.5) | 369 (34.0) | 44 (24.9) |
| 2015 | 372 (35.2) | 74 (44.3) | 267 (34.3) | 31 (28.2) |
| 2016 | 491 (35.6) | 46 (35.7) | 379 (36.0) | 66 (33.3) |
| 2017 | 606 (41.9) | 62 (36.3) | 491 (43.3) | 53 (37.1) |
| 2018 | 734 (49.6) | 109 (45.9) | 559 (49.4) | 66 (51.6) |
| **Migration background** | | | | |
| 2013 | 549 (41.3) | 103 (60.9) | 393 (40.7) | 53 (27.3) |
| 2014 | 568 (42.5) | 101 (63.9) | 400 (40.5) | 67 (35.3) |
| 2015 | 479 (42.9) | 77 (58.8) | 349 (42.5) | 53 (32.3) |
| 2016 | 536 (40.9) | 64 (49.2) | 382 (40.0) | 90 (40.2) |
| 2017 | 652 (46.6) | 78 (51.7) | 481 (46.7) | 93 (42.9) |
| 2018 | 690 (48.0) | 114 (51.1) | 513 (47.7) | 63 (45.3) |

Table 17.Trends in the prevalence of motor impairment in male children, 2013 to 2018

| | No. (%) of motor impairment | | | |
|---|---|---|---|---|
| | Total | Aged 4 years | Aged 5 years | Aged 6 years |
| **Total** | 10803 (62.4) | 1578 (76.5) | 8049 (61.9) | 1176 (52.4) |
| 2013 | 1874 (63.2) | 310 (84.9) | 1385 (62.4) | 179 (47.1) |
| 2014 | 1776 (62.4) | 262 (78.2) | 1281 (61.3) | 233 (55.7) |
| 2015 | 1519 (63.7) | 246 (79.6) | 1131 (63.4) | 142 (48.8) |

| | | | | |
|---|---|---|---|---|
| 2016 | 1724 (59.0) | 207 (74.2) | 1291 (58.7) | 226 (51.1) |
| 2017 | 1904 (61.2) | 233 (71.5) | 1447 (60.8) | 224 (55.0) |
| 2018 | 2006 (65.2) | 320 (71.1) | 1514 (65.2) | 172 (55.8) |
| **Non-migrant background** | | | | |
| 2013 | 942 (63.2) | 172 (83.5) | 705 (62.3) | 65 (42.8) |
| 2014 | 897 (61.3) | 158 (76.7) | 639 (59.9) | 100 (52.6) |
| 2015 | 725 (61.9) | 137 (77.0) | 541 (60.6) | 47 (46.5) |
| 2016 | 851 (55.7) | 101 (69.7) | 642 (54.8) | 108 (51.2) |
| 2017 | 921 (58.9) | 113 (71.1) | 722 (58.1) | 86 (53.4) |
| 2018 | 1022 (64.8) | 174 (71.9) | 780 (65.5) | 68 (46.3) |
| **Migration background** | | | | |
| 2013 | 932 (63.2) | 138 (86.8) | 680 (62.6) | 114 (50.0) |
| 2014 | 879 (63.6) | 104 (80.6) | 642 (62.7) | 133 (58.3) |
| 2015 | 794 (65.5) | 109 (83.2) | 590 (66.2) | 95 (50.0) |
| 2016 | 873 (62.6) | 106 (79.1) | 649 (63.0) | 118 (51.1) |
| 2017 | 983 (63.5) | 120 (71.9) | 725 (63.9) | 138 (56.1) |
| 2018 | 984 (65.6) | 146 (70.2) | 734 (65.0) | 104 (64.6) |

### 3.5.5 Trends of cognition impairment

After adjusting by gender, the trend of cognition impairment fluctuated from 2013 to 2018, which was most significant among girls and boys aged 4 years—fluctuated during six years among girls (from 39.7% to 39.4%) and boys (from 64.1% to 56.2%).

After adjusting by migration background, for both of girls and boys, the prevalence of cognition impairment among migrants was higher than that among non-migrant group($p$<0.001).

Table 18.Trends in the prevalence of cognition impairment in female children, 2013 to 2018

| | No. (%) of cognition impairment | | | |
|---|---|---|---|---|
| | Total | Aged 4 years | Aged 5 years | Aged 6 years |
| **Total** | 4536 (28.2) | 779 (39.0) | 3315 (27.4) | 442 (21.9) |
| 2013 | 756 (28.0) | 135 (39.7) | 548 (27.0) | 73 (22.1) |
| 2014 | 770 (27.7) | 136 (40.6) | 558 (26.9) | 76 (20.7) |
| 2015 | 658 (30.3) | 123 (41.3) | 479 (29.9) | 56 (20.4) |
| 2016 | 717 (26.7) | 95 (36.7) | 519 (25.8) | 103 (24.4) |
| 2017 | 820 (28.8) | 115 (35.7) | 622 (28.8) | 83 (23.1) |
| 2018 | 815 (27.9) | 175 (39.4) | 589 (26.7) | 51 (19.1) |
| **Non-migrant background** | | | | |
| 2013 | 336 (24.5) | 58 (33.9) | 244 (22.9) | 34 (24.8) |
| 2014 | 358 (24.9) | 64 (36.2) | 262 (24.1) | 32 (18.1) |
| 2015 | 265 (25.1) | 60 (35.9) | 186 (23.9) | 19 (17.3) |
| 2016 | 322 (23.3) | 40 (31.0) | 241 (22.9) | 41 (20.7) |
| 2017 | 344 (23.8) | 48 (28.1) | 269 (23.7) | 27 (18.9) |
| 2018 | 347 (23.4) | 67 (30.3) | 258 (22.8) | 22 (17.2) |
| **Migration background** | | | | |
| 2013 | 420 (31.6) | 77 (45.6) | 304 (31.5) | 39 (20.1) |
| 2014 | 412 (30.9) | 72 (45.6) | 296 (30.0) | 44 (23.2) |
| 2015 | 393 (35.2) | 63 (48.1) | 293 (35.6) | 37 (22.6) |
| 2016 | 395 (30.2) | 55 (42.3) | 278 (29.1) | 62 (27.7) |
| 2017 | 476 (34.0) | 67 (44.4) | 353 (34.3) | 56 (25.8) |

| | | | | |
|---|---|---|---|---|
| 2018 | 468 (32.5) | 108 (48.4) | 331 (30.8) | 29 (20.9) |

Table 19.Trends in the prevalence of cognition impairment in male children, 2013 to 2018

| | No. (%) of cognition impairment | | | |
|---|---|---|---|---|
| | Total | Aged 4 years | Aged 5 years | Aged 6 years |
| **Total** | 7067 (40.8) | 1180 (57.2) | 5128 (39.5) | 759 (33.8) |
| 2013 | 1305 (44.0) | 234 (64.1) | 942 (42.5) | 129 (33.9) |
| 2014 | 1184 (41.6) | 185 (55.2) | 848 (40.6) | 151 (36.1) |
| 2015 | 1018 (42.7) | 192 (62.1) | 731 (41.0) | 95 (32.6) |
| 2016 | 1089 (37.3) | 154 (55.2) | 796 (36.2) | 139 (31.4) |
| 2017 | 1231 (39.6) | 162 (49.7) | 919 (38.6) | 150 (36.9) |
| 2018 | 1240 (40.3) | 253 (56.2) | 892 (38.4) | 95 (30.8) |
| **Non-migrant background** | | | | |
| 2013 | 619 (41.5) | 131 (63.6) | 444 (39.2) | 44 (28.9) |
| 2014 | 583 (39.8) | 111 (53.9) | 406 (38.1) | 66 (34.7) |
| 2015 | 471 (40.2) | 102 (57.3) | 340 (38.1) | 29 (28.7) |
| 2016 | 511 (33.5) | 69 (47.6) | 382 (32.6) | 60 (28.4) |
| 2017 | 541 (34.6) | 75 (47.2) | 416 (33.5) | 50 (31.1) |
| 2018 | 574 (36.3) | 127 (52.5) | 414 (34.8) | 33 (22.4) |
| **Migration background** | | | | |
| 2013 | 686 (46.5) | 103 (64.8) | 498 (45.8) | 85 (37.3) |
| 2014 | 601 (43.5) | 74 (57.4) | 442 (43.2) | 85 (37.3) |
| 2015 | 547 (45.1) | 90 (68.7) | 391 (43.9) | 66 (34.7) |
| 2016 | 578 (41.4) | 85 (63.4) | 414 (40.2) | 79 (34.2) |
| 2017 | 690 (44.6) | 87 (52.1) | 503 (44.3) | 100 (40.7) |
| 2018 | 666 (44.4) | 126 (60.6) | 478 (42.3) | 62 (38.5) |

## 3.6 Association between BMI and Visual impairment

This part includes basiline description, univariate logistic regression and multiple logistic regression analysis to explore the association between BMI and visual impairment.

### 3.6.1 Baseline characteristics of preschool children by BMI categories

A total of 33,407 children aged 4 to 6 years old were enrolled in the survey from 2013 to 2018, including 17,304 boys and 16,103 girls. Table 20 reports descriptive statistics of the demographic characteristics of participants. The prevalence of children with visual impairment was 44.2% among those with normal body weight, 48.0% among those who were overweight, and 52.7% among those who were obese. The percentages of children falling into different categories of age, gender, survey year, migration background, social-economic status of parents, visual impairment, hearing impairment, motor impairment, langage impairment, cognition

impairment, screen time and quality of preschool outdoor environment were significantly different across BMI groups.

Table 20. Baseline characteristics of preschool children by BMI categories

| | Normal | Overweight | Obesity | Underweight | *p* Value [a] |
|---|---|---|---|---|---|
| | n=26977 | n=4595 | n=1478 | n=357 | |
| **Survey year** | | | | | <0.001 |
| 2013 | 4671 (17.3%) | 689 (15.0%) | 218 (14.8%) | 87 (24.4%) | |
| 2014 | 4601 (17.1%) | 721 (15.7%) | 235 (15.9%) | 62 (17.4%) | |
| 2015 | 3664 (13.6%) | 629 (13.7%) | 220 (14.9%) | 44 (12.3%) | |
| 2016 | 4522 (16.8%) | 774 (16.8%) | 261 (17.7%) | 55 (15.4%) | |
| 2017 | 4756 (17.6%) | 902 (19.6%) | 245 (16.5%) | 53 (14.8%) | |
| 2018 | 4763 (17.6%) | 880 (19.2%) | 299 (20.2%) | 56 (15.7%) | |
| **Gender** | | | | | <0.001 |
| Boys | 13701 (50.8%) | 2551 (55.5%) | 870 (58.9%) | 182 (51.0%) | |
| Girls | 13276 (49.2%) | 2044 (44.5%) | 608 (41.1%) | 175(49.0%) | |
| **Age** | | | | | <0.001 |
| 4 years | 3260 (12.1%) | 610 (13.3%) | 160 (10.8%) | 32 (9.0%) | |
| 5 years | 20364 (75.5%) | 3384 (73.6%) | 1062 (71.9%) | 268 (75.1%) | |
| 6 years | 3353 (12.4%) | 601 (13.1%) | 256 (17.3%) | 57 (16.0%) | |
| **Migration background** | | | | | <0.001 |
| Non-migrant | 14136 (52.4%) | 2101 (45.7%) | 537 (36.3%) | 197 (55.2%) | |
| Migrant | 12841 (47.6%) | 2494 (54.3%) | 941 (63.7%) | 160 (44.8%) | |
| **Vision impairment** | | | | | 0.036 |
| No | 16288 (55.0%) | 1402 (55.5%) | 465 (50.5%) | 187 (52.4%) | |
| Yes | 13317 (45.0%) | 1123 (44.5%) | 455 (49.5%) | 170 (47.6%) | |
| **Heaing impairment** | | | | | 0.202 |
| No | 22261(76.5%) | 1950 (77.2%) | 686 (74.6%) | 262 (73.4%) | |
| Yes | 6944 (23.5%) | 575 (2.8%) | 234 (25.4%) | 95 (26.6%) | |
| **Motor impairment** | | | | | <0.001 |
| Yes | 14432 (48.7%) | 1075 (42.6%) | 275 (29.9%) | 152 (42.6%) | |
| No | 15173 (51.3%) | 1450 (57.4%) | 645 (70.1%) | 205 (57.4%) | |
| **Language impairment** | | | | | <0.001 |
| Yes | 18237 (61.6%) | 1348 (53.4%) | 373 (40.5%) | 218 (61.1%) | |
| No | 11368 (38.4%) | 1177 (46.6%) | 547 (59.5%) | 139 (38.9%) | |
| **Cognition impairment** | | | | | <0.001 |
| Yes | 19593 (66.2%) | 1517 (60.1%) | 460 (50.0%) | 234 (65.5%) | |
| No | 10012 (33.8%) | 1008 (39.9%) | 460 (50.0%) | 123 (34.5%) | |
| **Father's education level** | | | | | <0.001 |
| Low | 3866 (14.3%) | 905 (19.7%) | 409 (27.7%) | 61 (17.1%) | |
| Middle | 4722 (17.5%) | 903 (19.7%) | 301 (20.4%) | 69 (19.3%) | |
| High | 13058 (48.4%) | 1822 (39.7%) | 385 (26.0%) | 152 (42.6%) | |
| Missing value | 5331 (19.8%) | 965 (21.0%) | 383 (25.9%) | 75 (21.0%) | |
| **Mother's education level** | | | | | <0.001 |
| Low | 3158 (11.7%) | 744 (16.2%) | 414 (28.0%) | 49 (13.7%) | |
| Middle | 6691 (24.8%) | 1207 (26.3%) | 419 (28.3%) | 92 (25.8%) | |
| High | 12842 (47.6%) | 1892 (41.2%) | 369 (25.0%) | 157 (44.0%) | |
| Missing value | 4286 (15.9%) | 752 (16.4%) | 276 (18.7%) | 59 (16.5%) | |
| **Father occupation type** | | | | | <0.001 |
| Fulltime | 9275 (34.4%) | 1407 (30.6%) | 417 (28.2%) | 138 (38.7%) | |
| Part-time | 430 (1.6%) | 75 (1.6%) | 29 (2.0%) | 7 (2.0%) | |
| Unemployment | 356 (1.3%) | 86 (1.9%) | 37 (2.5%) | 4 (1.1%) | |
| Missing value | 16916 (62.7%) | 3027 (65.9%) | 995 (67.3%) | 208 (58.3%) | |
| **Mother occupation type** | | | | | <0.001 |
| Fulltime | 1347 (5.0%) | 223 (4.9%) | 417 (28.2%) | 138 (38.7%) | |

| | | | | | |
|---|---|---|---|---|---|
| Part-time | 6082 (22.5%) | 919 (20.0%) | 29 (2.0%) | 7 (2.0%) | |
| Unemployment | 2914 (10.8%) | 480 (10.4%) | 37 (2.5%) | 4 (1.1%) | |
| Missing value | 16634 (61.7%) | 3027 (65.9%) | 995 (67.3%) | 208 (58.3%) | |
| **Screen time at weekend** | | | | | <0.001 |
| Never | 866 (3.5%) | 126 (3.1%) | 28 (2.2%) | 13 (3.9%) | |
| ≤30mins/day | 5559 (22.6%) | 775 (18.8%) | 158 (12.1%) | 67 (20.3%) | |
| 1~2hour/day | 6586 (26.7%) | 1284 (31.2%) | 437 (33.6%) | 88 (26.7%) | |
| ≥3hour/day | 941 (3.8%) | 221 (5.3%) | 122 (9.4%) | 9 (2.7%) | |
| Missing value | 10686 (43.4%) | 1707 (41.5%) | 556 (42.7%) | 153 (46.4%) | |
| **Screen time at weekday** | | | | | <0.001 |
| Never | 2570 (10.4%) | 328 (8.0%) | 54 (4.1%) | 28 (8.5%) | |
| ≤30mins/day | 7921 (32.1%) | 1286 (31.3%) | 338 (25.9%) | 96 (29.2%) | |
| 1~2hour/day | 3848 (15.6%) | 868 (21.1%) | 388 (29.8%) | 52 (15.8%) | |
| ≥3hour/day | 285(1.2%) | 93 (2.2%) | 52 (3.9%) | 3 (0.9%) | |
| Missing value | 10029(40.7%) | 1540(37.4%) | 471(36.2%) | 150(45.6%) | |
| **TV in room** | | | | | <0.001 |
| Yes | 612 (2.5%) | 158 (3.9%) | 81 (6.2%) | 7 (2.1%) | |
| No | 13985 (56.8%) | 2401 (58.5%) | 710 (54.8%) | 169 (51.4%) | |
| Missing value | 10022(40.7%) | 1544(37.6%) | 505(38.9%) | 153(40.5%) | |
| **Quality of outdoor environment** | | | | | |
| Good | 3197 (10.8%) | 238 (9.4%) | 79 (8.6%) | 45 (12.6%) | 0.017 |
| Bad | 26408 (89.2%) | 2287 (90.6%) | 841 (91.4%) | 312 (87.4%) | |

[a] *p* values for overall differences in prevalence by stratification.

### 3.6.2 Univariate logistic regression analysis between each independent variables and vision impairment outcome

Table 21 reports the univariable results of the analysis. Except for parental occupation, mother's education, and preschool quality of outdoor environment, all independent variables were significant in the univariate logistic regression model. Additionally, the interaction between BMI category and migration background was significant ($p$=0.02) after adjusting for age, gender, survey year, parental education and occupation, weekday and weekend screen time, whether there was a TV in the child's bedroom, and quality of preschool outdoor environment in the logistic regression model.

Table 21. Univariate logistic regressions exploring the association between each variable and visual impairment

| | Visual impairment | |
|---|---|---|
| | OR (99% CI) [a] | Adjusted OR (99% CI) [b] |
| **Survey year** [c] | 0.92 (0.91, 0.94) | 0.59 (0.37, 0.93) |
| **Gender** | | |
| Boys | Ref | Ref |
| Girls | 1.06 (1.01, 1.12) | 1.15 (0.96,1.39) |
| **Age** | | |
| 4 years | Ref | Ref |

| | | |
|---|---|---|
| 5 years | 0.65 (0.60, 0.71) | 0.52 (0.35, 0.75) |
| 6 years | 0.44 (0.39, 0.50) | 0.30 (0.19,0.48) |
| **Migration background** | | |
| Non-migrant | Ref | Ref |
| Migrant | 1.14 (1.08, 1.21) | 1.00 (0.81,1.24) |
| **BMI categories** | | |
| Normal | Ref | Ref |
| Overweight | 1.16 (1.07, 1.26) | 0.57 (0.33, 1.06) |
| Obesity | 1.40 (1.22, 1.61) | 0.49 (0.20, 1.12) |
| Underweight | 1.14 (0.87, 1.51) | 1.07 (0.44, 2.62) |
| **Father's education** | | |
| Low | Ref | Ref |
| Middle | 0.77 (0.70, 0.85) | 1.00 (0.73, 1.34) |
| High | 0.60 (0.55, 0.65) | 0.79 (0.59,1.05) |
| Missing value | | |
| **Mother's education** | | |
| Low | Ref | Ref |
| Middle | 0.86 (0.69, 1.09) | 0.57 (0.40, 0.79) |
| High | 1.18 (0.93, 1.50) | 0.53 (0.37,0.76) |
| Missing value | | |
| **Father occupation** | | |
| Fulltime | Ref | Ref |
| Part-time | 0.86 (0.69, 1.09) | 0.88 (0.57,1.35) |
| Unemployment | 1.18 (0.93, 1.50) | 0.77 (0.47,1.24) |
| Missing value | | |
| **Mother occupation** | | |
| Fulltime | Ref | Ref |
| Part-time | 0.99 (0.86, 1.14) | 0.87 (0.65,1.15) |
| Unemployment | 1.17 (1.00, 1.36) | 0.82 (0.59,1.13) |
| Missing value | | |
| **Screen time at weekend** | | |
| Never | Ref | Ref |
| ≤30mins/day | 0.93 (0.78, 1.11) | 0.73 (0.49,1.08) |
| 1~2hour/day | 1.13 (0.95, 1.34) | 0.79 (0.52,1.20) |
| ≥3hour/day | 1.54 (1.24, 1.91) | 1.03 (0.55,1.91) |
| Missing value | | |
| **Screen time at weekday** | | |
| Never | Ref | Ref |
| ≤30mins/day | 1.17 (1.05, 1.31) | 1.18 (0.90, 1.53) |

| | | |
|---|---|---|
| 1~2hour/day | 1.48 (1.31, 1.67) | 1.07 (0.76,1.52) |
| ≥3hour/day | 1.88 (1.44, 2.46) | 1.14 (0.49,2.68) |
| Missing value | | |
| **TV in children's room** | | |
| Yes | Ref | Ref |
| No | 0.72 (0.60, 0.87) | 1.33 (0.86,2.06) |
| Missing value | | |
| **Quality of outdoor environment** | | |
| Good | Ref | Ref |
| Bad | 1.02 (0.95,1.10) | 1.17 (0.87,1.56) |
| **Migration background*BMI categories** | | |
| Migration background* Normal weight | Ref | Ref |
| Migration background* Overweight | 1.24 (1.05,1.47) | 2.53 (1.21,5.35) |
| Migration background* Obesity | 1.18 (0.89,1.56) | 2.43 (0.76,8.05) |
| Migration background* Underweight | 0.88 (0.57,1.34) | 0.82 (0.08,8.41) |

[a] 99% Confidence Interval (CI) of Odds ratio Univariate logistic regression analysis;
[b] 99% Confidence Interval (CI) of Odds ratio adjusted by survey year, age, gender, migration background, father education, mother education, father occupation, mother occupation, screen time at weekday and weekend, TV in children's room, and quality of outdoor environment in the logistic regression model.
[c] Survey year as discrete variable including year from 2013 to 2018;

### 3.6.3 Multiple logistic regression analysis between BMI and Vision impairment outcome

Table 22 summarizes the association between BMI category and visual impairment. In multiple imputation analysis, our results showed obesity was associated with visual impairment [OR=1.20, 99% CI (1.02,1.42)] among children with an migration background in all models. After adding quality of outdoor environment in kindergarten as a variable in model III, the association was still significant, although less strong than in model II.

Table 22. The association between BMI category and visual impairment with estimates for the general population using multiple imputation

| Multiple imputation | Unadjusted Model [a] | Model I [b] | Model II [c] | Model III[d] |
|---|---|---|---|---|
| | OR (99% CI) | OR (99% CI) | OR (99% CI) | OR (99% CI) |
| Normal | Ref | Ref | Ref | Ref |
| Overweight | 1.16 (1.07, 1.26) | 1.17 (1.07, 1.27) | 1.17 (1.07, 1.27) | 0.97 (0.89, 1.05) |
| Obesity | 1.40 (1.22, 1.61) | 1.44 (1.25, 1.65) | 1.44 (1.25, 1.65) | 1.11 (0.97 1.27) |
| Underweight | 1.14 (0.87, 1.51) | 1.16 (0.88, 1.53) | 1.16 (0.88, 1.53) | 1.09 (0.88, 1.35) |
| German background | | | | |
| Normal | Ref | Ref | Ref | Ref |
| Overweight | 1.25 (0.93, 1.18) | 1.25(0.94, 1.20) | 1.01(0.89, 1.14) | 0.85 (0.75,1.01) |
| Obesity | 1.39 (1.09, 1.72) | 1.39(1.14, 1.80) | 1.18(0.94, 1.50) | 0.96 (0.76, 1.21) |
| Underweight | 1.08 (0.83, 1.75) | 1.08(0.81, 1.72) | 1.16(0.79, 1.69) | 1.13 (0.85, 1.51) |
| Migration background | | | | |
| Normal | Ref | Ref | Ref | Ref |
| Overweight | 1.25 (1.12, 1.40) | 1.26 (1.13, 1.42) | 1.20 (1.07, 1.35) | 1.06 (0.95, 1.19) |
| Obesity | 1.39 (1.17, 1.66) | 1.45 (1.22, 1.73) | 1.25 (1.05, 1.50) | 1.20 (1.02, 1.42) |

| | | | | |
|---|---|---|---|---|
| Underweight | 1.08 (0.71, 1.63) | 1.12 (0.74, 1.70) | 1.08 (0.71, 1.65) | 1.030.75, 1.42) |

[a] Unadjusted logistic regression results;
[b] Adjusted for survey year, age, gender, migration background;
[c] Adjusted for survey year, age, gender, migration background, father's education, mother's education, father's occupation, mother's occupation, TV in children's room, screen time at weekday, screen time at weekend;
[d] Adjusted for survey year, age, gender, migration background, father's education, mother's education, father's occupation, mother's occupation, TV in children's room, screen time at weekday, screen time at weekend, and quality of outdoor environment.

## 3.7 Association between BMI and Hearing impairment

This part includes univariate logistic regression and multiple logistic regression results to explore the association between BMI and hearing impairment.

### 3.7.1 Univariate logistic regression analysis between each independent variables and hearing impairment outcome

Table 23 reports the univariable results of the analysis. Except for survey year, BMI categories, interaction between migration background and BMI categories, all variables were significant in the univariate logistic regression model. Additionally, age was significant after adjusting for age, gender, survey year, parental education and occupation, weekday and weekend screen time, whether there was a TV in the child's bedroom, and quality of preschool outdoor environment in the logistic regression model.

Table 23. Univariate logistic regressions exploring the association between each variable and hearing impairment

| | Hearing impairment | |
|---|---|---|
| | OR (99% CI) [a] | Adjusted OR (99% CI) [b] |
| **Survey year [c]** | 0.99 (0.97, 1.00) | 0.83 (0.39, 1.86) |
| **Gender** | | |
| Boys | Ref | Ref |
| Girls | 1.06 (1.01, 1.12) | 1.10 (0.83,1.46) |
| **Age** | | |
| 4 years | Ref | Ref |
| 5 years | 0.69 (0.64, 0.74) | 0.67 (0.41,1.11) |
| 6 years | 0.40 (0.36, 0.45) | 0.29 (0.13,0.61) |
| **Migration background** | | |
| Non-migrant | Ref | Ref |
| Migrant | 1.29 (1.23, 1.36) | 0.95 (0.68,1.31) |
| **BMI categories** | | |
| Normal | Ref | Ref |

| | | |
|---|---|---|
| Overweight | 0.96 (0.87, 1.05) | 0.71 (0.26, 1.63) |
| Obesity | 1.11(0.95, 1.29) | 0.27 (0.01, 1.36) |
| Underweight | 1.18 (0.93, 1.49) | 1.79 (0.47, 5.82) |
| **Father's education** | | |
| Low | Ref | Ref |
| Middle | 0.80 (0.73, 0.87) | 0.92 (0.59, 1.45) |
| High | 0.64 (0.60, 0.69) | 0.87 (0.56,1.35) |
| Missing value | | |
| **Mother's education** | | |
| Low | Ref | Ref |
| Middle | 0.76 (0.70, 0.83) | 0.75 (0.46, 1.22) |
| High | 0.61 (0.56, 0.66) | 0.83 (0.50,1.38) |
| Missing value | | |
| **Father occupation** | | |
| Fulltime | Ref | Ref |
| Part-time | 0.98 (0.79, 1.20) | 1.00 (0.49,1.88) |
| Unemployment | 1.44 (1.18, 1.76) | 1.62 (0.83,3.10) |
| Missing value | | |
| **Mother occupation** | | |
| Fulltime | Ref | Ref |
| Part-time | 0.87 (0.77, 0.98) | 0.98 (0.63,1.55) |
| Unemployment | 1.11 (0.97, 1.27) | 1.17 (0.72,1.94) |
| Missing value | | |
| **Screen time at weekend** | | |
| Never | Ref | Ref |
| ≤30mins/day | 0.97 (0.83, 1.15) | 0.89 (0.48,1.68) |
| 1~2hour/day | 1.14 (0.97, 1.34) | 0.95 (0.51,1.86) |
| ≥3hour/day | 1.56 (1.29, 1.90) | 0.88 (0.34,2.26) |
| Missing value | | |
| **Screen time at weekday** | | |
| Never | Ref | Ref |
| ≤30mins/day | 1.12 (1.01, 1.24) | 1.24 (0.81, 1.94) |
| 1~2hour/day | 1.34 (1.20, 1.50) | 126 (0.73, 2.18) |
| ≥3hour/day | 1.60 (1.27, 2.01) | 1.73 (0.50, 5.72) |
| Missing value | | |
| **TV in children's room** | | |
| Yes | Ref | Ref |
| No | 0.70 (0.60, 0.81) | 0.99 (0.53,1.95) |
| Missing value | | |

| | | |
|---|---|---|
| **Quality of outdoor environment** | | |
| Good | Ref | Ref |
| Bad | 0.91 (0.84,0.99) | 0.83 (0.58,1.44) |
| **Migration background*BMI categories** | | |
| Migration background* Normal weight | Ref | Ref |
| Migration background* Overweight | 1.20 (0.98,1.47) | 1.33 (0.40,4.57) |
| Migration background* Obesity | 1.25 (0.90,1.75) | 2.99 (0.35,51.66) |
| Migration background* Underweight | 0.71 (0.44,1.14) | 1.56 (0.06,37.63) |

[a] 99% Confidence Interval (CI) of Odds ratio Univariate logistic regression analysis;
[b] 99% Confidence Interval (CI) of Odds ratio adjusted by survey year, age, gender, migration background, father education, mother education, father occupation, mother occupation, screen time at weekday and weekend, TV in children's room, and quality of outdoor environment in the logistic regression model.
[c] Survey year as discrete variable including year from 2013 to 2018;

### 3.7.2 Multiple logistic regression analysis between BMI and Hearing impairment outcome

Table 24 summarizes the association between BMI category and hearing impairment. In multiple imputation analysis, our results showed overweight and obesity was not associated with hearing impairment among children in all models. After adding quality of outdoor environment in kindergarten as a variable in model III, the association was still not significant.

Table 24. The association between BMI category and hearing impairment with estimates for the general population using multiple imputation

| Multiple imputation | Unadjusted Model [a] | Model I [b] | Model II [c] | Model III[d] |
|---|---|---|---|---|
| | OR (99% CI) | OR (99% CI) | OR (99% CI) | OR (99% CI) |
| Normal | Ref | Ref | Ref | Ref |
| Overweight | 0.96 (0.84, 1.09) | 1.03 (0.90, 1.17) | 0.96 (0.84, 1.09) | 0.96 (0.84, 1.09) |
| Obesity | 1.11 (0.91, 1.35) | 1.20 (0.98, 1.47) | 1.05 (0.85, 1.29) | 1.05 (0.85, 1.28) |
| Underweight | 1.18 (0.86, 1.60) | 1.24 (0.90, 1.68) | 1.21 (0.88, 1.65) | 1.21 (0.88, 1.65) |

[a] Unadjusted logistic regression results;
[b] Adjusted for survey year, age, gender, migration background;
[c] Adjusted for survey year, age, gender, migration background, father's education, mother's education, father's occupation, mother's occupation, TV in children's room, screen time at weekday, screen time at weekend;
[d] Adjusted for survey year, age, gender, migration background, father's education, mother's education, father's occupation, mother's occupation, TV in children's room, screen time at weekday, screen time at weekend, and quality of outdoor environment.

## 3.8 Association between BMI and language impairment

This part includes univariate logistic regression and multiple logistic regression results to explore the association between BMI and langage impairment.

### 3.8.1 Univariate logistic regression analysis between each independent variables and language impairment outcome

Table 25 reports the univariable results of the analysis. All variables were significant in the univariate logistic regression model. Additionally, BMI categories were not significant after adjusting for age, gender, survey year, parental education and occupation, weekday and weekend screen time, whether there was a TV in the child's bedroom, and quality of preschool outdoor environment in the logistic regression model.

Table 25. Univariate logistic regressions exploring the association between each variable and Language impairment

| | Language impairment | |
|---|---|---|
| | OR (99% CI) [a] | Adjusted OR (99% CI) [b] |
| **Survey year** [c] | 0.93 (0.91, 0.94) | 1.14 (0.57, 2.36) |
| **Gender** | | |
| Boys | Ref | Ref |
| Girls | 0.87 (0.82, 0.92) | 0.73 (0.55,0.97) |
| **Age** | | |
| 4 years | Ref | Ref |
| 5 years | 1.10 (1.00, 1.20) | 1.15 (0.67,2.00) |
| 6 years | 1.22 (1.09, 1.37) | 0.90 (0.45,1.82) |
| **Migration background** | | |
| Non-migrant | Ref | Ref |
| Migrant | 2.15 (2.02, 2.28) | 1.87 (1.39,2.51) |
| **BMI categories** | | |
| Normal | Ref | Ref |
| Overweight | 1.40 (1.25, 1.55) | 0.98 (0.57, 1.66) |
| Obesity | 2.35 (1.97, 2.80) | 1.00 (0.43, 2.20) |
| Underweight | 1.02 (0.76, 1.35) | 1.48 (0.42, 4.77) |
| **Father's education** | | |
| Low | Ref | Ref |
| Middle | 0.60 (0.54, 0.66) | 0.63 (0.41,0.96) |
| High | 0.41 (0.38, 0.45) | 0.40 (0.26,0.60) |
| Missing value | | |
| **Mother's education** | | |
| Low | Ref | Ref |
| Middle | 0.48 (0.43, 0.53) | 0.44 (0.27,0.71) |
| High | 0.32 (0.29, 0.35) | 0.30 (0.18,0.50) |
| Missing value | | |

| | | |
|---|---|---|
| **Father occupation** | | |
| Fulltime | Ref | Ref |
| Part-time | 1.17 (0.93, 1.47) | 0.91 (0.44,1.79) |
| Unemployment | 1.67 (1.31, 2.13) | 1.65 (0.80,3.50) |
| Missing value | | |
| **Mother occupation** | | |
| Fulltime | Ref | Ref |
| Part-time | 0.97 (0.84, 1.13) | 0.85 (0.56,1.30) |
| Unemployment | 1.34 (1.15, 1.57) | 1.51 (0.95,2.41) |
| Missing value | | |
| **Screen time at weekend** | | |
| Never | Ref | Ref |
| ≤30mins/day | 1.10 (0.90, 1.34) | 0.88 (0.46,1.75) |
| 1~2hour/day | 2.07 (0.71, 2.52) | 1.21 (0.62,2.42) |
| ≥3hour/day | 5.16 (4.07, 6.56) | 1.68 (0.67,4.31) |
| Missing value | | |
| **Screen time at weekday** | | |
| Never | Ref | Ref |
| ≤30mins/day | 1.76 (1.55, 2.01) | 1.48 (0.96, 2.32) |
| 1~2hour/day | 4.35 (3.80, 4.99) | 1.79 (1.06, 3.07) |
| ≥3hour/day | 11.79 (8.69, 16.21) | 2.46 (0.67, 10.03) |
| Missing value | | |
| **TV in children's room** | | |
| Yes | Ref | Ref |
| No | 0.32 (0.27, 0.39) | 0.64 (0.33,1.22) |
| Missing value | | |
| **Quality of outdoor environment** | | |
| Good | Ref | Ref |
| Bad | 0.89 (0.80,0.97) | 0.96 (0.62,1.48) |

[a] 99% Confidence Interval (CI) of Odds ratio Univariate logistic regression analysis;
[b] 99% Confidence Interval (CI) of Odds ratio adjusted by survey year, age, gender, migration background, father education, mother education, father occupation, mother occupation, screen time at weekday and weekend, TV in children's room, and quality of outdoor environment in the logistic regression model.
[c] Survey year as discrete variable including year from 2013 to 2018;

### 3.8.2 Multiple logistic regression analysis between BMI and Language impairment outcome

Table 28 summarizes the association between BMI categories and language impairment. In multiple imputation analysis, our results showed obesity was not associated with language impairment among children in all models. After adding mother's education as a variable in model III, the association was not significant.

Table 26. The association between BMI category and language impairment with estimates for the general population using multiple imputation

| Multiple imputation | Unadjusted Model [a] | Model I [b] | Model II [c] | Model III[d] |
|---|---|---|---|---|
| | OR (99% CI) | OR (99% CI) | OR (99% CI) | OR (99% CI) |
| Normal | Ref | Ref | Ref | Ref |
| Overweight | 1.40 (1.25, 1.55) | 1.31 (1.17, 1.47) | 1.16 (1.04, 1.30) | 1.11 (0.99, 1.25) |
| Obesity | 2.35 (1.97, 2.80) | 2.10 (1.76, 2.52) | 1.65 (1.37, 1.98) | 1.04 (1.00, 1.36) |
| Underweight | 1.02 (0.76, 1.35) | 1.02 (0.76, 1.36) | 0.98 (0.72, 1.31) | 0.97 (0.72, 1.30) |

[a] Unadjusted logistic regression results;
[b] Adjusted for survey year, age, gender, migration background;
[c] Adjusted for survey year, age, gender, migration background, father's education, mother's education, father's occupation, mother's occupation, TV in children's room;
[d] Adjusted for survey year, age, gender, migration background, father's education, mother's education, father's occupation, mother's occupation, TV in children's room, screen time at weekday, screen time at weekend, and quality of outdoor environment.

## 3.9 Association between BMI and Motor impairment

This part includes univariate logistic regression and multiple logistic regression results to explore the association between BMI and motor impairment.

### 3.9.1 Univariate logistic regression analysis between each independent variables and motor impairment outcome

Table 27 reports the univariable results of the analysis. Except for survey year, BMI categories, interaction between migration background and BMI categories, all variables were significant in the univariate logistic regression model. Additionally, age was significant after adjusting for age, gender, survey year, parental education and occupation, weekday and weekend screen time, whether there was a TV in the child's bedroom, and quality of preschool outdoor environment in the logistic regression model.

Table 27. Univariate logistic regressions exploring the association between each variable and Motor impairment

| | Motor impairment | |
|---|---|---|
| | OR (99% CI) [a] | Adjusted OR (99% CI) [b] |
| **Survey year [c]** | 1.03 (1.02, 1.05) | 0.57 (0.30, 1.08) |
| **Gender** | | |
| Boys | Ref | Ref |
| Girls | 0.42 (0.40, 0.45) | 0.33 (0.25,0.43) |
| **Age** | | |
| 4 years | Ref | Ref |

| | | |
|---|---|---|
| 5 years | 0.61 (0.55, 0.66) | 0.51 (0.31,0.83) |
| 6 years | 0.45 (0.40, 0.50) | 0.32 (0.17,0.60) |
| **Migration background** | | |
| Non-migrant | Ref | Ref |
| Migrant | 1.16 (1.10, 1.23) | 0.98 (0.74,1.29) |
| **BMI categories** | | |
| Normal | Ref | Ref |
| Overweight | 1.28 (1.15, 1.42) | 0.93 (0.47, 1.87) |
| Obesity | 2.23 (1.85, 2.69) | 0.87 (0.30, 2.64) |
| Underweight | 1.28 (0.97, 1.69) | 1.35 (0.28, 8.52) |
| **Father's education** | | |
| Low | Ref | Ref |
| Middle | 0.74 (0.67, 0.81) | 0.71 (0.47,1.06) |
| High | 0.58 (0.53, 0.63) | 0.66 (0.44,1.99) |
| Missing value | | |
| **Mother's education** | | |
| Low | Ref | Ref |
| Middle | 0.67 (0.60, 0.74) | 0.92 (0.59,1.45) |
| High | 0.52 (0.47, 0.56) | 0.74 (0.46,1.18) |
| Missing value | | |
| **Father occupation** | | |
| Fulltime | Ref | Ref |
| Part-time | 0.97 (0.77, 1.21) | 0.75 (0.41,1.34) |
| Unemployment | 1.56 (1.22, 2.00) | 1.14 (0.59,2.24) |
| Missing value | | |
| **Mother occupation** | | |
| Fulltime | Ref | Ref |
| Part-time | 0.94 (0.81, 1.08) | 0.93 (0.63,1.37) |
| Unemployment | 1.31 (1.12, 1.53) | 1.12 (0.72,1.74) |
| Missing value | | |
| **Screen time at weekend** | | |
| Never | Ref | Ref |
| ≤30mins/day | 0.97 (0.81, 1.15) | 0.82 (0.48,1.41) |
| 1~2hour/day | 1.08 (0.91, 1.28) | 0.88 (0.50,1.55) |
| ≥3hour/day | 1.47 (1.18, 1.83) | 1.37 (0.59,3.20) |
| Missing value | | |
| **Screen time at weekday** | | |
| Never | Ref | Ref |
| ≤30mins/day | 1.19 (1.07, 1.33) | 1.12 (0.78, 1.62) |

| | | |
|---|---|---|
| 1~2hour/day | 1.54 (1.37, 1.74) | 1.28 (0.80, 2.05) |
| ≥3hour/day | 1.84 (1.41, 2.43) | 0.81 (0.25, 2.59) |
| Missing value | | |
| **TV in children's room** | | |
| Yes | Ref | Ref |
| No | 0.72 (0.60, 0.87) | 0.80 (0.43,1.45) |
| Missing value | | |
| **Quality of outdoor environment** | | |
| Good | Ref | Ref |
| Bad | 0.90 (0.82,0.99) | 1.00 (0.67,1.49) |

[a] 99% Confidence Interval (CI) of Odds ratio Univariate logistic regression analysis;
[b] 99% Confidence Interval (CI) of Odds ratio adjusted by survey year, age, gender, migration background, father education, mother education, father occupation, mother occupation, screen time at weekday and weekend, TV in children's room, and quality of outdoor environment in the logistic regression model.
[c] Survey year as discrete variable including year from 2013 to 2018;

### 3.9.2 Multiple logistic regression analysis between BMI and Motor impairment outcome

Table 28 summarizes the association between BMI category and motor impairment. In multiple imputation analysis, our results showed overweight and obesity were associated with motor impairment among children in all models. After adding mother's education in kindergarten as a variable in model III, the association was still significant.

Table 28. The association between BMI category and motor impairment with estimates for the general population using multiple imputation

| Multiple imputation | Unadjusted Model [a] | Model I [b] | Model II [c] | Model III[d] |
|---|---|---|---|---|
| | OR (99% CI) | OR (99% CI) | OR (99% CI) | OR (99% CI) |
| Normal | Ref | Ref | Ref | Ref |
| Overweight | 1.28 (1.15, 1.42) | 1.36 (1.22, 1.53) | 1.26 (1.12, 1.41) | 1.25 (1.11, 1.40) |
| Obesity | 2.23 (1.85, 2.69) | 2.32 (1.92, 2.83) | 2.00 (1.65, 2.44) | 1.95 (1.60, 2.38) |
| Underweight | 1.28 (0.97, 1.69) | 1.38 (1.00, 1.84) | 1.34 (1.00, 1.80) | 1.34 (1.00, 1.79) |

[a] Unadjusted logistic regression results;
[b] Adjusted for survey year, age, gender, migration background;
[c] Adjusted for survey year, age, gender, migration background, father's education, father's occupation, mother's occupation, TV in children's room, screen time at weekday, screen time at weekend, and quality of outdoor environment;
[d] Adjusted for survey year, age, gender, migration background, father's education, mother's education, father's occupation, mother's occupation, TV in children's room, screen time at weekday, screen time at weekend, and quality of outdoor environment.

## 3.10 Association between BMI and Cognition impairment

This part includes univariate logistic regression and multiple logistic regression results to explore the association between BMI and cognition impairment.

### 3.10.1 Univariate logistic regression analysis between each independent variables and cognition impairment outcome

Table 29 reports the univariable results of the analysis. All variables were significant in the univariate logistic regression model. Additionally, BMI categories was not significant after adjusting for age, gender, survey year, parental education and occupation, weekday and weekend screen time, whether there was a TV in the child's bedroom, and quality of preschool outdoor environment in the logistic regression model.

Table 29. Univariate logistic regressions exploring the association between each variable and Cognition impairment

| | Cognition impairment | |
|---|---|---|
| | OR (99% CI) [a] | Adjusted OR (99% CI) [b] |
| **Survey year** [c] | 0.98 (0.96, 0.99) | 0.75 (0.39, 1.49) |
| **Gender** | | |
| Boys | Ref | Ref |
| Girls | 0.56 (0.53, 0.60) | 0.42 (0.32,0.55) |
| **Age** | | |
| 4 years | Ref | Ref |
| 5 years | 0.54 (0.49, 0.59) | 0.62 (0.38,1.01) |
| 6 years | 0.42 (0.37, 0.47) | 0.39 (0.20,0.76) |
| **Migration background** | | |
| Non-migrant | Ref | Ref |
| Migrant | 1.39 (1.31, 1.47) | 1.04 (0.77,1.39) |
| **BMI categories** | | |
| Normal | Ref | Ref |
| Overweight | 1.30 (1.16, 1.45) | 1.26 (0.75, 2.09) |
| Obesity | 1.95 (1.64, 2.32) | 0.92 (0.39, 2.05) |
| Underweight | 1.02 (0.76, 1.36) | 1.56 (0.47, 4.77) |
| **Father's education** | | |
| Low | Ref | Ref |
| Middle | 0.62 (0.56, 0.69) | 0.74 (0.49,1.12) |
| High | 0.43 (0.40, 0.47) | 0.58 (0.38,0.87) |
| Missing value | | |
| **Mother's education** | | |
| Low | Ref | Ref |
| Middle | 0.54 (0.49, 0.59) | 0.46 (0.29,0.72) |
| High | 0.34 (0.31, 0.38) | 0.45 (0.28,0.73) |
| Missing value | | |

| | | |
|---|---|---|
| **Father occupation** | | |
| Fulltime | Ref | Ref |
| Part-time | 1.00 (0.78, 1.26) | 0.76 (0.38,1.45) |
| Unemployment | 1.93 (1.52, 2.46) | 1.10 (0.56,2.13) |
| Missing value | | |
| **Mother occupation** | | |
| Fulltime | Ref | Ref |
| Part-time | 1.03 (0.89, 1.20) | 1.11 (0.73,1.72) |
| Unemployment | 1.66 (1.41, 1.95) | 1.89 (1.19,3.03) |
| Missing value | | |
| **Screen time at weekend** | | |
| Never | Ref | Ref |
| ≤30mins/day | 0.88 (0.73, 1.06) | 0.68 (0.38,1.23) |
| 1~2hour/day | 1.19 (0.99, 1.44) | 0.85 (0.46,1.57) |
| ≥3hour/day | 1.68 (1.34, 2.12) | 0.84 (0.35,1.98) |
| Missing value | | |
| **Screen time at weekday** | | |
| Never | Ref | Ref |
| ≤30mins/day | 1.39 (1.23, 1.58) | 1.33 (0.89, 2.04) |
| 1~2hour/day | 2.07 (1.82, 2.37) | 1.46 (0.87, 2.45) |
| ≥3hour/day | 2.89 (2.20, 3.79) | 2.19 (0.69, 7.13) |
| Missing value | | |
| **TV in children's room** | | |
| Yes | Ref | Ref |
| No | 0.54 (0.45, 0.64) | 0.70 (0.38,1.23) |
| Missing value | | |
| **Quality of outdoor environment** | | |
| Good | Ref | Ref |
| Bad | 0.82 (0.74,0.91) | 0.89 (0.58,1.36) |

[a] 99% Confidence Interval (CI) of Odds ratio Univariate logistic regression analysis;
[b] 99% Confidence Interval (CI) of Odds ratio adjusted by survey year, age, gender, migration background, father education, mother education, father occupation, mother occupation, screen time at weekday and weekend, TV in children's room, and quality of outdoor environment in the logistic regression model.
[c] Survey year as discrete variable including year from 2013 to 2018;

### 3.10.2 Multiple logistic regression analysis between BMI and Cognition impairment outcome

Table 30 summarizes the association between BMI category and cognition impairment. In multiple imputation analysis, our results showed overweight and obesity was associated with

cognition impairment among children in all models. After adding quality of outdoor environment in kindergarten as a variable in model III, the association was still significant.

Table 30. The association between BMI category and cognition impairment with estimates for the general population using multiple imputation

| Multiple imputation | Unadjusted Model [a] | Model I [b] | Model II [c] | Model III[d] |
|---|---|---|---|---|
| | OR (99% CI) | OR (99% CI) | OR (99% CI) | OR (99% CI) |
| Normal | Ref | Ref | Ref | Ref |
| Overweight | 1.30 (1.16, 1.45) | 1.38 (1.23, 1.55) | 1.22 (1.08, 1.37) | 1.20 (1.07, 1.35) |
| Obesity | 1.95 (1.64, 2.32) | 2.02 (1.69, 2.42) | 1.62 (1.35, 1.94) | 1.54 (1.28, 1.85) |
| Underweight | 1.02 (0.76, 1.36) | 1.08 (0.80, 1.45) | 1.03 (0.76, 1.39) | 1.03 (0.76, 1.39) |

[a] Unadjusted logistic regression results;
[b] Adjusted for survey year, age, gender, migration background;
[c] Adjusted for survey year, age, gender, migration background, father's education, mother's education, father's occupation, mother's occupation, TV in children's room, screen time at weekday, screen time at weekend;
[d] Adjusted for survey year, age, gender, migration background, father's education, mother's education, father's occupation, mother's occupation, TV in children's room, screen time at weekday, screen time at weekend, and quality of outdoor environment.

# 4. DISCUSSION

The aim of this study was to investigate prevalence and six-year trend of preschool children health results from SEHE, to detect main health problems among children, to test associations between BMI and comprehensive developmental delay (vision, hearing, motor, speech, and cognition impairment), and to explore the potential role of BMI predicting developmental disorder among preschool children. In the following sections, the results will be shortly summarised and discussed according to the objectives and mirrored with current literature. Afterwards, the stengths and limitaions will be presented and an outlook for future research and reasonable health policy will be recommended.

## 4.1 Prevalence and trends of BMI

The overall prevalence of overweight and obesity was 7.6% and 2.8% respectively. The prevalence of overweight and obesity in boys (7.9%, 3.2%) was more than with girls (7.2%, 2.3%), and with migration background (8.9%, 3.7%) was higher than with non-migrant background (6.3%, 1.8%). The prevalence of overweight in Rhine-Neckar County and the City of Heidelberg was lower than national average level in Germany (9.0% in 2017), but the prevalence of obesity was higher than the national average level (2.0% in 2017) (Schienkiewitz et al. 2019).

The prevalence of overweight (from 6.7% to 7.3%) and obesity (from 2.3 to 3.0%) showed an increasing trend from 2013 to 2018, while respective prevalence of “German Health Interview and Examination Survey for Children and Adolescents” (KIGGS) Wave 2 remained stable from 2014 to 2017 (Schienkiewitz et al. 2019).

This difference might be explained with the improvement of working guidelines in Baden-Württemberg every two years. The pubic health professionals improved the health measurements and data collection. Therefore, the data quality has improved a lot. Another reason might be that the working guidelines varie from different federal states in Germany, the standard of mearsurement and assessment differ. In KIGGS investigation data of children’s weight and height was obtained by telephone interview in which parents were asked to report about their children’s health. Telephone interview might decrease the accuracy of data.

The prevalence of overweight among migrant children was higher than among non-migrant children in this study, which is consistent with previous research in UK (Jebb et al. 2004), Germany (Kuepper-Nybelen et al. 2005), Neitherland (Fredriks et al. 2005), Austria (Kirchengast and Schober 2006), Hannover (Zhou et al. 2018), Munich (Koller and Mielck 2009), Bavaria (Kalies et al. 2002). More and more research proved that migrant children have a higher risk for overweight and obesity. This might be explained that migrant groups not only may have a more sedentary lifestyle with less physical activity, and worse nutritional habits (Dawson et al. 2005), but also may have higher risck environment such as parental style (Lamerz et al. 2005), TV in room (Kuepper-Nybelen et al. 2005), the quality of outdoor environment (QOE) in preschool (Boldemann et al. 2006; Pagels et al. 2014; Söderström et al. 2013) and community (Miranda et al. 2017), access to fitness equipment (Sager 2012b).

### 4.2 Prevalence and trends of developmental impairment

The overall prevalence of developmental impairment was 45.1% (vision), 23.5% (hearing), 52.3% (motor), 39.6% (language), 34.7% (cognition) respectively. The prevalence of motor impairment showed an increasing trend from 2013 to 2018 whereas the prevalence of vision impairment

showed a decreasing trend. The rate of language showed the opposite trend, first decreasing and then increasing. The trend of cognition and hearing was similar, fluctuating steadily and slightly. After adjusting by age, sex, migrant background, it still showed the similar trend. The trend of vision impairment in this study was consistent with the previous study with trends among global population from 1990 to 2010 (Stevens et al. 2013) and German population from 1993 to 2009 (Wolfram and Pfeiffer 2012). This result might be explained by the improvement in assessment criteria and working guidelines in Baden-Württemberg every two years. There is another explaination for decreasing trend of visual impairment : younger children are more susceptible to vision impairment. Previous studies showed that ethnicity (Nangia et al. 2011), education (Nangia et al. 2011; Soler et al. 2016), socioeconomic status (Grzybowski et al. 2020b; Nangia et al. 2011), outdoor time, availability of a TV in children's rooms (Adhikari et al. 2018) are contributing to vision impairment. However, children's growth and development is a dynamic process. During normal development emmetropization as a normal physiological process of eye growth occurs after birth to reduce birth hyperopia and complete 82% of whole term before one year (Saunders et al. 2002). Maturation of vision is a long term process of several years until reaching full maturity (Madan et al. 2005). This might be the possible pathologic mechanism for trend of vision impairment.

The increasing trend of motor impairment from 2013 to 2018 in this study was consistent with previous studies in Australian children from 1991 to 2005. Motor development includes two section: gross and fine motor development. Generally, the motor development follows a predictable sequence, with fine motor skills developing after gross motor skills. Individual fators such as gender (Chow and Chan 2011; Cliff et al. 2009), ethinicity (Chow et al. 2001), preterm birth (Holsti et al. 2002), age (Chow et al. 2001; Iivonen et al. 2011; Krombholz 2006) were found to be associated with MI. Lifestyle factor like lack of physical activity(Bürgi et al. 2011) was a risk factor for MI; environmental factors such as family structure (Cools et al. 2011), kindergarden area (Chow and Chan 2011), community density (Cools et al. 2011), and socioeconomic status (Roth et al. 2010) of family were considered to increase the risk for motor impairment (Iivonen and Sääkslahti 2014).

The prevalence of developmental impairment differed significantly by age, gender and migrant background. Among five domains of developmental impairment, the prevalence of vision and hearing impairment in girls was higher than in boys, and the prevalence of motor, language and cognition impairment in boys was higher than in girls. Children with migration background had higher prevalence than with non-migrant background in all developmental impairment. Except for language impairment, younger children had higher prevalence of developmental impairment.
Similar to this result, some previous studies showed sex, migrant background differences (Stich et al. 2012) in the prevalence of developmental impairment. The general prevalence of developmental impairment was higher than in other regions such as Bavaria (Stich et al. 2012), which might be explained by different test for school entry examination in different federal states of Germany.

Many factors have impact on children development. The significant factor is age. With age increasing, children will acquisite skill at developmental milestone (Hay et al. 2009). Younger children may not master the skills at the school entry examination (Karch 1990). Younger children with developmental impairment might be too young but obtain skills shortly thereafter. However, it is surprising that older children had higher prevalence of language impairment. One possible explaination is that the assessment of language test changed accoding to working guidelines of Baden-Württemberg in the last six years. Other reason might be explained by a selection bias- older children who have developmental impairment were not included in previous examinations.

Our results show that gender has got an impact on development. Boys were more likely to have developmental impairment than girls, which has been found in previous studies (Stich et al. 2012; Wohlfeil 1991a) (Le Thi et al. 2019). The exact reason for gender difference is still unclear and needs to be studied further.
Migrant background impacts on developmental impairment, which is consistent with previous research (Stich et al. 2012). One important reason could be parental life style, socioecomic status (Sager 2012a), language barrier, neighborhood outdoor environment (Miranda et al. 2017).

## 4.3 Association between BMI and Developmental Impairment

BMI was found to be associatied with impairment of vision, motor, and cognition in this study. This section will be discussed separately according to the main results.

### 4.3.1 Association between BMI and Vision impairment

The results indicate that among children with an migration background, those with obesity was significantly more likely to have a visual impairment.

In previous studies, associations between obesity and visual impairment have been observed among children and adolescents aged over 6 years (Peng et al. 2016b; Zhang et al. 2018). One possible explanation for this association is that both health problems already existed when these individuals were of preschool age. In our study, preschool children with obesity had a greater risk of visual impairment. Another explanation for this correlation from the biological perspective is that overweight and obese children may have low concentrations of serum retinol compared to those with normal body weight (Chaves et al. 2008).

For our analysis quality of preschool outdoor environment was added as a covariate in multiple regression models. The results of model III indicate that the quality of preschool outdoor environment is both correlated with obesity and visual impairment. It is possible that outdoor play time (Pagels et al. 2014) and neighbourhood outdoor environment (Miranda et al. 2017) may contribute to physical activity participation. Previous studies from South Korean (Morgan et al. 2017), Sweden (Boldemann et al. 2006; Pagels et al. 2014; Söderström et al. 2013), the United States (Moore and Cosco 2010), and Spain (Miranda et al. 2017) have shown that quality of school outdoor environment may explain part of the association between obesity and visual impairment.

This study also found that obese children with a migrant background were more susceptible to visual impairment than migrant children with normal weight, which was consistent with previous research (Le Thi et al. 2019). This result may be explained by differences in socioeconomic status, culture, family structure or parenting rearing pattern. Results from the German Socioeconomic Panel Study (SOEP) suggest that residential isolation of migrant groups exists in Germany being

caused by differences in socioeconomic status in comparison with the general population. On average, migrant groups live in smaller homes with more family members and have less education than non-migrant groups (Sager 2012a).

Research from Australia has shown that living in a supportive neighbourhood may promote children's physical activity (Giles-Corti and Donovan 2002). Supportive neighbourhood environments among migrant groups may positively affect physical activity, which could prevent obesity and associated visual impairment. Some research supports this view (Heinemann et al. 1988; Willis et al. 2013). Low parental education may also increase children's likelihood of obesity(Lamerz et al. 2005), which increases the risk of unhealthy life style such as low physical activity, and more time watching TV, and leads to visual impairment.

### 4.3.2 Association between BMI and Motor impairment

The results indicate that among preschool children, those with overweight and obesity were significantly more likely to have a motor impairment.

Associations between obesity and motor impairment have been observed in previous studies (D'Hondt et al. 2011; Logan et al. 2011). One possible explanation for this association is that both health problems already existed when these individuals were of preschool age. Another possible reason might be that overweight and obesity children don't have good performance on physical activites and resist participating in physical activities, which easily leads to motor impairment. Besides, parents and teachers may discourage children with motor impairment, which further leads to less physical activities. One study determined the link between body weight and running competence, which found that locomotor skills were related to impaired musculoskeletal functions of obese children (Wearing et al. 2006). This demonstrates the relathionship between obesity, muscular function and motor skills.

Gross motor skills such as jumping and hopping consume high energy. Motor impairment may lead to low physical activities in obese children, which may further lead to overweight and obesity (Parsons et al. 1999).

Parents and teacher should choose the physical activities according to children's body weight status and motor skill capability. Obese children should be encouraged to participate in lower energy expenditure of motor skills such as balancing, walking, and catching to reduce the long-term impact of differences in motor skills caused by obesity in later life and psychological behavior problems.

### 4.3.3 Association between BMI and Cognition impairment

The results indicate that among preschool children, those with overweight and obesity were significantly more likely to have cognition impairment.

This result was consistent with previous studies (Galván et al. 2014). For example, one study from German preschool children demonstrated that BMI increased by one unit meaned verbal function decreased by one unit (Ettner and Grzywacz 2003). Another study suggested association between obesity and cognition among German girls aged 6 years old (Cawley and Spiess 2008).

One possible explanation for this association is that both health problems already existed when these individuals were of preschool age. In our study, preschool children with obesity had a greater risk of cognition impairment. Another explanation for this correlation from the biological perspective is that obesity impacts on cognitive function and brain volume (Taki et al. 2008). Obese children are less likely to participate in physical activity then normanl children. From physiological mechanisms pespectives, some studies showed that physical activity increased blood flow through the brain. Especially when taking medium and high intensity physical training, the blood flow through the brain increases significantly to provide necessary nutrients and stimulate brain neurotransmitter release (Gligoroska and Manchevska 2012). The latest studies found that Brain (Brain Derived Neurotrophic Factor) BDNF is the key molecule to improve learning and memory (Gómez-Pinilla et al. 2002). Physical activities impact on BDNF by intracellular signaling system. Some studies suggested that physical activities might increases the level of mitochondrial uncoupling protein 2 to control the production of ATP and free redicals (Gligoroska and Manchevska 2012).

For analysis, quality of preschool outdoor environment was added as a covariate in multiple regression models. The results of model III indicate that the quality of preschool outdoor environment is both correlated with obesity and cognition impairment. It is possible that outdoor play time (Pagels et al. 2014) and neighbourhood outdoor environment (Miranda et al. 2017) may contribute to physical activity participation. Prior from South Korean (Morgan et al. 2017), Sweden (Boldemann et al. 2006; Pagels et al. 2014; Söderström et al. 2013), the United States (Moore and Cosco 2010), and Spain (Miranda et al. 2017) has shown that quality of school outdoor environment may explain part of the association between obesity and cognition impairment but cannot do so fully.

### 4.4 Strengths and limitations

Our study had several strengths. First, this study leveraged a large sample that included all children who will enter primary school in Rhine-Neckar County and the City of Heidelberg. Second, this is one of few population-based studies to explore the associations between weight status and development impairments among preschool children by using multiple logistics regression. Third, no selection bias occurred during the investigation procedure. Fourth, our study estimates the correlation between BMI category and developmental impairment based on multiple regression models. Confounding and interaction factors were controlled for by the adjusted model and stratification. Missing values were predicted by multiple imputation. Overall, our research found that obesity was related to developmental impairment in German preschool children and stressed the importance of obesity prevention and detection in early childhood.

This study also had some limitations. First, because we used multivariable regression and a pooled cross-sectional dataset, we cannot establish the causal effect of obesity on developmental impairment. Second, although we took advantage of all the information in this dataset, confounders that could not be controlled for in multiple regression remain in the model. For example, because of protection of personal information, we were unable to obtain children's home addresses, so we could not measure the quality of neighborhood outdoor environments. Biochemical examinations should be added to the SEE to generate more biological evidence for future research in this area. More-specific information about children’s families is also desirable.

### 4.5 Conclusion and utlook for research and public health policy

The results of this thesis indicate health inequalities among migrants compared to the German population and consequently, could point out the need of action regarding specific prevention measures for preschool children with migrant background. Although, it is difficult to summary recommendations for prevention based on secondary data. Due to limited data, root cause for health inequalities among migrants and natives couldn't be recognized. Further research exploring possible risk factors such as neighborhood outdoor enviroment, parental style, biochemical examinations, family structure, birth information will better understand and address origins cause of health inequalities. A cohort study is needed to determine the casual effect in the future. Besides, government and health authorties should focus on children with migrant background and allocate more health resources for them. For government, it is urgently needed to built a health promotion project for family with migrant background, including the adaptation of teaching programs for children and parents, health care service for poor families, and community assistance from neighborhood; For health authorities, the parents' questionnaire of SEHE should be improved, adding questions such as family structure, community address, living environment, parental rearing patterns, giving individual advice according to SEHE results and update follow-up information in time; For preschool, teachers should pay more attention to migrant group, give educational support and social adaptability training as well as psychological counseling if necessary.

The increasing trend of overweight and obesity is a major public health concern. Government and health authorities should focus on the health surveillance of overweight and obese groups. According to the results of this study, obesity was associated to vision, motor and cognition impairment. If overweight and obesity were well controlled, the other health problems would reduce to some degree. From the perspective of social and economic benefits, obesity prevention is undoubtedly cost-effective. Physical activities play an important role in children's growth and development which could help children develop motor and cognition skills, as well as prevent vision impairment. Teachers should encourage children- especially obese children- to participate in exercises with appropriate intensity to promote the children's development. Parents should reduce the children screen time of video or TV, help children built good living habits and diet habits.

As known from this study, motor impairment showed an increasing trend, while vision impairment decreased but still kept high level. The future work should be focused on the screening of motor and vision development. For the government the required test items of SEHE should be adjusted in order to realize reasonable allocation of health care resources and relieve the work pressure of public health professionals; For preschool, teachers should extend the time for outdoor activity or indoor exercises, provide teaching programs for children with motor and vision impairment; For families, parents should encourage children take part in more outdoor activity and increase parent – children interaction time.

# 5. SUMMARY

In Germany, School Entry Health Examination (SEHE) as the mandatory surveillance is to detect health status, developmental impairment and the potential risk factors and provide a reasonable reference for effective advice and intervention measures for government in time. SEHE takes up considerable resources of public health services in Germany. Therefore, the contradictions between growing health needs and provision of health services is gradually prominent with the increase of people with migration background. It is an imperative issue to use public health services effectively and rationally. In order to sharpen the focus of public health services, it is urgent to answer the question as follows: what is major problem of children development; which group is suspectiable?

The prevalence of overweight and obese children has increased globally in recent decades and shows an increasing trend at younger age. Meanwhile, preschool children face more health challanges such as development impairment of vision, hearing, motor, language and cognition before entrying elementary school. This study was designed to describe prevalence and the six-year trends of overweight and obesity, developmental delay on vision acuity, hearing loss, motor impairment, language retardation, cognitive disorder, and to test associations between BMI and comprehensive developmental delay (vision, hearing, motor, speech, and cognition impairment), and to explore the potential role of BMI predicting developmental disorder among preschool children, which can help make reasonable health policy and effective intervention targeting on young obese children.

Before the examination, parents receive a formal written consent from the public health office. The information including age, immigration background, parents' education and occupation, usage of electronic equipment was obtained from the parents' questionnaire. Data includes measurements of physical examination and children development.The criteria and methodology to identify developmental impairment during the examination follows the Work Guideline for School Entry Examination (WGSE) of the Ministry of Social Affairs and Integration, Baden-Württemberg (Ministry of Social Affairs and Integration Baden-Württemberg 2017).

In this survey, 37858 children aged 4 to 6 years old were enrolled from 2013 to 2018, 33407 children had valid information, including 17304 boys and 16103 girls. The response rate was 88.2%. The overall prevalence of overweight and obesity was 7.6% and 2.8% respectively. The overall prevalence of developmental impairment was 45.1% (vision), 23.5% (hearing), 52.3% (motor), 39. 6%(language),34.7%(cognition). The prevalence of overweight and obesity showed an ascending tendency with the increasing of year. Meanwhile, the prevalence of motor impairment showed an increasing trend from 2013 to 2018. In the same time period the prevalence of visual impairment showed first an upwards trend and a downward one. The rate of language showed the opposite trend, first decreasing and then increasing. The trend of cognition and hearing was similar, fluctuating steadily and slightly. The prevalence of all developmental impairment differed after adjusting by gender, age, migrant background.

In multiple imputation analysis, After compared Unadjusted Model, Model I(Adjusted for survey year, age, gender, migration background),Model II(Adjusted for survey year, age, gender, migration background, father's education, mother's education, father's occupation, mother's occupation, TV in children's room, screen time at weekday, screen time at weekend), Model III(Adjusted for survey year, age, gender, migration background, father's education, mother's education, father's occupation, mother's occupation, TV in children's room, screen time at weekday, screen time at weekend, and quality of outdoor environment), the results showed obesity was associated with visual impairment [OR=1.20, 99% CI (1.02,1.42)] among children with an migration background, motor impairment [OR=1.95, 99% CI (1.60,2.38)], cognition impairment [OR=1.54, 99% CI (1.28,1.85)] among all preschool children.

One possible explanation for this association between obesity and vision impairment is that overweight and obese children may have low concentrations of serum retinol compared to those with normal body weight. It is possible that outdoor play time and neighbourhood outdoor environment may contribute to physical activity participation.

Associations between obesity and motor impairment have been observed in previous studies. One possible reason might be that overweight and obesity children don't have good performance on physical activites and resist participating in physical activities, another reason might be that locomotor skills were related to impaired musculoskeletal functions of obese children.
The explanation for this correlation between obesity and cognition impairment from the biological perspective is that obesity impacts on cognitive function and brain volume. Obese children are less likely to participate in physical activity then normanl children. From physiological mechanisms pespectives, some studies showed that physical activity increased blood flow through the brain. the blood flow through the brain increases significantly to provide necessary nutrients and stimulate brain neurotransmitter release.

This study indicates that the prevalence of overweight and obesity, motor impairment showed an ascending tendency with the increasing of year among preschool children aged from 4 to 6 years. Children with migration background had higher prevalence than non-migrant background in all developmental impairment, ovweight and obesity. Those with obesity were significantly more likely to have vision impairment, motor impairment and cognition impairment problems. Obese Children with migrant background are of major public health concern and need support by government, public health authority, prechool, and family.

# 6. ZUSAMMENFASSUNG

In Deutschland dient die Schuleintrittsgesundheitsprüfung (SEHE) als obligatorische Überwachung dazu, den Gesundheitszustand, Entwicklungsstörungen und die potenziellen Risikofaktoren zu erkennen und eine angemessene Referenz für wirksame Beratungs- und Interventionsmaßnahmen für die Regierung rechtzeitig bereitzustellen. SEHE beansprucht in Deutschland beträchtliche Ressourcen des öffentlichen Gesundheitswesens, weshalb die

Widersprüche zwischen wachsenden Gesundheitsbedürfnissen und der Bereitstellung von Gesundheitsdiensten mit der Zunahme von Einwanderern allmählich zunehmen. In den letzten Jahren wird zunehmend gefordert, die öffentlichen Gesundheitsdienste effektiv und rational zu nutzen. Um den Schwerpunkt des öffentlichen Gesundheitswesens besser zu setzen, ist es erforderlich, die Frage zu beantworten: welches sind die Hauptprobleme für die Entwicklung von Kindern? welche Gruppen sind gefährdet.

Die Prävalenz von übergewichtigen und adipösen Kindern hat in den letzten Jahrzehnten weltweit zugenommen und zeigt einen steigenden Trend in jüngeren Jahren. Inzwischen sind Kinder im Vorschulalter mit mehr gesundheitlichen Herausforderungen konfrontiert, wie z. B. Entwicklungsstörungen des Sehens, Hörens, der Motorik, der Sprache und der Kognition, bevor sie in die Grundschule kommen. Diese Studie wurde konzipiert, um die Prävalenz und die Sechs-Jahres-Trends von Übergewicht und Adipositas, Entwicklungsverzögerung bei Sehschärfe, Hörverlust, motorischer Beeinträchtigung, Sprachverzögerung und kognitiver Störung zu beschreiben und Assoziationen zwischen BMI und umfassender Entwicklungsverzögerung (Seh-, Hör-, Motorik-, Sprach- und kognitive Beeinträchtigung) zu testen und die potenzielle Rolle des BMI bei der Vorhersage von Entwicklungsstörungen bei Vorschulkindern zu erforschen, was dazu beitragen kann, eine adäquate Gesundheitspolitik und eine effektive Intervention bei jungen adipösen Kindern zu entwickeln.

Vor der Untersuchung erhalten die Eltern eine formelle schriftliche Einwilligung vom Gesundheitsamt. Die Informationen einschließlich Alter, Migrationshintergrund, Bildung und Beruf der Eltern, Nutzung elektronischer Geräte wurden aus dem Fragebogen der Eltern gewonnen. Die Daten umfassen Messungen der körperlichen Untersuchung und der Entwicklung der Kinder. Die Kriterien und die Methodik zur Feststellung von Entwicklungsbeeinträchtigungen bei der Untersuchung folgen der Arbeitsrichtlinie zur Schuleingangsuntersuchung (WGSE) des Ministeriums für Soziales und Integration Baden-Württemberg (Ministerium für Soziales und Integration Baden-Württemberg 2017).

In dieser Erhebung wurden von 2013 bis 2018, 37858 Kinder im Alter von 4 bis 6 Jahren erfasst, 33407 Kinder hatten gültige Angaben, darunter 17304 Jungen und 16103 Mädchen. Die

Rücklaufquote betrug 88,2 %. Die Gesamtprävalenz von Übergewicht und Adipositas betrug 7,6 % bzw. 2,8 %. Die Gesamtprävalenz von Entwicklungsstörungen betrug 45,1% (Sehen), 23,5% (Hören), 52,3% (Motorik), 39. 6% (Sprache), 34,7% (Kognition). Die Prävalenz von Übergewicht und Adipositas zeigte mit zunehmendem Alter eine steigende Tendenz. Die Prävalenz der motorischen Beeinträchtigung zeigte von 2013 bis 2018 eine steigende Tendenz. Im gleichen Zeitraum zeigte die Prävalenz der Sehbehinderung zunächst einen Aufwärtstrend und dann einen Abwärtstrend. Die Prävalenz von Sprache zeigte den entgegengesetzten Trend, erst abnehmend und dann ansteigend. Der Trend der Kognition und des Hörens war ähnlich und schwankte konstant und leicht. Die Prävalenz aller Entwicklungsbeeinträchtigungen unterschied sich nach Bereinigung nach Geschlecht, Alter, Migrationshintergrund.

In der multiplen Imputationsanalyse wurden nach dem Vergleich Unadjustiertes Modell, Modell I (Bereinigt um Erhebungsjahr, Alter, Geschlecht, Migrationshintergrund), Modell II(Bereinigt um Erhebungsjahr, Alter, Geschlecht, Migrationshintergrund, Bildung des Vaters, Bildung der Mutter, Beruf des Vaters, Beruf der Mutter, TV im Kinderzimmer, Bildschirmzeit am Wochentag, Bildschirmzeit am Wochenende),
Modell III(Adjustiert für Erhebungsjahr, Alter, Geschlecht, Migrationshintergrund, Bildung des Vaters, Bildung der Mutter, Beruf des Vaters, Beruf der Mutter, Fernsehen im Kinderzimmer, Bildschirmzeit am Wochentag, Bildschirmzeit am Wochenende und Qualität der Außenumgebung), zeigten die Ergebnisse, dass Fettleibigkeit mit Sehstörungen assoziiert war [OR=1. 20, 99% CI (1.02,1.42)] bei Kindern mit Migrationshintergrund, motorischen Beeinträchtigungen [OR=1.95, 99% CI (1.60,2.38)], kognitiven Beeinträchtigungen [OR=1.54, 99% CI (1.28,1.85)] bei allen Vorschulkindern.
Eine mögliche Erklärung für diesen Zusammenhang zwischen Fettleibigkeit und Sehstörungen ist, dass übergewichtige und fettleibige Kinder im Vergleich zu Kindern mit normalem Körpergewicht niedrige Konzentrationen von Retinol im Serum haben könnten. Es ist möglich, dass die Spielzeit im Freien und die Umgebung im Freien zur Teilnahme an körperlicher Aktivität beitragen.

In früheren Studien wurden Assoziationen zwischen Adipositas und motorischen Beeinträchtigungen beobachtet. Ein möglicher Grund könnte sein, dass übergewichtige und fettleibige Kinder keine guten Leistungen bei körperlichen Aktivitäten erbringen und sich gegen

die Teilnahme an körperlichen Aktivitäten sträuben, ein anderer Grund könnte sein, dass die motorischen Fähigkeiten mit den beeinträchtigten muskulo-skelettalen Funktionen der fettleibigen Kinder in Zusammenhang stehen.
Die Erklärung für diesen Zusammenhang zwischen Adipositas und Kognitionsbeeinträchtigung aus biologischer Sicht ist, dass Adipositas Auswirkungen auf die kognitive Funktion und das Gehirnvolumen hat. Adipöse Kinder nehmen seltener an körperlichen Aktivitäten teil als normalgewichtige Kinder. Aus der Perspektive physiologischer Mechanismen zeigten einige Studien, dass körperliche Aktivität den Blutfluss durch das Gehirn erhöht. Der Blutfluss durch das Gehirn erhöht sich signifikant, um notwendige Nährstoffe bereitzustellen und die Freisetzung von Neurotransmittern im Gehirn zu stimulieren.

Diese Studie zeigt, dass die Prävalenz von Übergewicht und Adipositas, motorischer Beeinträchtigung eine aufsteigende T, motorischen Beeinträchtigungen und kognitiven Störungen. Adipöse Kinder mit Migrationshintergrund stellen ein großes Problem für die öffentliche Gesundheit dar und benötigen Unterstützung durch die Regierung, die Gesundheitsbehörden, die Vorschule und die Familie.

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# 8. PERSONAL PUBLICATIONS

Liu, W., Schwertz, R., Welker, A., Welker, J., Chen, S., Dambach, P., & Marx, M. (2021). **Associations between BMI and visual impairment of 33 407 preschool children in Germany: a pooled cross-sectional study**. European Journal of Public Health, 31(1), 105-111.

# APPENDIX

## Appendix 1 Health examimation for children

NAME: [redacted]

| | | | | |
|---|---|---|---|---|
| Einwilligungen vollständig | ☐ Ja | ☐ nein | ☐ teilweise | |
| Elternfragebogen | ☐ Ja | ☐ nicht vorgelegt | | |
| Erzieherinnenfragebogen | ☐ vorhanden | ☐ nicht in KITA | ☐ nicht vorhanden | ☐ keine EV |

**ARZT :** ☐ 10 ☐ 20 ☐ 30 ☐ 40 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9

**SMA :** ☐ 10 ☐ 20 ☐ 30 ☐ 40 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9

UDATUM ☐☐.☐☐. 20☐☐ KITA NR. ☐☐☐☐☐☐ Bei der Untersuchung war(en) anwesend:

Asylbewerber-/ Flüchtlingsstatus ☐ Zuwanderungsjahr ☐☐ Sorgeberechtigte Person ☐ ☐ sonstige Personen

**Impfstatus** ☐ Impfbuch nicht vorgelegt ☐ besitzt kein Impfbuch ☐ besitzt kein Impfb., lt. schriftl. Erklärung nicht geimpft ☐ Impfberatung durchgeführt

6-fach Impfung ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ ≥4

☐ Bei Infanrix hexa, Infanrix IPV HiB und Hexyon. Grundimmunisierung nach 2+1 Schema druchgeführt und abgeschlossen.

| Tetanus | Diphth | Pertuss | HiB | HBV | Polio | Pneumo | MMR | Masern Mono | Röteln Mono | Varizellen | Meningo C | FSME | HAV | Influenza | Rota |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ☐ 0 | ☐ 0 | ☐ 0 | ☐ 0 | ☐ 0 | ☐ 0 | ☐ 0 | ☐ 0 | ☐ 0 | ☐ 0 | ☐ 0 | ☐ 0 | ☐ 0 | ☐ 0 | | ☐ 0 |
| ☐ 1 | ☐ 1 | ☐ 1 | ☐ 1 | ☐ 1 | ☐ 1 | ☐ 1 | ☐ 1 | ☐ 1 | ☐ 1 | ☐ 1 | ☐ 1 | ☐ 1 | ☐ 1 | 1 2 | Rotarix ☐ 1 |
| ☐ 2 | ☐ 2 | ☐ 2 | ☐ 2 | ☐ 2 | ☐ 2 | ☐ 2 | ☐ 2 | ☐ 2 | ☐ 2 | ☐ 2 | | ☐ 2 | ☐ 2 | 16/17 ☐☐ | ☐ 2 |
| ☐ 3 | ☐ 3 | ☐ 3 | ☐ 3 | ☐ 3 | ☐ 3 | ☐ 3 | ☐ 3 | ☐ 3 | ☐ 3 | ☐ 3 | | ☐ ≥3 | ☐ ≥3 | 17/18 ☐☐ | Rotateq ☐ 1 |
| ☐ ≥4 | ☐ ≥4 | ☐ ≥4 | ☐ ≥4 | ☐ ≥4 | ☐ ≥4 | ☐ ≥4 | davon nach dem 2. Geburtstag | | | | ☐ andere Impfungen | | | 18/19 ☐☐ | ☐ 2 |
| | | | | | | | ☐ 1 ☐ 2 | ☐ 1 ☐ 2 | ☐ 1 ☐ 2 | ☐ 1 ☐ 2 | | | | 19/20 ☐☐ | ☐ 3 |

Nachweis über FU-Untersuchung nicht vorgelegt. ☐

**Nicht nachgewiesen :**

| U2 | U3 | U4 | U5 | U6 | U7 | U7a | U8 | U9 |
|---|---|---|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

☐ Kind mit besonderen Bedarfen

☐ Besuch eines Schulkindergartens

☐ Inklusionsassistent/in

☐ Sonstiges:_____

## EINSCHULUNGSUNTERSUCHUNG

| | | | | | |
|---|---|---|---|---|---|
| **Größe** | | n.dgf. ☐ | ☐☐☐ cm | P: | |
| **Gewicht** (in leichter Bekleidung) | | n.dgf. ☐ | ☐☐,☐ kg | P: | |
| **BMI** | | | (kg/m²) | P: | |

| | Fehlende MA | n.dgf. | Befund | Arzt | Int-FB | häusl. /VSP | in Behandl. | A.E. |
|---|---|---|---|---|---|---|---|---|
| **Einbeinhüpfen** | ☐ | ☐ | rechts ☐☐ (Hüpfer) links ☐☐ (Hüpfer) | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Fehlende MA | n.dgf. | Befund | | Arzt | A.E. |
|---|---|---|---|---|---|---|
| * **Hörtest** (bis 20 dB) Reintonaudiometrie Frequenz in kHz | ☐ | ☐ | re. 0,5 1,0 2,0 4,0 6,0<br>30 dB ☐☐☐☐☐<br>40 dB ☐☐☐☐☐<br>≥ 50 dB ☐☐☐☐☐<br>Alle Frequenzen bei 20dB gehört ☐ | li. 0,5 1,0 2,0 4,0 6,0<br>30 dB ☐☐☐☐☐<br>40 dB ☐☐☐☐☐<br>≥ 50 dB ☐☐☐☐☐<br>Alle Frequenzen bei 20dB gehört ☐ | ☐ | ☐ |
| * **Sehtest** (Visus F 1,0)<br>☐ Brille, falls ja:<br>☐ ohne Brille untersucht<br>räuml. Sehen<br>Farbsinn | ☐ | ☐<br>☐<br>☐<br>☐ | **F rechts** ☐1,0 ☐0,9 ☐0,8 ☐0,7 ☐0,6 ☐≤0,5<br>**F links** ☐1,0 ☐0,9 ☐0,8 ☐0,7 ☐0,6 ☐≤0,5<br>Vorschaltlinse besser ☐re ☐li<br>räumliches Sehen auffällig: ☐<br>Farbsinn auffällig: ☐ | bekannte Sehstörung?<br>☐ nein<br>☐ ja<br>☐ k.A.<br>augenärztliche Behandlung?<br>☐ nein<br>☐ ja<br>☐ k.A. | ☐ | ☐ |

Legende: Fehlende MA = Fehlende Mitarbeit | n.dgf = nicht durchgeführt | Arzt = medizinischer Abklärungs-Behandlungsbedarf | Int FB = intensiver Förderbedarf | VSP = Förderung Kita | häuslich = Förderung im Elternhaus | A.E. = Altersentsprechend

☐ Bitte Termin für Vorsorgeuntersuchung U ..... vereinbaren

☐ Kontrolle Hörtest / Sehtest erbeten

☐ weitere Empfehlungen/Notizen:

| | fehlende MA | n.dgt. | Befund | Arzt | Int. FB | hausl /VSP | in Behandl | A.E. |
|---|---|---|---|---|---|---|---|---|
| **Sprache (i. d. ersten 3 Lebensjahren):** ☐ D ☐ TR ☐ RUS ☐ ITA ☐ andere It.ISO ☐☐☐ ☐ <10 Mon. Dt.-Kontakt | | | | | | | | |
| **1. Spontansprache** Ohne gezielte Prüfung fiel(en) auf: | ☐ | ☐ | Satzbau ☐ Artikel ☐ Verb ☐ Plural ☐ Präposition ☐ Stottern/Poltern ☐ | | | | | |
| **2. HASE (Heidelberger Auditives Screening in der Einschulungsuntersuchung)** | | | | | | | | |
| Nachsprechen Sätze (NS) | ☐ | ☐ | ☐0 ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10 | | | | | ☐ |
| Wiedergabe Zahlenfolgen (WZ) | ☐ | ☐ | ☐0 ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10 | | | | | ☐ |
| Nachsprechen Kunstwörter (NK) | ☐ | ☐ | ☐0 ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10 | | | | | ☐ |
| **3. Sprachverständnis (KVS,** bei NS im Grenzbereich) | ☐ | ☐ | richtig von drei Manipulationsaufgaben (KVS) ☐ 0 ☐ 1 ☐ 2 ☐ 3 | | | | | |
| | | | Bewertung des Sprachscreenings (ohne SETK) : | Weitere Abkl. erforderlich ☐ | | | | ☐ |
| **Bewertung der Sprache ohne Artikulation** | | | | ☐ | ☐ | ☐ | ☐ | ☐ |
| **4. Artikulation** | ☐ | ☐ | *auffällig*<br>☐ B ☐ L/N ☐ ch1 wie in Bücher ☐ ch2 wie in Drache ☐ G/K ☐ S/Z ☐ SCH ☐ R ☐ F/W/PF ☐ T/D ☐ Kons.-verb.<br>☐ andere ..... ☐ Aussprachverständlichkeit auffällig | ☐ | | ☐ | ☐ | ☐ |
| **Graphomotorik**<br>Händigkeit<br>Druck<br>Haltung<br>Führung | ☐ | ☐ | ☐ rechts ☐ links ☐ unklar<br>☐ unauffällig ☐ auffällig ☐ legt Handgel. nicht auf<br>☐ sicher ☐ auffällig ☐ Palmargriff<br>☐ sicher ☐ unsicher<br>Gesamtbewertung Graphomotorik : | ☐ | ☐ | ☐ | ☐ | ☐ |
| **Visuomotorik** (DP0 – DP1) | ☐ | ☐ | DP0 ☐0 ☐1 ☐2 ☐3 ☐4 DP1 ☐0 ☐1 ☐2 ☐3 ☐4 ☐5 | ☐ | ☐ | ☐ | ☐ | ☐ |
| **Menschzeichnung** | ☐ | ☐ | ☐ Kopffüßler ☐ unstrukturiert | ☐ | ☐ | ☐ | ☐ | ☐ |
| **Mengenerfassung** | ☐ | ☐ | ☐0 ☐1 ☐2 ☐3 ☐4 ☐5 | | ☐ | ☐ | ☐ | ☐ |
| **Verhalten während der Untersuchung** | | | ☐ Konzentration ☐ Mitarbeit ☐ Arbeitstempo ☐ Ausdauer<br>☐ Impulskontrolle ☐ Selbstvertrauen ☐ Frustrationstoleranz ☐ anderes | ☐ | ☐ | ☐ | ☐ | ☐ |

Ärztliche Nachuntersuchung geplant ☐ durchgeführt ☐ am ☐☐.☐☐.20☐☐

Ein Sprachentwicklungstest (SETK 3-5) ist geplant ☐ wurde durchgeführt ☐

Eine Wiedervorstellung zu Schritt 2 ist aus heutiger Sicht erforderlich ☐ Schritt 1 der ESU abgeschlossen ☐

Eine Wiedervorstellung zu HASE in Schritt 2 ist erforderlich ☐

Datum, Unterschrift der Assistentin: ..... Unterschrift der Ärztin / Arztes: .....

**Erzieherin** Sprachförderung in KiTa ☐ nein ☐ ja ☐ k. A. seit:

auffällig: Körpermotorik ☐ 1 ☐ 1k.A. ☐ 2 ☐ 2k.A. | Sprache ☐ 1 ☐ 1k.A. ☐ 2 ☐ 2k.A. | soz.Komp ☐ 1 ☐ 1k.A. ☐ 2 ☐ 2k.A. | emot.Komp. ☐ 1 ☐ 1k.A. ☐ 2 ☐ 2k.A. | Entw.Selbständigkeit ☐ 1 ☐ k.A.

Beobachtungsdatum ☐☐.☐☐.20☐☐ Hinw. auf Hyperaktivität ☐ grenzw. ☐ auffällig ☐ k.A.

Fragebogen für das Alter von ☐ 4 ☐ 5 ☐ 6 Jahren

**Elternangaben**

**Dauer KiTa-Besuch bis jetzt (in Jahren):** nie ☐ bis 1 ☐ 1 bis 2 ☐ 2 bis 3 ☐ >3 ☐ k.A. ☐

**spezielle Förderung / Therapie** nein ☐ ja ☐ k.A. ☐

| | ja | WL | | Beginn Monat / Jahr | Ende Monat / Jahr |
|---|---|---|---|---|---|
| Sprachförderung in KiTa | ☐ | ☐ | | ☐☐/20☐☐ | ☐☐/20☐☐ |
| Logopädie | ☐ | ☐ | | ☐☐/20☐☐ | ☐☐/20☐☐ |
| Ergotherapie | ☐ | ☐ | | ☐☐/20☐☐ | ☐☐/20☐☐ |
| Psychotherapie / psychiatrische Therapie | ☐ | ☐ | | ☐☐/20☐☐ | ☐☐/20☐☐ |
| Andere Förder- o. Heilmaßnahmen | ☐ | ☐ | | ☐☐/20☐☐ | ☐☐/20☐☐ |

Welche?_____

**Medienkonsum (h/Tag)** Wochentag nie ☐ bis 1/2 ☐ 1/2 bis 2 ☐ 3 bis 4 ☐ ≥5 ☐

Samstag / Sonntag nie ☐ bis 1/2 ☐ 1/2 bis 2 ☐ 3 bis 4 ☐ ≥5 ☐

| | Mutter | Vater |
|---|---|---|
| Hat die deutsche Staatsangehörigkeit | ☐ ja ☐ nein | ☐ ja ☐ nein |
| ist in Deutschland geboren | ☐ ja ☐ nein | ☐ ja ☐ nein |

| **Schulabschluss** | Mutter | Vater |
|---|---|---|
| <10. Klasse | ☐ | ☐ |
| 10. Klasse | ☐ | ☐ |
| Abitur, FH-Reife | ☐ | ☐ |
| keine Angabe | ☐ | ☐ |

| **Berufstätigkeit** | Mutter | Vater |
|---|---|---|
| Vollzeit | ☐ | ☐ |
| Teilzeit | ☐ | ☐ |
| nicht erwebstätig | ☐ | ☐ |
| Sonstiges | ☐ | ☐ |
| keine Angabe | ☐ | ☐ |

# EINSCHULUNGSUNTERSUCHUNG

**Basisuntersuchung am** ☐☐.☐☐. 20☐☐

**Datum der Sprachstandsdiagnose (SETK 3-5):** ☐☐.☐☐. 20☐☐

ARZT: ☐10 ☐20 ☐30 ☐40 ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9

**SETK (Sprachentwicklungstest für Kinder 3-5,** nur bei Kindern mit Unsicherheiten im vorausgegangenen Sprachscreening in der Basisuntersuchung)

Nicht durchführbar ☐ Befund vorgelegt ☐ extern vergeben ☐

| 1. SETK | | | | |
|---|---|---|---|---|
| Verstehen von Sätzen (VS) | Satzgedächtnis (SG) | Phonolog. Gedächtnis Nichtwörter (PGN) | Morphologische Regelbildung (MR) | Gedächtnisspanne für Wortfolgen (GW) |
| Rohwerte: ☐☐ | ☐☐☐ | ☐☐ | ☐☐ | ☐ |
| verweigert / abgebrochen | | | | |
| ☐V ☐A | ☐V ☐A | ☐V ☐A | ☐V ☐A | ☐V |

| Bewertung Sprache (sofern nicht auf Seite 4 markiert oder nicht direkt in PC eingegeben) | ☐ Folgende Bewertung in die Akte übernehmen (Achtung: eine evtl. schon vorhandene Gesamtbewertung wird damit überschrieben) | Arzt | Int.FB | häusl. /VSP | In Behandl. | A.E. |
|---|---|---|---|---|---|---|
| | | ☐ | ☐ | ☐ | ☐ | ☐ |

**Schritt 2**

Untersuchung in Schritt 2 am ☐☐.☐☐. 20☐☐

ARZT: ☐10 ☐20 ☐30 ☐40 ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9

SMA: ☐10 ☐20 ☐30 ☐40 ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9

Untersuchungsverfahren: SOPESS ☐ anderes ☐ SETK ☐

| 2. SETK | am ☐☐.☐☐. 20☐☐ | | | Sprachförderung hat stattgefunden ☐ |
|---|---|---|---|---|
| Nicht durchführbar ☐ | Befund vorgelegt ☐ | | | extern vergeben ☐ |
| Verstehen von Sätzen (VS) | Satzgedächtnis (SG) | Phonolog. Gedächtnis Nichtwörter (PGN) | Morphologische Regelbildung (MR) | Gedächtnisspanne für Wortfolgen (GW) |
| Rohwerte: ☐☐ | ☐☐☐ | ☐☐ | ☐☐ | ☐ |
| verweigert / abgebrochen | | | | |
| ☐V ☐A | ☐V ☐A | ☐V ☐A | ☐V ☐A | ☐V |

Bewertung der Sprache ohne Artikulation (nach einem durchgeführten oder vorgelegten SETK, oder auch in Ausnahmefällen ohne SETK):

| altersentsprechend | In Behandlung | Zusätzliche intensive Fördermaßnahmen | häusl / Förderung im Rahmen des Orientierungsplanes | Arzt |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

Erzieherin: nicht im KiGa ☐ nicht möglich ☐ keine EV ☐ Beobachtungsdatum ☐☐.☐☐. 20☐☐

auffällig:

| Körpermotorik | Körperbew. | H-F-Mot. | Sprachent. | Kog.Ent. | soz.Komp. |
|---|---|---|---|---|---|
| ☐☐☐ 1 2 3 | ☐☐ 1 2 | ☐ 1 | ☐☐ 1 2 | ☐☐ 1 2 | ☐☐ 1 2 |

| emot.Komp. | Selbständigkeit | Hinw. auf Hyperaktivität | |
|---|---|---|---|
| | | grenzw. | auffällig |
| ☐☐ 1 2 | ☐☐ 1 2 | ☐ | ☐ |

**Notizen und Befunde:** ärztliche (Wieder-)Vorstellung ☐ Schritt 2 unauffällig ☐

Hinweise auf besondere **Bedarfe**:

| Körper | Sehverm. | Gehör | geistig | Sprache | Förderschule | Sonstiges |
|---|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

Empfehlung zur **Zurückstellung** ☐ Schrift 2 der ESU **abgeschlossen** ☐

Datum, Unterschrift Arzt / Ärztin

## Befundbogen für sorgeberechtigte Personen und zur Weitergabe an den Arzt/die Ärztin

Name, Vorname, Geburtsdatum

*Bei der Untersuchung anwesend waren* *Datum der Untersuchung* **Alter:**

### Impfstatus und U-Heft

### Impfbuch

| | Tetanus | Diphtherie | Pertussis | HIB | HBV | Polio | Pneumo | MMR | Masern mono | Röteln mono | Varizellen | Meningo-C | FSME | HAV | | Influenza 1 | Influenza 2 | Rotarix | Rotateq |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14/15 | | | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 15/16 | | | 1 | 1 |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | 2 | 2 | 16/17 | | | 2 | 2 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | 3+ | 3+ | 17/18 | | | | 3 |
| 4+ | 4+ | 4+ | 4+ | 4+ | 4+ | 4+ | | | | | | | Andere Impfungen: | | | | | | |

**Erläuterungen zum Impfstatus:** Die **hervorgehobenen Felder** zeigen an, welche **Standardimpfungen** ein Kind bis zum **Alter von 23 Monaten** erhalten haben sollte (Impfkalender 2016/2017 der Ständigen Impfkommission beim Robert Koch-Institut). **Fehlende Impfungen** sollten **zum frühestmöglichen Zeitpunkt nachgeholt** werden. Ausnahme: Pneumokokken-Impfungen werden nach dem 24. Lebensmonat nicht nachgeholt. Bei besonderen Impfplänen können einzelne Impfdosen gegen Haemophilus influenzae B, Hepatitis B und Polio entfallen. Im Alter von 5 bis 6 Jahren steht eine Auffrischungsimpfung gegen Tetanus, Diphtherie und Keuchhusten an (siehe A). Weitere Impfungen, zum Beispiel gegen FSME (Frühsommermeningoenzephalitis), können je nach dem Lebensumfeld eines Kindes angezeigt sein. Bitte sprechen Sie Ihren Arzt darauf an.

Gesetzliche Früherkennungsuntersuchungen U-Heft nicht vorgelegt ☐ Fehlende Vorsorgeuntersuchungen:

### Befunde im Einzelnen

Größe ☐ Gewicht ☐ kg BMI ☐ Bewertung:

### Einbeinhüpfen

rechts ☐ Hüpfer links ☐ Hüpfer

### Hörtest (Reintonaudiometrie in kHz/20 dB)

rechts alle Freq. bei 20 dB gehört ☐ links alle Freq. bei 20 dB gehört ☐ Mögliche Sti

| Gehört: | 0,5 | 1 | 2 | 4 | 6 |
|---|---|---|---|---|---|
| 30 dB | ☐ | ☐ | ☐ | ☐ | ☐ |
| 40 dB | ☐ | ☐ | ☐ | ☐ | ☐ |
| ≥50 dB | ☐ | ☐ | ☐ | ☐ | ☐ |

| Gehört: | 0,5 | 1 | 2 | 4 | 6 |
|---|---|---|---|---|---|
| 30 dB | ☐ | ☐ | ☐ | ☐ | ☐ |
| 40 dB | ☐ | ☐ | ☐ | ☐ | ☐ |
| ≥50 dB | ☐ | ☐ | ☐ | ☐ | ☐ |

### Sehtest (Sehvermögen in die Ferne)

rechts | | links | |

auffällig:

### Graphomotorik

Händigkeit Führung

Druck

Haltung Gesamtbewertung

### Malentwicklung

Nachmalen von Zeichen (DP0/DP1) ☐ von ☐ richtig gemalt

Menschzeichnung

### Spontane Mengenerfassung

Kann die Menge von ☐ spontan erfassen

### Sprache

**Familiensprache(n)**

**Artikulation** auffällige Laute:

**Spontansprache** ohne gezielte Prüfung fielen auf:

**HASE (Heidelberger Auditives Screening in der Einschulungsuntersuchung)**

Sätze nachsprechen ☐ Punkte

Zahlen wiedergeben ☐ Punkte

Kunstwörter nachsprechen ☐ Punkte

*Nur wenn beim Nachsprechen von HASE-Sätzen 7 Punkte (6-Jährige) erreicht wurden:*

**Sprachverständnis** ☐ von drei Manipulationsaufgaben (KVS) richtig ausgeführt

Gesamtbewertung

### Verhalten (in Untersuchung)

Aufgefallen war

### Weitere Maßnahmen aus Schritt 1

### Notizen

Datum und Unterschrift des Arztes/der Ärztin Unterschrift der Assistentin

V. ISGA 2015.R06

**Questionnair for parents**

## Fragebogen für sorgeberechtigte Personen (Schritt 1)

**Sehr geehrte Eltern,**
**sehr geehrte Sorgeberechtigte,**

erleichtert wird die Einschulungsuntersuchung, wenn frühere Erkrankungen und die Entwicklung des Kindes bekannt sind. Deshalb bitten wir Sie, mit diesem Fragebogen Fragen zur familiären und gesundheitlichen Situation Ihres Kindes zu beantworten.

Die Beantwortung aller Fragen ist **freiwillig**. Sie können den Fragebogen vollständig, teilweise oder gar nicht ausfüllen. Nur mit Ihren Angaben können wir Untersuchung und Beratung auf Ihr Kind abstimmen. Abgesehen hiervon entsteht Ihrem Kind und Ihnen jedoch kein Nachteil, wenn Sie den Bogen nicht oder nicht vollständig ausfüllen.

Der Fragebogen wird nach der Einschulungsuntersuchung mit den anderen Unterlagen Ihres Kindes zur schulärztlichen Untersuchung im Gesundheitsamt verschlossen aufbewahrt und spätestens vier Jahre nach der termingerechten Einschulung beim Gesundheitsamt vernichtet. Eine Weiterleitung des Fragebogens an die Schule oder eine andere Stelle erfolgt unter keinen Umständen.

Wenn Sie den Fragebogen ausgefüllt an uns zurück geben, willigen Sie ein, dass wir den Fragebogen für die Untersuchung Ihres Kindes nutzen. Sie können den Fragebogen jederzeit zurück erhalten. Ihre Angaben aus dem Fragebogen werden danach nicht mehr verwendet.

Mit freundlichen Grüßen

*(Angabe von Kontaktdaten des Gesundheitsamtes)*

Name, Vorname und Geburtsdatum des Kindes

Kindertageseinrichtung/Gruppe

Telefon-Nummer der Eltern/Sorgeberechtigten (für Rückfragen)

**1. Wie lange besucht Ihr Kind bis jetzt eine Kindertageseinrichtung?**

| nie | bis zu 1 Jahr | 1 bis 2 Jahre | 2 bis 3 Jahre | 3 Jahre und länger |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

Wie viele Stunden ist Ihr Kind pro Woche in der Kindertageseinrichtung?

☐ Stunden

**2. Bei wem lebt Ihr Kind hauptsächlich?** *(Hier bitte nur ein Kreuz machen!)*

Bei den Eltern ○

Bei einem Elternteil (Mutter oder Vater) ○

Andere (bitte ergänzen) ○ _____

**3. Mit wie vielen Geschwistern/Halbgeschwistern lebt Ihr Kind zusammen?**

**Anzahl:** ☐

Bitte geben Sie das Geburtsjahr der Geschwister/Halbgeschwister an:

☐☐☐☐ ☐☐☐☐ ☐☐☐☐ ☐☐☐☐

**4. Welche Sprachen wurden mit Ihrem Kind während der ersten drei Lebensjahre gesprochen?**

Deutsch ○ Andere Sprachen ○ Deutsch und eine andere Sprache ○

Welche anderen Sprachen? _____

**5. In welchem Land wurde Ihr Kind geboren?**

In Deutschland ○

In einem anderen Land ○

In welchem? _____

## 6. Einige Fragen zum Gesundheitszustand Ihres Kindes

### 6.1 Hat oder hatte Ihr Kind jemals folgende Krankheiten?

Hörstörungen — Ja ○ Nein ○

Wenn ja, ist das Kind deswegen aktuell in Behandlung? — Ja ○ Nein ○

Sehstörungen — Ja ○ Nein ○

Wenn ja, ist das Kind deswegen aktuell in Behandlung? — Ja ○ Nein ○

Hat Ihr Kind eine Brille (Sehhilfe)? — Ja ○ Nein ○

Wenn ja, in welchem Alter hat Ihr Kind die Sehhilfe bekommen? Mit ☐ Jahren

Andere chronische Erkrankung (beispielsweise Asthma, Rheuma, Zuckerkrankheit, Herzleiden, Anfallsleiden) — Ja ○ Nein ○

Wenn ja, welche: _____

Hat Ihr Kind eine Behinderung — Ja ○ Nein ○

Wenn ja, welcher Art? _____

Ist Ihr Kind jemals operiert worden? — Ja ○ Nein ○

Wenn ja, warum? _____

War Ihr Kind schon mal im Krankenhaus/ Sozialpädiatrischen Zentrum (SPZ)? — Ja ○ Nein ○

Wenn ja, warum? _____

### 6.2 Benötigt oder nimmt Ihr Kind vom Arzt/von der Ärztin verschriebene Medikamente? (außer Vitamine) — Ja ○ Nein ○

Wenn ja, welche? _____

Müssen Medikamente während der Zeit in der Kindertages-Einrichtung/in der Schule verabreicht werden? — Ja ○ Nein ○

Wenn ja, welche? _____

### 6.3 Bekommt oder wartet Ihr Kind auf eine spezielle Förderung oder Therapie? — Ja ○ Nein ○

| Wenn ja, bitte ankreuzen: | | Kind steht auf der Warteliste | Therapie begonnen (Monat/Jahr) | Falls Therapie beendet, wann? (Monat/Jahr) |
|---|---|---|---|---|
| ○ | Sprachförderung in der Kindertageseinrichtung | ○ | | |
| ○ | Logopädie | ○ | | |
| ○ | Ergotherapie | ○ | | |
| ○ | Psychotherapie/ psychiatrische Therapie | ○ | | |

| | | | | |
|---|---|---|---|---|
| ○ | Andere Förder- oder Heil-maßnahmen* | ○ | | |

* Welche? _____

Eine Beratung über …

eine Erziehungsberatungsstelle: geplant ○ findet statt ○ abgeschlossen ○

ein Sozialpädiatrisches Zentrum (SPZ): geplant ○ findet statt ○ abgeschlossen ○

**7. Wie lange sieht Ihr Kind durchschnittlich pro Tag Fernsehsendungen und Filme an und/oder spielt mit dem Smartphone/Tablet/ Computer/an der Spielkonsole?**
(Bitte kreuzen Sie an, was am ehesten zutrifft.)

| | Gar nicht | Bis zu 30 Minuten/Tag | ½ bis 2 Stunden/Tag | 3 bis 4 Stunden/Tag | 5 oder mehr Stunden/Tag |
|---|---|---|---|---|---|
| An einem Wochentag | ○ | ○ | ○ | ○ | ○ |
| An einem Samstag/Sonntag | ○ | ○ | ○ | ○ | ○ |

Steht ein Fernsehgerät/ein PC/eine Spielkonsole im Kinderzimmer? Ja ○ Nein ○

**8. Machen Sie sich Sorgen um die Entwicklung oder das Verhalten Ihres Kindes**
(beispielsweise wegen einer in der Familie vorkommenden Lese-Rechtschreibschwäche, psychischen Belastung oder anderer Probleme in der Familie)? Ja ○ Nein ○

Wenn Sie dazu eine Beratung wünschen, dann nehmen Sie bitte Kontakt mit uns auf.

**9. Was sind Stärken und Begabungen Ihres Kindes?**

_____

_____

_____

---

**Die folgenden Angaben sind, wie der übrige Fragebogen auch, freiwillig.**

**Sie werden zur anonymen statistischen Auswertung ausschließlich dem Landesgesundheitsamt zur Verfügung gestellt.**

## Die Eltern des Kindes

| | Mutter | Vater |
|---|---|---|
| sind geboren im Jahr: | ☐☐☐☐ | ☐☐☐☐ |

haben folgende Staatsangehörigkeit:

| | | |
|---|---|---|
| deutsch | ○ | ○ |
| andere Staatsangehörigkeit | ○ | ○ |
| Wenn ja, welche? | _____ | _____ |

sind in folgendem Land geboren:

| | | |
|---|---|---|
| Deutschland | ○ | ○ |
| in einem anderen Land | ○ | ○ |
| Wenn ja, in welchem? | _____ | _____ |

| | | |
|---|---|---|
| leben hauptsächlich in Deutschland seit (Jahreszahl): | ☐☐☐☐ | ☐☐☐☐ |

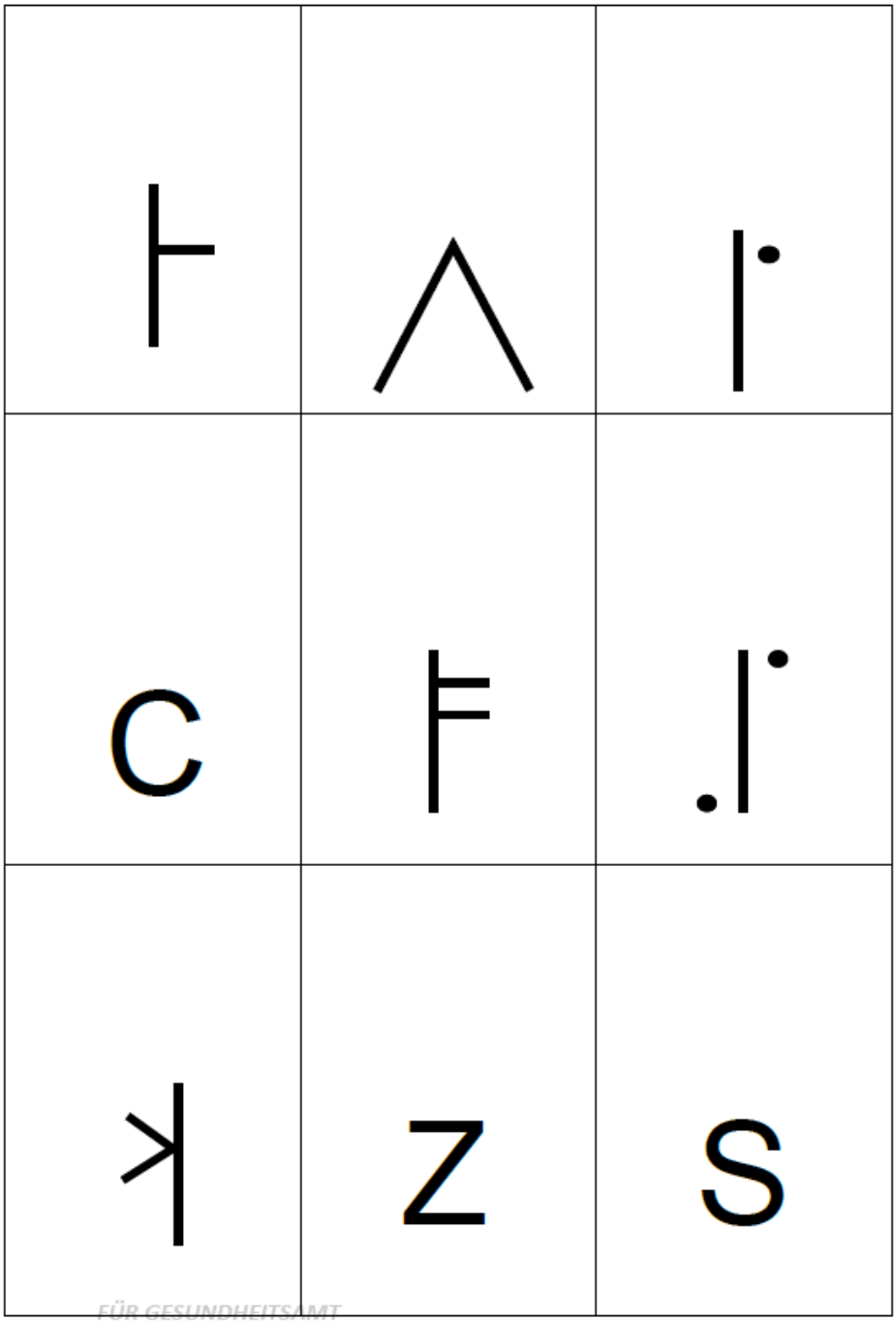
Angaben zum Schulabschluss:

| | | |
|---|---|---|
| weniger als 10. Klasse | ○ | ○ |
| 10. Klasse | ○ | ○ |
| Abitur, FH-Reife | ○ | ○ |
| Keine Angabe | ○ | ○ |

Angaben zur Berufstätigkeit:

| | | |
|---|---|---|
| in Vollzeit erwerbstätig* | ○ | ○ |
| in Teilzeit erwerbstätig* | ○ | ○ |
| nicht erwerbstätig | ○ | ○ |
| Sonstiges (z. B. Elternzeit) | ○ | ○ |
| Keine Angabe | ○ | ○ |

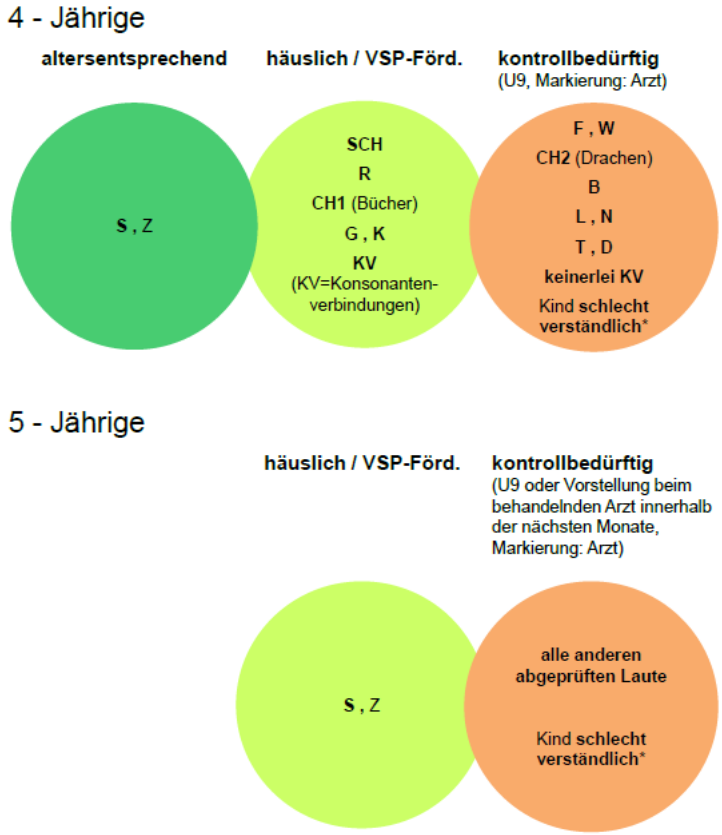
**Appendix 2 Motor skills test template**



## Appendix 3 The pictures from the sound test sheet

| | | |
|---|---|---|
|  |  |  |
| B-CH1-R | W-F-L | V(F)-G-L |
|  |  |  |
| G-B-L | K-Z- | DR-CH2-N |
|  |  |  |
| D-M-N | T-SCH | SCH-R- |
|  |  |  |
| S-N- | ZW-RG | KN-PF- |
|  |  |  |
| L-F-L | N-ST | R-F-N |

## Appendix 4 Assessment of the articulation in the ESU




* **Kontrollbedürftig** (Markierung: Arzt) nur, sofern aufgrund der schlechten Verständlichkeit des Kindes Auswirkungen auf die Kommunikationsfähigkeit und Teilhabe vermutet werden.

# CURRICULUM VITAE

**Personal information**

| | |
|---|---|
| Name: | Liu |
| First name: | Weina |
| Gender: | Female |
| Date of Birth: | 19/05/1986 |
| Place of Birth: | Xinjiang, China |
| Marital status: | Married |
| Nationality: | China |
| Email-address: | liuweina0519@126.com |

**Education**

| | |
|---|---|
| Mar. 2018 - Present | Institute of Global health, Medcine faculty, Heidelberg University, Heidelberg, Germany |
| Sept. 2009 - Jun. 2011 | Shandong University, Jinan, China<br>Bachelor Degree of Preventive Medicine. |
| Sept. 2009 - Jun. 2014 | Shandong University, Jinan, China<br>Master Degree of Child and Adolescent Health &Maternal and Child Health Care. |
| Sept. 2006 - May. 2009 | Shehezi No.1 High School of Xinjiang Province, Shehezi, China |

**Publications**

Liu, W., Schwertz, R., Welker, A., Welker, J., Chen, S., Dambach, P., & Marx, M. (2021). Associations between BMI and visual impairment of 33 407 preschool children in Germany: a pooled cross-sectional study. European Journal of Public Health, 31(1), 105-111.

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# EIDESSTATTLICHE VERSICHERUNG

1. Bei der eingereichten Dissertation zu dem Thema
HSP70 promotes cell proliferation and inhibits cell apoptosis through the interaction with eIF4G in hepatocellular carcinoma 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.
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