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Master of Science in International Health

**Prevalence of anemia among Indigenous children in Latin
America: a systematic review**

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Executive Summary

Background

Child anemia is still a critical public health problem around the world (Aheto *et al.*, 2019). It is the most common blood disorder worldwide and mainly affects developing countries (McLean *et al.*, 2008). It afflicts 27% of people worldwide, 89% of whom live in low- and middle-income countries (Kassebaum, 2016), affecting children from Indigenous and non-Indigenous communities. In Latin America there are approximately 58 million people who belong to around 800 Indigenous communities, representing 9.8% of the regional population (CEPAL, 2020b). Indigenous children in many countries in Latin America live in extremely vulnerable conditions, including worrying levels of malnutrition in situations of food insecurity, difficult access to water and elevated prevalence of diarrheal infections (Pan American Health Organization, 2013). Even though there are several studies about malnutrition and anemia that included Indigenous children, no systematic review about anemia among Indigenous children in Latin America is available.

Objective

To describe the prevalence pattern of anemia among Indigenous children in Latin America.

Methods

The present systematic review was carried out following the PRISMA guidelines for meta-analyses and systematic reviews. Data were extracted from three databases (PubMed, Google Scholar, and LILACS) by two independent researchers between May and June 2021. Inclusion in the systematic review was based on the following criteria:

Indigenous: The study population consisted of aboriginal or Indigenous people, those living from the oldest known period and whose culture is separate from that of colonizers or new settlers. Excluded were those that do not have a specific categorization of Indigenous people in their results. **Prevalence of anemia:** Anemia was reported as a primary or secondary outcome in the study. Excluded were all the articles not mentioning prevalence of anemia even though they could present results

about malnutrition. **Children:** The study was conducted on children, from 0 to 12 years old. Excluded were all those articles that focused only on teenagers from 13 years old and older. If studies report both estimates for children from 0 to 12 and for children 13 years and older, we included them. **Countries:** The study was conducted in any of the countries of Latin America. Excluded were studies that covered all countries in the Caribbean which are not part of continental South and Central America. **Language:** The study languages considered were English, Spanish, and Portuguese. **Peer-reviewing:** Only published peer-reviewed articles were selected. Dissertations from bachelors, master or PhD degrees were not considered in this study. **Date:** All articles found in the searches will be included irrespective of the date provided they met all the previous eligibility criteria.

Results

Most of the articles found were in English. However, almost half of the articles included in this systematic search were in Spanish and Portuguese (In English: 23, Spanish: 9, Portuguese: 9). The oldest article was from 1987 and the newest article was from 2021. 10 studies used data at the national level and the other studies were conducted in 30 specific regions. Almost all the studies were cross-sectional studies (40 articles) and 2 cohort studies. Bolivia, Brazil, and Peru showed the highest values of prevalence of anemia in this systematic review (see Appendix 5). The highest value of prevalence of anemia including boys and girls (86.1%) was found in Brazil, among Terenas children from 6-24 months in Córrego Seco and Limão Verde, district of Aquidauana, in Mato Grosso do Sul state (Morais, Alves and Fagundes-Neto, 2005). Almost all the Indigenous communities reported in this systematic review presented values of prevalence of anemia as a severe public health problem ($\geq 40.0\%$); those communities were Achuar, Urarina, and Quichua, Aguaruna, Aruak, Awajún, Aymara, Cabécar, Guaraní, Kamaiurá, Karapotó, Karibe, Kaxinanuá, Macro-Jê, Piaroa, Quechua, Suruí, Terena, Xavante, Yomybato, Yucpa.

Conclusions

- ✓ Anemia constitutes a severe public health problem among Indigenous children in Bolivia, Brazil, Colombia, Costa Rica, Ecuador, Guatemala, Mexico, and Peru.

21 Indigenous communities in Latin America showed child anemia as a severe public health problem.

- ✓ 39 Indigenous communities in Latin America have been reported to have child anemia as a public health problem.
- ✓ Risk factors for anemia include being Indigenous, and thus living conditions, and access to health services; specific nutritional causes; and the prevalence of infectious diseases such as hepatitis, parasitosis, and skin and respiratory tract infections.
- ✓ Articles from countries like Guatemala and Bolivia, which have the highest proportion of Indigenous communities in Latin America do not exceed three articles in this systematic review (Guatemala 1, Bolivia 2). This is an indicator of how scarce studies about prevalence of anemia among Indigenous children in Latin America are.
- ✓ Indigenous children from all ages show prevalence of anemia. However, those that are below two years old showed higher values.
- ✓ The most recent reported date of data collection was 2017 considering all the studies included in this systematic review. Therefore, more up-to-date research is needed to provide current values of prevalence of anemia among Indigenous children in Latin America.

1.1. Recommendations

- It is crucial to conduct further studies to document prevalence of anemia of specific Indigenous communities in Latin America.
- Studies about prevalence of anemia among Indigenous children should be combined with other studies about malnutrition to have more information about how to prevent anemia.
- Governments should increase the number of community effectiveness studies to assess the impact of nutrition campaigns among Indigenous communities.
- Studies of prevalence of anemia from Indigenous communities present in different countries, such as the Aymara and Quechua, should be compared to have a better understanding of the general situation of those communities.

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Chapter 1

1. Introduction

1.1. Anemia

Worldwide, childhood anemia remains a significant public health problem (Aheto *et al.*, 2019). In 2016, it was estimated that 155 million children under five years experienced a delay in growth around the world (22.9%) (UNICEF/WHO/World Bank Group, 2017). Anemia is a blood disorder in which erythrocytes are unable to transport oxygen through hemoglobin (Hb) to tissues and is defined by Hb levels below age- and gender-specific thresholds (WHO, 2011). In developing countries, it is the most common blood disorder (McLean *et al.*, 2008). About 27% of people worldwide are affected, and 89% live in low- or middle-income countries (Kassebaum, 2016). Frequently, multiple factors contribute to anemia's etiology, and sociodemographic conditions play an important role, especially in countries with low income (WHO, 2017). By identifying the main risks associated with anemia while taking into account associated sociodemographic circumstances, it will become possible to prioritize prevention strategies (Vázquez *et al.*, 2019).

1.1.1. Vulnerable groups

Anemia is most prevalent in population groups under the age of 5 years, particularly infants and children under the age of two, adolescents, and women of reproductive age (15–49 years); it is also common among the elderly, though their prevalence and etiology are not as well-known as their younger counterparts (WHO, 2017).

1.1.2. Health consequences

Recent research has estimated that anemia accounts for close to 9% of the global disability burden throughout all conditions (FAO, 2017). As a result, it has significant effects on human health and economic development. Anemia is associated with negative outcomes among several populations, including maternal mortality, low birthweight, premature births, and delayed development among young children; however, despite strong biological plausibility, no causal link has been established for all outcomes (WHO, 2017).

1.1.3. Impact of anemia on the economy and development

Anemia affects work productivity and cognitive development in adults and children, so quantitative analyses have been conducted on the economic impact of anemia on income or wage losses resulting from reduced productivity or impairments to cognitive development. Anemia and iron deficiency are estimated to cause physical and cognitive losses of US\$ 3.64 per person, or 0.81 % of gross domestic product (GDP), in some developing countries (WHO, 2017). The lifetime costs of iron-deficiency anemia in India, where anemia is very common, for example, were estimated as 8,3 million disability-adjusted life years (DALYs) and \$24 billion (corresponding to 1.3% of GDP) in 2013 (Plessow *et al.*, 2015).

1.1.4. Assessment of anemia

Anemia is most frequently assessed at a population level by measuring blood hemoglobin concentration; however, it can also be diagnosed more rarely by measuring hematocrit (packed cell volume), mean cell volume, blood reticulocyte count, or using hemoglobin electrophoresis. Hemoglobin levels vary depending on factors such as age, gender, height, smoking status, and physiological state (e.g. pregnancy) (WHO, 2017). Anemia will be indicated if a hemoglobin level is below cutoff values for sex, age, and pregnancy (WHO, 2011).

1.1.5. Magnitude and distribution of anemia

All countries for which country-level estimates were generated had a prevalence of anemia of at least 5%, indicating at least a mild public health problem (WHO, 2017). According to the World Health Organization (2017), anemia is regarded as a problem of public health significance as follows:

Table 1. Categories of public health significance of prevalence of anemia.

Prevalence of anemia (%)	Category of public health significance
≤4.9	No public health problem
5.0–19.9	Mild public health problem
20.0–39.9	Moderate public health problem
≥40	Severe public health problem

1.2. Latin America

Geographically, Latin America is all the countries of South America and Central

America (including Mexico), i.e., the entire hemisphere excluding North America (Sánchez-Recio, 2019). Although there is a lot of controversy about what Latin America is and that such a position cannot be entirely correct (Sánchez-Recio, 2019), in this study Latin America will include the following countries: Argentina, Belize, Bolivia, Brazil, Colombia, Chile, Costa Rica, Ecuador, El Salvador, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panamá, Paraguay, Peru, Surinam, Uruguay and Venezuela.

Latin American countries are characterized by the presence of Indigenous communities that were present before the settlement of the Spanish conquerors in 1492. From that moment on, Indigenous populations were treated differently. Some of those communities are still present in the continent with varied ways of living. Those living in the most remote areas, such as the Amazon rain forest or the Andean mountains or in the Colombian Sierra Nevada de Santa Marta have been able to preserve their traditions and receive special status from the governments to continue with their way of living. However, in most of the cases living in poverty.

In Latin America, there are estimated to be 58 million Indigenous people, who constitute 9.8% of the population (CEPAL, 2020b). There are countries having 41.0% of their population Indigenous, such as Bolivia or Guatemala, and others with 0.0% such as Uruguay (World Bank Group, 2015). Table 2 provides information on Latin America's Indigenous population and its proportion. In Latin America, the proportion of Indigenous people living in poverty is illustrated as follows: 72.9% in Panamá, 56.3% in Colombia, 52.2% in Mexico, 50.6% in Ecuador, 47.8% in Bolivia, 31.5% in Brazil, 20% in Peru, 15.4% in Chile and 3.7% in Uruguay (CEPAL, 2020b). This illustrates the dire state of Indigenous populations in many countries of Latin America.

In many countries of the region, Indigenous children are in a highly vulnerable situation. In some countries, the situation has become so acute that even national governments are recognizing the humanitarian crisis (e.g. Argentina and Colombia) given the very high infant mortality rate, a severe malnutrition crisis, precarious access to clean water, and a prevalence of diarrheal diseases. (Pan American Health Organization, 2013).

Table 2. Indigenous peoples and proportion of the total population in Latin American countries (World Bank Group, 2015).

Country	Indigenous peoples	Proportion of the total population*
Argentina	30	2.4%
Belize	4	NA
Bolivia	114	41.0%
Brazil	241	0.5%
Chile	9	4.6%
Colombia	83	3.3%
Costa Rica	8	2.4%
Ecuador	32	7.0%
El Salvador	3	0.2%
French Guiana	6	NA
Guatemala	24	41.0%
Guyana	9	NA
Honduras	7	7.2%
Mexico	67	15.0%
Nicaragua	9	6.0%
Panamá	7	12.2%
Paraguay	20	1.7%
Perú	52	26.0%
Surinam	5	NA
Uruguay	0	0.0%
Venezuela	50	2.8%
Total	780	7.8%
*The indigenous population was estimated using “self-identification” in all the censuses, except for Peru, which provides only “mother tongue” as a means of identification. In this case, the indigenous population was estimated by identifying as “indigenous” all the members of a household where the head of the household speaks an indigenous language.		

1.3. Prevalence of anemia in Indigenous children in Latin America

In Latin American countries, data about malnutrition in children under 5 years of age by ethnic group had been presented without reference to anemia prevalence until 2013 (Pan American Health Organization, 2013). Furthermore, there are some studies reporting prevalence of child anemia in Indigenous populations in most of Latin American countries, but there is no systematic review available that includes all the countries in Latin America providing a more comprehensive picture of the disease. As will be described below, there are systematic reviews and even some meta-analyses available but with focus on the general population, giving average estimates on population level, which masks the situation in the Indigenous communities

In similar contexts, systematic reviews and meta-analyses have been conducted about the prevalence of anemia in children. For example, Gebrie and Alebel (2021) determined the pooled prevalence of anemia and its predictor factors among children in Ethiopia and found that low socioeconomic status, low literacy, as well as helminthic infection of the children and rural residence of the families are predictors of anemia among children.

There have been several studies which included Indigenous children, but there is no systematic review on child anemia among Indigenous children in Latin America available. For example, as part of their review of the literature, Shimabuku *et al.* (2020) studied the availability of data on double burdens of overweight and obesity (OW/OB) in Latin-American children under five. According to the authors, the prevalence of anemia ranges from 3.4% to 67%, and the prevalence of anemia is greater in rural areas and at high altitudes, in extreme poverty, in low levels of education, and in Indigenous communities. Nevertheless, they do not report specific values for prevalence of anemia among Indigenous children.

A recent systematic review and meta-analysis estimated the prevalence of anemia in Latin America; according to their findings, the prevalence of anemia ranges from 4% in Costa Rica to 70% in Haiti for preschool children and from 2.5% in Argentina to 67.59% in Haiti for older children. In children aged under 12 years, the prevalence of anemia was 28.6 percent according to a random effects model (Vázquez *et al.*, 2019). However, they do not mention specific values for prevalence of anemia among Indigenous children.

A systematic review conducted in 2011 and updated in 2014 found that Chile had the lowest prevalence of anemia among children under 6 years of age (5.1%), in the middle were countries such as Peru with prevalence of anemia of 22% and in Panama and Haiti was 40% and 45.5%, respectively, showing the highest prevalence rates in the region (Mujica-Coopman *et al.*, 2015). According to their findings, anemia continues to be a public health problem for children under the age of 6 and women of childbearing age in most Latin American and Caribbean countries with data available, but again specific anemia prevalence values among Indigenous children were not reported.

One of the most recent systematic reviews and meta-analyses that aimed to estimate the prevalence of anemia in Latin America and the Caribbean used websites, reference lists, and electronic databases of health ministries (Vázquez *et al.*, 2019). Vázquez *et al.* (2019) used 61 studies which included 38,028 school-age 128,311 preschool- children from 21 Latin American countries and found that the number of children with anemia was 17.49% and 32.93%, respectively. However, they did not show values of prevalence of anemia for Indigenous children.

Other researchers reviewed the health research conducted among Indigenous populations in Latin America during the period 1995-2004 to better understand the key issues related to Indigenous health, and they concluded that policy studies are particularly needed in the area of Indigenous health (San Sebastián and Hurtig, 2007). However, this review does not provide specific values for prevalence of anemia in Indigenous children.

According to Horta *et al.* (2013) the First National Survey of Indigenous People's Health and Nutrition in Brazil, conducted in 2008–2009, was the most comprehensive study carried out on the nutritional status of Indigenous children in Brazil, and one of the most extensive and detailed ever in Latin America in that moment. Horta *et al.* (2013) evaluated the health and nutritional status of children < 5 years, in addition to interviewing mothers or caretakers, yet they did not present any values of prevalence of anemia in Indigenous children in Brazil.

Another review conducted by Lício, Fávaro and Chaves (2016) describes the frequency of anemia among Brazilian Indigenous children and women. They found that the rates of prevalence of anemia ranged from 29.6%-84%, 42.9%-92.3% and 23.1%- 74.6% for children aged, 6 to 59 months, 6 to 23 months, and 6 to 119 months, respectively. This is the most complete review found for a single country about prevalence of anemia in Indigenous children in Latin America. No other countries in the region have reported systematic reviews about prevalence of anemia of their Indigenous children.

There is a systematic review of the prevalence of anemia due to iron deficiency in Brazil between January 1996 and January 2007 available at the country level (Jordão, Bernardi and Barros Filho, 2009). Nevertheless, they do not mention Indigenous

children at all. A similar study, based on data on blood hemoglobin recorded in the Demographic and Family Health Survey (ENDES), 2007-2013, identified child and maternal-child care factors, as well as socio-demographic factors associated with anemia in children between 6 and 35 months in Peru (Velásquez *et al.*, 2016). They found that the prevalence of anemia of children from 6 to 35 months old was 47.9%, but they did not show specific values for Indigenous children.

At the global level, a systematic review was conducted in order to describe the prevalence, severity, and etiology of anemia in Indigenous populations worldwide between 1996 and 2010 (Khambalia, Aimone and Zlotkin, 2011). This was a thorough review that included four Latin American countries, Brazil, Guatemala, Mexico, and Venezuela, but does not provide a whole panorama of the Latin American continent.

Using data from Bolivia, Colombia, Guatemala, and Peru from the Demographic and Health Survey (DHS), researchers explored the effects of self-identifying as Indigenous and/or afro-descendant, as well as other variables (Mena-Meléndez, 2020); nevertheless, this study does not give specific numbers for Indigenous children. Finally, malnutrition in children was the subject of a report published by the Pan American Health Organization in 2008, which assessed malnutrition prevalence, age-specific deficiencies, and variations in poor growth among countries as well as among Indigenous children but refraining from reporting child anemia prevalence (Pan American Health Organization, 2008).

It is remarkable that there has been a great effort to study anemia as a public health problem in children in Latin America and that there have been studies concerned on showing the state of health of the Indigenous children population in Latin America. Due to the persistent invisibility of Indigenous people, national governments, international organizations, and researchers are trying to show the need for disaggregated data to especially consider Indigenous population in their studies and put particular attention to these groups that have been marginalized for several decades in the past.

1.4. Indigenous populations in Latin America

In an effort to define Indigenous peoples in an efficient manner, the International Labor Organization (ILO) Convention 169 on Indigenous and Tribal Peoples in Independent Countries provides a definition that can be used to identify at least four dimensions within Indigenous peoples: recognition of identity, common origin, territoriality and the linguistic and cultural dimension, which must be taken into account when establishing operational criteria (CEPAL, 2014).

Numerous factors, ranging from a lack of accurate and easily accessible information to the very nature of Indigenous identities in Latin America and the Caribbean, make it difficult to determine the exact number of Indigenous people in that region. (World Bank Group, 2015). It has become increasingly relevant and controversial to define who is and who is not Indigenous in the past few decades. Not only is this due to the emergence of groups that were thought extinct, but also to a new set of laws, covenants, and international agreements addressing Indigenous rights, Indigenous people trust their official recognition in making decisions that affect their lives, assets, and cultures. (World Bank Group, 2015). Indigenous people in Latin America are twice as likely to be poor as non-Indigenous people, according to the World Bank: 43% are poor and 24% are extremely poor, a rate nearly two times greater than non-Indigenous people (World Bank Group, 2015).

It is difficult to identify who is Indigenous and who is not. For some studies, researchers use the classification of a population of a particular region according to documents from the government of that country. However, in other cases, researchers determine who is Indigenous according to criteria set by themselves. For example, one criteria applied by Oliveira et al. (2011) was considering Indigenous those children whose parents or grandparents were Indigenous. Another criteria used by Franco et al. (1990) was that all children whose two surnames were of Mapuche origin (an Indigenous community particularly from Chile), who had physical features characteristic of their race and whose mothers recognized themselves as having Mapuche ancestry were considered as Mapuche. Another example is the study of Villalpando et al. (2003), in which an Indigenous child is one born into a family where

at least one mother aged 12-49 speaks a native language.

1.5. Purpose of the study

This study aims at providing a systematic and comprehensive overview of the situation of malnutrition of Indigenous children in Latin America in the last three decades. Since anemia is an indicator of both poor health and poor nutrition (McLean *et al.*, 2008), combining evidence from single studies about prevalence of anemia in Indigenous children in Latin America can provide valuable data to governments to continue working for the welfare of their Indigenous population, particularly children. A systematic literature review can also bring up explicit and comprehensive evidence for public health policymaking concerning feeding programs done by the governments of those countries. In addition, no systematic review of this topic currently exists.

1.6. Main Objective

To describe the prevalence pattern of anemia among Indigenous children in Latin America.

Chapter 2

2. Methodology

2.1. Introduction

This chapter describes how the studies about prevalence of anemia in Indigenous children in Latin America were searched, retrieved, and analyzed in a systematic way.

2.2. Study design

The study design is a systematic literature review, which aims to identify and synthesize the best quality evidence in relation to a specific research question (McClean *et al.*, 2020) using systematic methods to find out the answer to a specific question (Ahn and Kang, 2018). The results of systematic reviews summarize the results of well-designed studies and provide important information regarding the effectiveness of health interventions; for example, they are very useful in decision making in health care; For example, they are used to formulate clinical practice guidelines, economic analyses, decision-making processes, or risk assessments (Vidal Ledo, Oramas Díaz and Borroto Cruz, 2015). According to Pussegoda (2017), in healthcare decision-making, systematic reviews are considered the gold standard due to the fact that they evaluate all of the available evidence concerning specific questions, such as the benefits and harms of specific health care interventions.

2.2.1. Search strategy

PRISMA guidelines were followed in completing this systematic review. Data was extracted from three databases (PubMed, Google Scholar, and LILACS) by two independent researchers between May and June 2021. Discrepancies in search results were resolved by concordant agreement.

In this study the LILACS (Latin American and Caribbean Literature in Health Sciences) database is important because especially captures studies from the Latin American context. LILACS is a database available online with free and open access. It was created in 1982 due to the need of the countries of the region to register their intellectual production. It is still active today. It compiles articles from 918 publications from 26 countries, theses, congress proceedings, conferences, book

chapters, technical-scientific reports, and government publications (Di Stéfano, 2018).

2.2.2. Categories and key words

Key words were divided into four main categories as follows:

- Disease : Anemia
- Age : Children
- Location : Latin America
- Population : Indigenous

According to these categories, specific search terms will be used in the different databases. The following search terms were used for PUBMED and Google Scholar. Different spelling for countries and the Indigenous communities were used according to differences in common use.

- Location : Latin America

Central America, South America, Latin America, Argentina, Belize, Belice, Bélice, Bolivia, Brazil, Brasil, Colombia, Chile, Costa Rica, Ecuador, El Salvador, Guatemala, Guyana, Guiana, Honduras, Mexico, Méjico, México, Mejico, Nicaragua, Panama, Panamá, Paraguay, Peru, Perú, Surinam, Uruguay, Venezuela.

- Population : Indigenous

Indigenous, Mapuche, Atacameña, Guaraní, Guarani, Yanomami, Tikuna, Ticuna, Zenú, Zenu, Nasa, Pastos, Pasto, Emberá, Emberá-chamí, Embera, Emberachami, Aimara, Aymara, Bribris, Cabecares, Cabecar, Ngobes, Ngobe, Guaimies, Guaimi, Quichua, Quechua, Kechua, Kichwa, Lencas, Lenca, Maya, Mayas, Pipiles, Pipil, Garifuna, Xinka, Jinca, Ladino, Lempira, Intibuca, La Paz, Nahuas, Zapotecas, Zapoteca, Mixtecas, Mixteca, Otomíes, Otomí, Otomi, Tzotziles, Tzotzil, Tzeltales, Tzeltal, Mazahuas, Mazahua, Mazatecos, Mazateca, Huastecos, Huasteca, Choles, Chol, Purépechas, Purecha, Chinantecas, Chinanteca, Mixes, Tlapanecos, Tlapaneca, Tarahumaras, Tarmaura, Chorotega, Cacaoopera, Matagalpa, Kunas, Kuna, Ngobe-Bugle, Wounaan, Naso, Charrúa, Wayuu, Wayu, Wayú.

The searches in PUBMED and Google Scholar were run for only one combination adding the four categories with the Boolean operator “AND”. The different terms in each category were added with the Boolean operator “OR” as follows:

(Children OR Child OR Childhood OR Infant) AND (Anemia) AND (Central America OR South America OR Latin America OR Argentina OR Belize OR Belice OR Bélice OR Bolivia OR Brazil OR Brasil OR Colombia OR Chile OR Costa Rica OR Ecuador OR El Salvador OR Guatemala OR Guyana OR Guiana OR Honduras OR Mexico OR Méjico OR México OR Mejico OR Nicaragua OR Panama OR Panamá OR Paraguay OR Peru OR Perú OR Surinam OR Uruguay OR Venezuela) AND (Indigenous OR Mapuche OR Atacameña OR Guaraní OR Guarani OR Yanomami OR Tikuna OR Ticuna OR Zenú OR Zenu OR Nasa OR Pastos OR Pasto OR Emberá OR Emberá-chamí OR Embera or Emberachami OR Aimara OR Aymara OR Bribris OR Cabecares OR Cabecar OR Ngobes OR Ngobe OR Guaimies OR Guaimi OR Quichua OR Quechua OR Kechua OR Kichwa OR Lencas OR Lenca OR Maya OR Mayas OR Pipiles OR Pipil OR Garifuna OR Xinka OR Jinca OR Ladino OR Lempira OR Intibuca OR La Paz OR Nahuas OR Zapotecas OR Zapoteca OR Mixtecas OR Mixteca OR Otomíes OR Otomí OR Otomi OR Tzotziles OR Tzotzil OR Tzeltales OR Tzeltal OR Mazahuas OR Mazahua OR Mazatecos OR Mazateca OR Huastecos OR Huasteca OR Choles OR Chol OR Purépechas OR Purecha OR Chinantecas OR Chinanteca OR Mixes OR Tlapanecos OR Tlapaneca OR Tarahumaras OR Taraumara OR Chorotega OR Cacaopera OR Matagalpa OR Kunas OR Kuna OR Ngobe-Bugle OR Wounaan OR Naso OR Charrúa OR Wayuu OR Wayu OR Wayú).

LILACS database can be used in different ways. One way was using the same list of search terms as was used in Google Scholar and PUBMED. However, this search did not show more than 5 useful articles. Another way was using just three terms at a time. LILACS database was used through the Virtual Health Library using three search terms with the Boolean operator AND. Therefore, due to the different combinations possible, 214 searches were made combining the search terms, as follows:

1. Anemia AND child AND each of the countries in Latin America.
2. Anemia AND children AND each of the countries in Latin America.

3. Anemia AND child AND each of the Indigenous communities previously mentioned.
4. Anemia AND children AND each of the Indigenous communities previously mentioned.
5. Anemia AND crianças AND indios.

2.2.3. Criteria for inclusion and exclusion

Studies were included in the current systematic review if the following criteria were met:

- **Indigenous:** The study population included Indigenous people. Excluded were those that do not have a specific categorization of Indigenous people in their results.
- **Prevalence of anemia:** The study reported a prevalence estimate of anemia as a primary or secondary outcome. Excluded were all the articles not mentioning prevalence of anemia even though they could present results about malnutrition.
- **Children:** The study was conducted on children, from 0 to 12 years old. Excluded were all those articles that focused only on teenagers from 13 years old and older. If studies report both estimates for children from 0 to 12 and for children 13 years and older, we included them.
- **Countries:** The study was conducted in any of the countries of Latin America. Excluded were studies that covered all countries in the Caribbean which are not part of continental South and Central America.
- **Language:** The study languages considered were English, Spanish, and Portuguese.
- **Peer-reviewing:** Only published peer-reviewed articles were selected. Dissertations from bachelors, master or PhD degrees were not considered in this study.
- **Date:** All articles found in the searches will be included irrespective of the date provided they met all the previous eligibility criteria.

2.2.4. Study selection

PUBMED and Google scholar searches were done first, followed by LILACS searches, checking always for duplicates. This stage included title and abstract screening. In case of doubt, the methods section was screened to corroborate that the study included prevalence of anemia among Indigenous children in any Latin American country. Checking that all exclusion criteria were applied; a full list of relevant articles was created for data extraction.

2.2.5. Data extraction

Relevant information from selected studies was recorded by using a data extraction sheet according to the following categories: Study (title, author, year, journal), geographical location (country, region), type of study, study objective, design, dataset, sampling technique (random or convenience), date of data collection, sample size, age group, exposure, outcome, type of measurement (Percentage/Odds ratio/Risk ratio), statistical methods used, control group, study results, prevalence of anemia (%), study conclusions, study limitations, study recommendations, reviewer's notes.

2.3. Analysis

Provided the studies met the eligibility criteria, they were assessed for quality according to the STROBE Statement. The STROBE Statement describes a checklist of 22 items for articles about various kinds of studies, which include title, abstract, introduction, method, results, and discussion, providing guidance on writing observational studies that improves reporting of study results and facilitates critical analysis and interpretation of study results by reviewers, editors, and readers (Vandenbroucke *et al.*, 2007). The checklist is useful to help have clarity of reporting in articles as a prerequisite to evaluation (von Elm *et al.*, 2014).

Afterwards, the systematic search was analyzed, as well as the study characteristics. Then, a description of pooled results was given. A descriptive analysis of prevalence of anemia was done grouping by country, by age range and by Indigenous community.

Chapter 3

3. Results

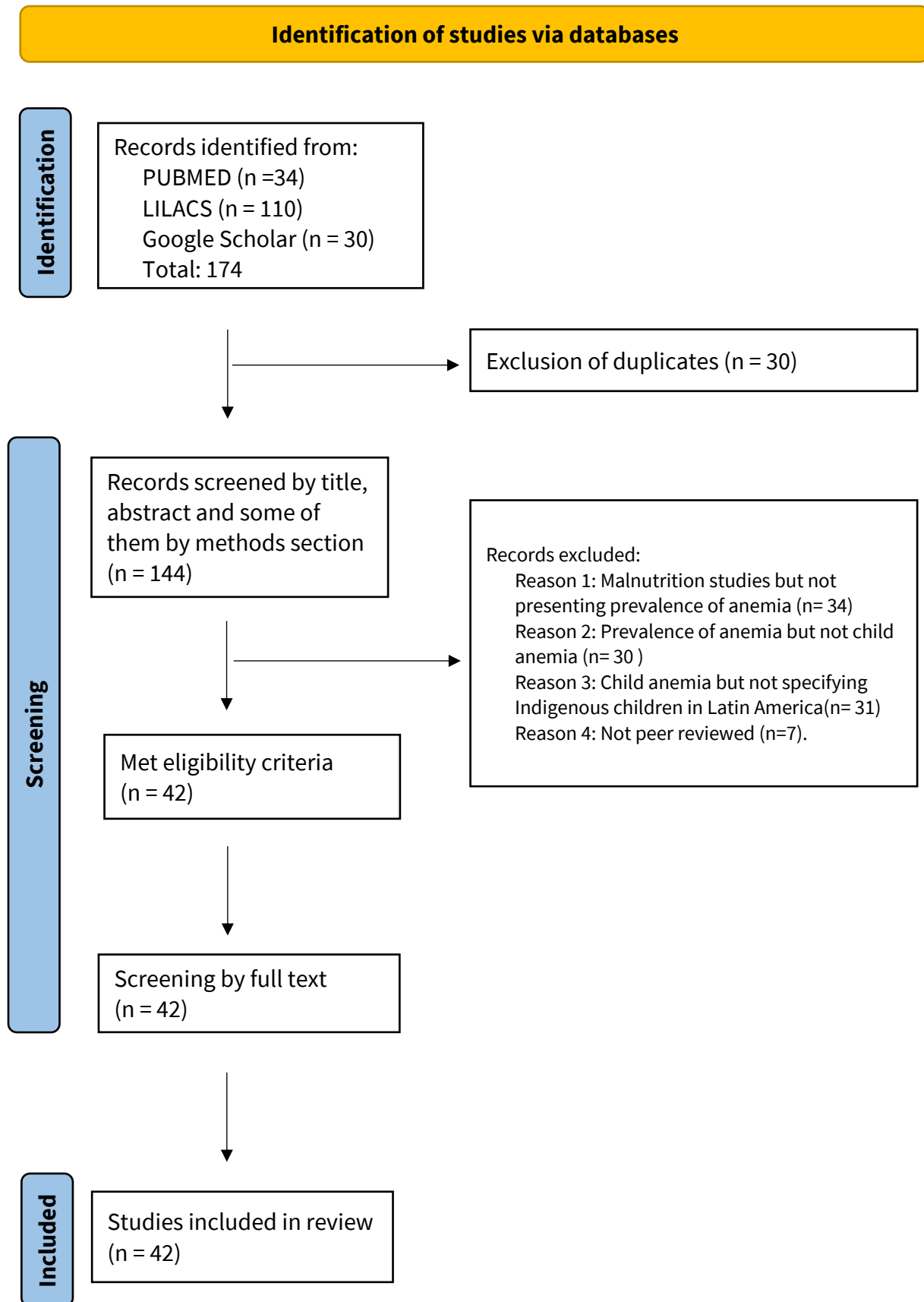
3.1. Introduction

In this chapter, we describe the results of a systematic search and analysis of studies that show the prevalence of anemia among Indigenous children in Latin America. Most of the studies are cross-sectional descriptive studies. Details for this are given below. The report of the articles is grouped in two sections, results of the systematic search and results of the analysis; for the latter there are three major groups: description of the general study characteristics, description of pooled results and description of the individual studies.

3.2. Results of the systematic search

The systematic search was done during May and June 2021. The preliminary search, undertaken using pre-defined search terms in 3 databases, yielded a total of 174 records (PUBMED (n = 34), LILACS (n = 110) and Google Scholar (n = 30)). Graph 1 describes the whole process according to PRISMA 2020 flow diagrams for systematic reviews. From the 174 records that were identified as useful for this study, 30 articles were excluded because of duplication. Afterwards, the remaining articles (n=144) were screened by title, abstract and some of them by methods section. At this stage, records were excluded mainly for five reasons. First, some of them were malnutrition studies but did not present prevalence of anemia (n=34); second, some articles presented prevalence of anemia but not child anemia (n=30); third, some presented child anemia but did not show specific data for Indigenous children in Latin America (n=31); and fourth, research works such as master or PhD thesis which are not peer reviewed were excluded (n=7). Thus, 42 articles met the eligibility criteria. Finally, these 42 articles were included in this systematic review.

Graph 1. PRISMA 2020 flow diagram for this systematic review.



There was a second reviewer that independently did the same searches done by the principal researcher. The second reviewer found 31 articles that matched with the principal researcher results. The other articles found by the second reviewer were not included because they did not meet the inclusion criteria.

3.3. Quality analysis and data extraction

Selected articles were assessed for quality according to the STROBE Statement. Scores ranged from 13 to 21 points for cross-sectional studies (Appendix 2) and the two cohort studies received scores of 21 and 35 (Appendix 3). All articles were judged of good quality to be included in the subsequent analyses.

3.4. Results of the systematic analysis

Data extracted from every article is shown in Appendix 1. A summary of this data can be found in Appendix 4, which shows values of prevalence of anemia by Indigenous community with basic data about the samples taken in all the articles included in this systematic review. Since there are two or more samples taken to measure prevalence of anemia in most of the articles, the different samples taken in all the studies were numbered from 1 to 133. Therefore, following graphs will have a number in parenthesis that makes a reference to one of those samples.

3.4.1. Description of the general study characteristics

3.4.1.1. Language, date and country

Most of the articles found were in English. However, almost half of the articles included in this systematic search were in Spanish and Portuguese (In English: 23, Spanish: 9, Portuguese: 9). The principal researcher was able to read and understand articles in these three languages. The oldest article was from 1987 and the newest article was from 2021. In this review, we reviewed studies conducted in various Latin American countries. The article distribution by country can be found in Table 3.

Table 3. Distribution of articles by country.

Country	# Articles	Percentage (%)	References
Bolivia	2	4.8	Cordero et al. (2019); Terán et al. (2018)
Brazil	13	31.0	Welch et al. (2020); Ferreira et al. (2017); Campos et al. (2016); Barreto et al. (2014); Coimbra et al. (2013); Leite et al. (2013); Pereira et al. (2012); Oliveira et al. (2011); Mondini et al. (2009); Orellana et al. (2006); Mondini et al. (2007); Morais et al. (2005); Baruzzi et al. (2001)
Chile	3	7.1	Franco et al. (1987); Franco et al. (1990); Franco et al. (1996)
Colombia	4	9.5	Cediel et al. (2020); Gaviria et al. (2017); Bolaños et al. (2014) Cardona et al. (2014)
Costa Rica	1	2.4	Monge-Rojas et al. (2005)
Ecuador	3	7.1	De Louize et al. (2021); Ramírez-Luzurriaga et al. (2020); Robalino et al. (2007)
Guatemala	1	2.4	Ramírez-Zea et al. (2014)
Mexico	7	16.7	Batis et al. (2020); Palacios-Rodríguez et al. (2019); De la Cruz-Góngora et al. (2018); Aguirre-Arenas et al. (2013); Monarrez-Espino et al. (2004); Rivera et al. (2003); Villapando et al. (2003)
Perú	5	11.9	Díaz et al. (2015); Flórez-Bendezú et al. (2015); Anticona & San Sebastian (2014); Cabada et al. (2014); Huamán-Espino & Valladares (2006)
Venezuela	3	7.1	Verhagen et al. (2013); García-Casal et al. (2008); Diez et al. (1999)
Total	42	100.0	

3.4.1.2. Region

Among the studies included in this review there are some articles that have a specific study area and others are studies that include data from a national database that covers the whole country area. In some cases, one study included more than one study area, for example Terán et al. (2018) included Caranavi (Yungas) and Taraco (Puna) in Bolivia. Mondini et al. (2007) and Mondini et al. (2009) were both conducted in the Mato Grosso region in Brazil. 10 studies used data at the national level and the other studies were conducted in 30 specific regions. Table 4 shows the distribution of articles by country and region.

Table 4. Distribution of articles by country and region.

Country	Region	Author
Bolivia	National	(Cordero <i>et al.</i> , 2019)
Bolivia	Caranavi (Yungas)	(Teran <i>et al.</i> , 2018)
Bolivia	Taraco (Puna)	(Teran <i>et al.</i> , 2018)
Brazil	Rio de Janeiro (Araponga, Mamangá, Parati-Mirim, Sapukai, Sítio Rio Pequeno) and Sao Paulo (Boa Vista)	(Barreto, Cardoso and Coimbra, 2014)
Brazil	Paraná (Kreen-Aka-rôre)-village Nacipotire	(Baruzzi <i>et al.</i> , 2001)
Brazil	Terra Nova settlement, and Plak-Ô reservation in São Sebastião, Alagoas state	(Campos <i>et al.</i> , 2016)
Brazil	National	(Leite <i>et al.</i> , 2013)
Brazil	Pimentel Barbosa Indigenous Reserve, Mato Grosso state	(Ferreira <i>et al.</i> , 2017)
Brazil	North, Northeast, Central-West and Southeast/South)	(Leite <i>et al.</i> , 2013)
Brazil	Alto Xingu, Mato Grosso state	(Mondini <i>et al.</i> , 2007)
Brazil	Alto Xingu, Mato Grosso state	(Mondini <i>et al.</i> , 2009)
Brazil	Terenas villages of Córrego Seco and Limão Verde, district of Aquidauana, in Mato Grosso do Sul state	(Moraes, Alves and Fagundes-Neto, 2005)
Brazil	Município de Jordão, in the valley of Juruá, Acre state	(Oliveira <i>et al.</i> , 2011)
Brazil	Sete de Setembro Indigenous Land, in Rondônia and Mato Grosso	(Orellana <i>et al.</i> , 2006)
Brazil	Aldeia Plak-Ô and povoado Terra Nova, located in the municipality of São Sebastião, Alagoas	(Ferro Pereira <i>et al.</i> , 2012)
Brazil	Villages, Etênhriritipá and Pimentel Barbosa, State of Mato Grosso, Central Brazil	(Welch <i>et al.</i> , 2020)
Chile	Cautín province	(Franco <i>et al.</i> , 1987); (Franco <i>et al.</i> , 1990); (Franco <i>et al.</i> , 1996)
Colombia	Cali	(Bolaños-Gallardo <i>et al.</i> , 2014)
Colombia	Caldas department	(Cardona-Arias, Rivera-Palomino and Carmona-Fonseca, 2014)
Colombia	National	(Cediel <i>et al.</i> , 2020)
Colombia	Cauca department	(Gaviria <i>et al.</i> , 2017)
Costa Rica	Indian reservation of Ujarrás, Puntarenas	(Monge-Rojas <i>et al.</i> , 2005)
Ecuador	Morona-Santiago province: Upano Valley and Cross-Cutucú	(DeLouize <i>et al.</i> , 2021)
Ecuador	National	(Ramírez-Luzuriaga <i>et al.</i> , 2020)
Ecuador	Riobamba canton of Chimborazo province	(Robalino Flores <i>et al.</i> , 2017)
Guatemala	National	(Ramirez-Zea <i>et al.</i> , 2014)

Mexico	Mountain: State of Mexico; highlands: Veracruz; coast: Hidalgo	(Aguirre Arenas <i>et al.</i> , 2013)
Mexico	National	(Batis <i>et al.</i> , 2020)
Mexico	National	(De La Cruz-Góngora <i>et al.</i> , 2013)
Mexico	Northern Mexico (municipios Guachochi, Balleza and Batopilas)	(Monárrez-Espino <i>et al.</i> , 2004)
Mexico	National	(Palacios-Rodríguez <i>et al.</i> , 2019)
Mexico	National	(Rivera <i>et al.</i> , 2003)
Mexico	National	Villapando <i>et al.</i> (2003)
Peru	Peruvian Amazon	(Anticona and San Sebastian, 2014)
Peru	Madre de Dios	(Cabada <i>et al.</i> , 2014)
Peru	Provinces of Bagua and Condorcanqui in the Amazon region	(Díaz <i>et al.</i> , 2015)
Peru	National	(Flores Bendeزú <i>et al.</i> , 2015)
Peru	Districts of Aramango and Imaza in the province of Bagua; and Cenepa, Nieva and Santiago in the province of Condorcanqui	(Huamán-Espino and Valladares E, 2006)
Venezuela	Zulia state (Aroy)	(Diez-Ewald <i>et al.</i> , 1999)
Venezuela	Municipality of Atures (50 km north of Puerto Ayacucho)	(García-Casal <i>et al.</i> , 2008)
Venezuela	Amazon Region	(Verhagen <i>et al.</i> , 2013)
Venezuela	Orinoco Delta	(Verhagen <i>et al.</i> , 2013)

3.4.1.3. Study methods

(a) Study design

Cross-sectional studies. Almost all the studies were cross-sectional studies (40 articles). Only three studies included exposure: (1) provision of iron-fortified flour and soy (-3%) (Aguirre Arenas *et al.*, 2013); (2) lead exposure (Anticona and San Sebastian, 2014); and (3) tuberculosis (Baruzzi *et al.*, 2001). Besides, there were 10 studies that used secondary data were considered as cross-sectional due to the study design of the original study where the data was extracted (Rivera *et al.*, 2003; Villalpando S., Shamah T., Ramírez-C., Mejía F., Rivera, J., 2003; De La Cruz-Góngora *et al.*, 2013; Ramirez-Zea *et al.*, 2014; Flores Bendeزú *et al.*, 2015; Cordero *et al.*, 2019; Palacios-Rodríguez *et al.*, 2019; Batis *et al.*, 2020; Cediél *et al.*, 2020; Ramírez-Luzuriaga *et al.*,

2020). These studies used databases such as the Mexican National Health and nutrition Survey from 2012 or the 2010 Colombian Demographic and Health Survey.

Cohort studies. Only two articles were cohort studies: Franco et al. (1996) with the title “Iron supplementation in Chilean Mapuche infants of the Cautin Province, Chile” and Welch et al. (2020) with the title “The Xavante Longitudinal Health Study in Brazil: Objectives, design, and key results”. Franco et al. (1996) aimed to re-evaluate the iron nutrition of a group of Mapuche infants at one year of age, and then to study their response to an iron supplementation test, up to 15 months. Therefore, prevalence of anemia was measured at the beginning of their study, and this was the data used in this systematic review. On the other hand, considering ongoing historical processes that may be related to increases in child malnutrition, adult obesity, and cardiovascular disease risks, Welch et al. (2020) sought to provide granular tracking of present health challenges faced by Indigenous communities in Brazil. Likewise, prevalence of anemia of Indigenous children was presented as one of the baseline health indicators.

(b) Sampling and Sample size

Almost all the studies clarified that sampling was random, and in six studies sampling was for convenience. Although it seems that the sampling was random in the other studies, 15 articles did not specify whether sampling was random or not. All the studies showed sample size which greatly diverged across the studies. The smallest sample size was 36 (Robalino Flores *et al.*, 2017) and the largest sample sizes were from those studies including secondary data from national databases, such as the Ecuadorian or Mexican National Nutrition and Health Surveys that included data from Indigenous populations. Only seven studies described analytical methods of the sampling strategy.

(c) Age

Age ranges showed a huge variety among all the studies. Some studies considered children just from one age range, e.g. 6-24 months (Aguirre Arenas *et al.*, 2013). Other studies, such as those including data at the national level, included broader age

ranges. For example, Baruzzi et al. (2001) included children from 6 months to 14 years old. Other provided measurements for a wide variety of age ranges, for example Villapando et al. (2003) 12-23 months, 24-35 months, 6-59 months, 36-47 months, 5-6 years, 7-8 years, 5-11 years, 48-59 months, 9-10 years, 11 years, and 6-11 months. In order to better analyze age ranges and be able to make some comparisons along the studies, all ranges that did not specify a start point (e.g. <5 years) were modified to start from 6 months old (e.g. <5 years = 6 to 59 months), according to the WHO indications for measurements of anemia (WHO, 2017).

(d) Date of data collection

The most recent data collection of prevalence of anemia from Indigenous communities was done in 2017 by De Louize et al. (2021) (see Appendix 4). Then, in 2016 by Cordero et al. (2019) , and in 2013 by Florez-Bendezú et al. (2015). All the other studies were older than 2013, which means that up to date (2021) there are not many recent studies about prevalence of anemia among Indigenous children in Latin America. 13 studies did not specified date of data collection.

(e) Indigenous communities

Some studies mentioned the name of the Indigenous community while others just mentioned the location and that Indigenous communities lived there. Studies including data from National databases considered the whole Indigenous population of the country without specifying the names of those communities. The 42 articles of this systematic review included 39 Indigenous communities from Latin America: Achuar, Aguaruna, Aruak, Awajún, Aymara, Cabécar, Embera-Chamí, Guaraní, Inga, Kamaiurá, Karapotó, Karibe, Kaxinanuá, Kofan, Ma-cro-Jê, Mapuche, Misak (Guambiano), Nasa (Resguardo San Lorenzo, de Caldon), Nasa, Piaroa, Quichua, Shuar, Suruí, Taraumara, Terena, Urarina, Warao, Xavante, Yanacona, Yanomami, Yomybato, Yucpa. The distribution of the articles by Indigenous community can be observed in table 5.

(f) Male or female

Most of the studies did not provide separated data for boys and girls. Some of them

made the distinction giving the number of boys and girls sampled, for example Terán et al. (2018). However, other studies gave values of prevalence of anemia for boys and girls but did not give the number of boys nor girls sample, for example Monge-Rojas (2005).

Table 5. Distribution of articles by Indigenous community.

#	Indigenous community	Country	Region	Author
1	Achuar	Perú	Peruvian Amazon	Anticona & San Sebastian (2014)
2	Aguaruna	Perú	Districts of Aramango and Imaza in the province of Bagua; and Cenepa, Nieva and Santiago in the province of Condorcanqui	Huamán-Espino & Valladares (2006)
3	Aruak	Brazil	Alto Xingu, Mato Grosso state	Mondini et al. (2009)
4	Awajún	Perú	Provinces of Bagua and Condorcanqui in the Amazon region	Díaz et al. (2015)
5	Aymara	Bolivia	El Alto, Caranavi (Yungas), Taraco (Puna)	Burke et al. (2018) , Terán et al. (2018)
8	Cabécar	Costa Rica	Indian reservation of Ujarrás, Puntarenas	Monge-Rojas et al. (2005)
10	Embera-Chamí	Colombia	Caldas	Cardona et al. (2014)
11	Guaraní	Brazil	Rio de Janeiro (Sapukai, Parati-Mirim, Araponga, Sítio Rio Pequeno e Mamanguá) and Sao Paulo (Boa Vista)	Barreto et al. (2041)
12	Inga	Colombia	Cali	Bolaños et al. (2014)
13	Kamaiurá	Brazil	Alto Xingu, Mato Grosso state	Mondini et al. (2007)
14	Karapotó	Brazil	Plak-Ô reservation and Terra Nova settlement, in São Sebastião, state of Alagoas	Campos et al. (2016), Pereira et al. (2012)
16	Karibe	Brazil	Alto Xingu, Mato Grosso state	Mondini et al. (2009)
17	Kaxinanuá	Brazil	Município de Jordão, in the valley of Juruá	Oliveira et al. (2011)
18	Kofan	Colombia	Cali	Bolaños et al. (2014)
19	Ma- cro-Jê	Brazil	Paraná (Kreen-Aka-rôre)-village Nacipotire	Baruzzi et al. (2001)
20	Mapuche	Chile	Cautín province	Franco et al. (1996)
22	Misak (Guambiano)	Colombia	Cali	Bolaños et al. (2014)
23	Nasa (Resguardo San Lorenzo, de Caldono)	Colombia	Cauca department	Gaviria et al. (2017)
24	Nasa	Colombia	Cali	Bolaños et al. (2014)
25	Piaroa	Venezuela	Atures Municipality and is located 50 kilometers north of Puerto Ayacucho	García-Casal et al. (2008)
26	Quichua	Perú, Colombia	Peruvian Amazon, Cali	Anticona & San Sebastian (2014), Bolaños et al. (2014)
28	Shuar	Ecuador	Morona-Santiago province: Upano Valley and Cross-Cutucú	De Louize et al. (2021)
29	Suruí	Brazil	Sete de Setembro Indigenous Land, in Rondônia and Mato Grosso	Orellana et al. (2006)
30	Taraumara	Mexico	Northern Mexico (municipios de Guachochi, Balleza y Batopilas)	Monarrez-Espino et al. (2004)
31	Terena	Brazil	Terenas villages of Limão Verde and Córrego Seco, district of Aquidauana, in Mato Grosso do Sul state	Morais et al. (2005)
32	Urarina	Perú	Peruvian Amazon	Anticona & San Sebastian (2014)
33	Warao	Venezuela	Amazon Region	Verhagen et al. (2013)
34	Xavante	Brazil	Pimentel Barbosa Indigenous Reserve and Etênhrítipá, State of Mato Grosso, Central Brazil	Ferreira et al. (2017), Welch et al. (2020)
36	Yanacona	Colombia	Cali	Bolaños et al. (2014)
37	Yanomami	Venezuela	Amazon Region	Verhagen et al. (2013)
38	Yombyato	Perú	Madre de Dios	Cabada et al. (2014)
39	Yucpa	Venezuela	Zulia state (Aroy)	Diez et al. (1999)

(e) Outcome measures

Prevalence of anemia. Prevalence of anemia was the outcome measure for this systematic review and was presented in all the studies as percentage. In some articles, prevalence of anemia was reported for girls and boys and in some cases overall prevalence of anemia was reported with 95% confidence intervals.

Diagnostic resource. The main diagnostic resource was the Hemocue. The Hemocue is a portable and electronic hemoglobinometers that provides fast Hemoglobin results with a high degree of quality and can be operated using electricity or batteries (Sanchis-Gomar *et al.*, 2013). Since it is very easy to use it is a popular way of measuring hemoglobin levels in the population. Details of these methods can be seen in table 6.

Table 6. Diagnostic resources used in the studies.

Diagnostic resource	No. of studies	Percentage (%)
Hemocue	31	73.8
Cyanmetahemoglobin method	4	9.5
Automated biometry (SysmexXe - 2100)	1	2.4
Chromogenic method	1	2.4
Coulter counter	1	2.4
EDTA tube	1	2.4
Haemogram test	1	2.4
Ultralogic 800	1	2.4
Not specified	1	2.4
Total	42	100.0

Diagnostic criteria. Almost all the studies followed the recommendations of the World Health Organization to diagnose anemia among children (WHO, 2011). Those values are for children from 6 to 59 months: <11.0 mg/dL, for children from 5 to 11 years old: <11.5 mg/dL, and for children from 12 to 14 years old: <12.0 mg/dL. Some of the studies used other values; for example, Diez *et al.* (1999) used the following parameters to diagnose anemia among children: <10.7 for children between 1 to 2 years old and <10.9 for children between 3 to 5 years old.

3.4.2. Description of pooled results

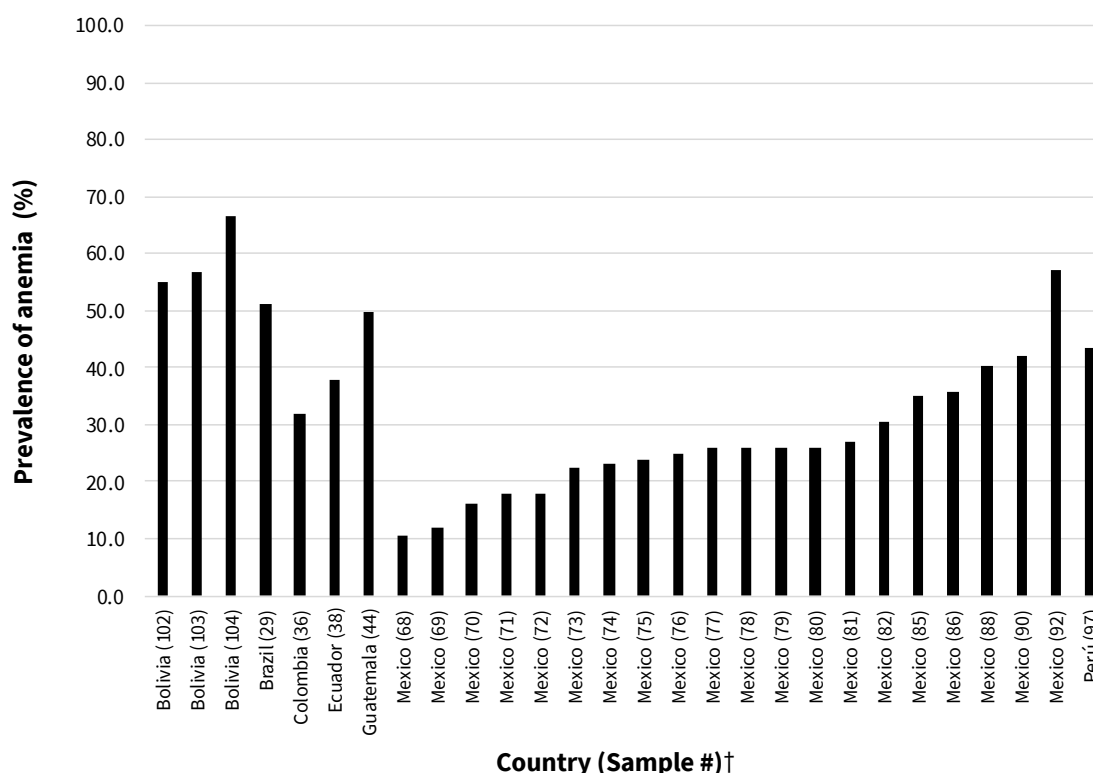
Condensed data from all the studies selected for this systematic review are presented on Appendix 4. Every sample from each study was numbered, so that each sample can be identified with a number from 1 to 133 for the subsequent analyses.

3.4.2.1. Prevalence of anemia by country

Bolivia, Brazil, and Peru show the highest values of prevalence of anemia in this systematic review (see Appendix 5). The highest value of prevalence of anemia including boys and girls (86.1%) was found in Brazil, among the Terenas children from 6 to 24 months in Limão Verde and Córrego Seco, district of Aquidauana, in Mato Grosso do Sul state (Morais, Alves and Fagundes-Neto, 2005). Moreover, The highest value of prevalence of anemia by sex (Boys 100% and Girls 100%) was found in the Piaroa Indigenous community in Atures Municipality, Puerto Ayacucho, Venezuela among children between 1 and 3 years old (García-Casal *et al.*, 2008). On the other hand, In Bolivia was observed the lowest prevalence of anemia of this systematic review (0.0%) among children between 11 and 12 years old from the Aymara Indigenous community in Caranavi in the Taraco district situated on the shores of Lake Titicaca at an altitude between 3,810 and 4,050 meters above the sea level (Teran *et al.*, 2018). The second lowest value of the prevalence of anemia including boys and girls (4.5%) was found in Chile, among Mapuche children from 8 to 14 months old from rural areas in the province of Cautín (Franco *et al.*, 1987). As a general overview, Bolivia, Brazil, Peru, and Venezuela showed the highest values of prevalence of anemia, as can be observed in Appendix 4, which shows values of prevalence of anemia by country.

As mentioned above, 10 studies in this systematic review used national databases such as the Mexican National Health and nutrition Survey from 2012 or the 2010 Colombian Demographic and Health Survey. Using this kind of data provides reliable information only for large geographic domains, so it can provide information at the national level for the central government, but with less reliability for regional governments and no data for local governments. This data is presented in graph 2.

Graph 2. Prevalence of anemia by country from articles using national databases that include Indigenous communities.



† Sample # according to the table in Appendix 4.

a. Bolivia

The highest prevalence of anemia in Bolivia was found in the Aymara Indigenous community. The prevalence was 84% among children from 6 to 7 years old in the Taraco (Puna) region (Teran *et al.*, 2018). This was the fourth highest value of prevalence of anemia found in this systematic review. At the national level, the Aymara community showed the highest prevalence of anemia (73.8%) for children from 6 to 59 months (Cordero *et al.*, 2019). Among children from 11 to 12 years old in the Taraco (Puna) region, prevalence of anemia was higher in boys (78%) than in girls (70%) (Teran *et al.*, 2018). At the national level, the Quechua Indigenous community showed values from 55% to 66.4% among children from 6 to 59 months old (Cordero *et al.*, 2019). In Bolivia was observed the lowest prevalence of anemia of this systematic review (0.0%) among children between 11 and 12 years old from the Aymara Indigenous community in Caranavi in the Taraco district situated on the shores of Lake Titicaca at an altitude between 3,810 and 4,050 meters above the sea level (Teran *et al.*, 2018).

a. Brazil

10 Indigenous communities were reported in the different studies from Brazil, i.e. Aruak, Guaraní, Kamaiurá, Karapotó, Karibe, Kaxinanuá, Mâ-cro-Jê, Suruí, Terena and Xavante. The three highest values of prevalence of anemia in this systematic review were found in Brazil. The highest value (88.9%) is from Guaraní children from 6 to 11 months from the regions of Rio de Janeiro (Sapukai, Parati-Mirim, Araponga, Sítio Rio Pequeno e Mamanguá) and Sao Paulo (Boa Vista) (Barreto, Cardoso and Coimbra, 2014). In this study, prevalence of anemia among boys was 100% and 80% among girls. Second, from the Terena Indigenous community in the villages of Limão Verde and Córrego Seco, district of Aquidauana, in Mato Grosso do Sul state, children from 6 to 24 months showed a prevalence of anemia of 86.1% (Morais, Alves and Fagundes-Neto, 2005). Third, in the Alto Xingu, Mato Grosso state, Karibe children from 6 to 24 months old, showed a prevalence of anemia of 85% (Mondini *et al.*, 2009).

All the Indigenous communities presented values higher than 40%. According to WHO (2017), it means that all of them present a severe public health problem (see Table 1).

The lowest values of prevalence of anemia in Brazil (10.6%, 11.8) were found among Xavante children from 6 to 59 months and from 5 to 9 years, respectively, in the villages Pimentel Barbosa and Etênhiritipá, State of Mato Grosso, Central Brazil (Welch *et al.*, 2020).

b. Chile

The second lowest values for prevalence of anemia in this systematic review were found in Chile among the Mapuche Indigenous community. Three values were reported in Chile: 4.5% among children between 8-14 months (Franco *et al.*, 1987), 4.5% among children between 8-15 months (Franco *et al.*, 1990), and 28.3% among 12-month-old children (Franco *et al.*, 1996).

c. Colombia

The highest value of the prevalence of anemia in Colombia (36.4%) and the lowest value (8.6%) were found in the Embera-Chamí Indigenous community in the Department of Caldas among children from 10 to 15 years and 6 to 10 years old,

respectively (Cardona-Arias, Rivera-Palomino and Carmona-Fonseca, 2014). A recent study showed prevalence of anemia of 31.9% among children from 6 to 59 months from Indigenous communities at the national level.

d. Costa Rica

Only one study from Costa Rica was found in this systematic review. A sample of 84 children from 10 to 16 years old from the Cabécar Indigenous community in the Indian reservation of Ujarrás, Puntarenas's province, showed a prevalence of anemia of 57% (Boys 59%, girls 45%) (Monge-Rojas *et al.*, 2005).

e. Ecuador

Prevalence of anemia in Ecuador was reported for Indigenous communities at the national level of 37.8% (95% CI: (27.9-48.9)) (Ramírez-Luzuriaga *et al.*, 2020) and 18.8% among children from 5 to 6 years old in the Riobamba canton of Chimborazo province, not specifying any Indigenous community (Robalino Flores *et al.*, 2017). Values of prevalence of anemia for the Shuar Indigenous community were reported for children from 0 to 4 years old (20.4%), from 5 to 11 years (10.9%) and from 12 to 14 years old (11%) (DeLouize *et al.*, 2021).

f. Guatemala

Only one study from Guatemala was found in this systematic review. A sample at national level of 5735 Indigenous children from 6 to 59 months old showed a prevalence of anemia of 49.6% (95% CI: 46.4, 52.8) (Ramírez-Zea *et al.*, 2014).

g. Mexico

Most of the studies found from Mexico were at the national level. Only one study reported prevalence of anemia for one Indigenous community, the Taraumara (Monárrez-Espino *et al.*, 2004). The highest prevalence of anemia at the national level (57%; 95%CI (50.6, 65.2)) was found among Indigenous children between 12 to 23 months (Villalpando S., Shamah T., Ramírez-C., Mejía F., Rivera, J., 2003). The lowest prevalence of anemia (10.4%; 95% CI((8.2-13.2)) was found among children from 5 to 11 years old at the national level in 2012 (De La Cruz-Góngora *et al.*, 2013). Prevalence of anemia of 10.4% was also found among Taraumara children from 6 to 14 years old

in Northern Mexico (municipios de Guachochi, Balleza y Batopilas) (Monárrez-Espino *et al.*, 2004).

h. Peru

The highest prevalence of anemia (76.5%) in Peru was found in the Aguaruna Indigenous community in the Districts of Aramango and Imaza in the province of Bagua, and Cenepa, Nieva and Santiago in the province of Condorcanqui among children less than three years old (Huamán-Espino and Valladares E, 2006). The lowest value for the prevalence of anemia (26.6%) was found in the Indigenous community of Yomybato in the Department of Madre de Dios among children and adolescents from 5 to 19 years old (Cabada *et al.*, 2014). Values from 45.6% to 56.9% were found in the Achuar, Urarina, and Quichua Indigenous communities in the Peruvian Amazon among children and adolescents below 17 years old (Anticona and San Sebastian, 2014).

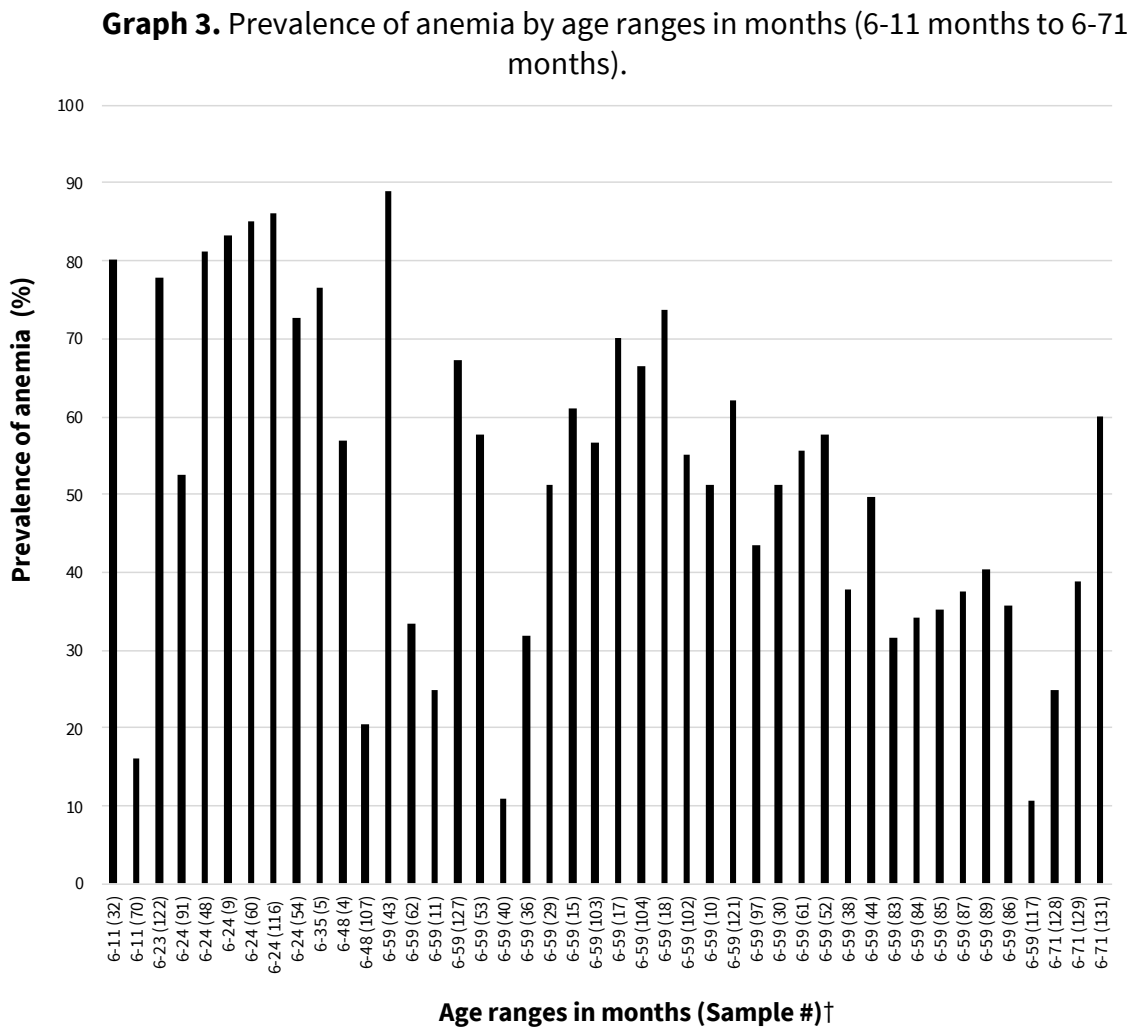
i. Venezuela

In Venezuela was reported the highest value of prevalence of anemia by sex (Boys 100% and Girls 100%) among children between 1 and 3 years old, and 91.0% for boys and 100.0% for girls between 4 to 10 years old in the Piaroa Indigenous community in Atures Municipality, Puerto Ayacucho (García-Casal *et al.*, 2008). High values of prevalence of anemia were also observed among children between 6 to 11 years old from the Yucpa Indigenous community in the Zulia state: Peraya population 72.0% and Aroy population 66.7% (Diez-Ewald *et al.*, 1999). The lowest value of prevalence of anemia (9.0%) was found among children from the Yanomami and Warao Indigenous community between 4 to 16 years old in the Orinoco Delta (Verhagen *et al.*, 2013).

3.4.2.2. Prevalence of anemia by age

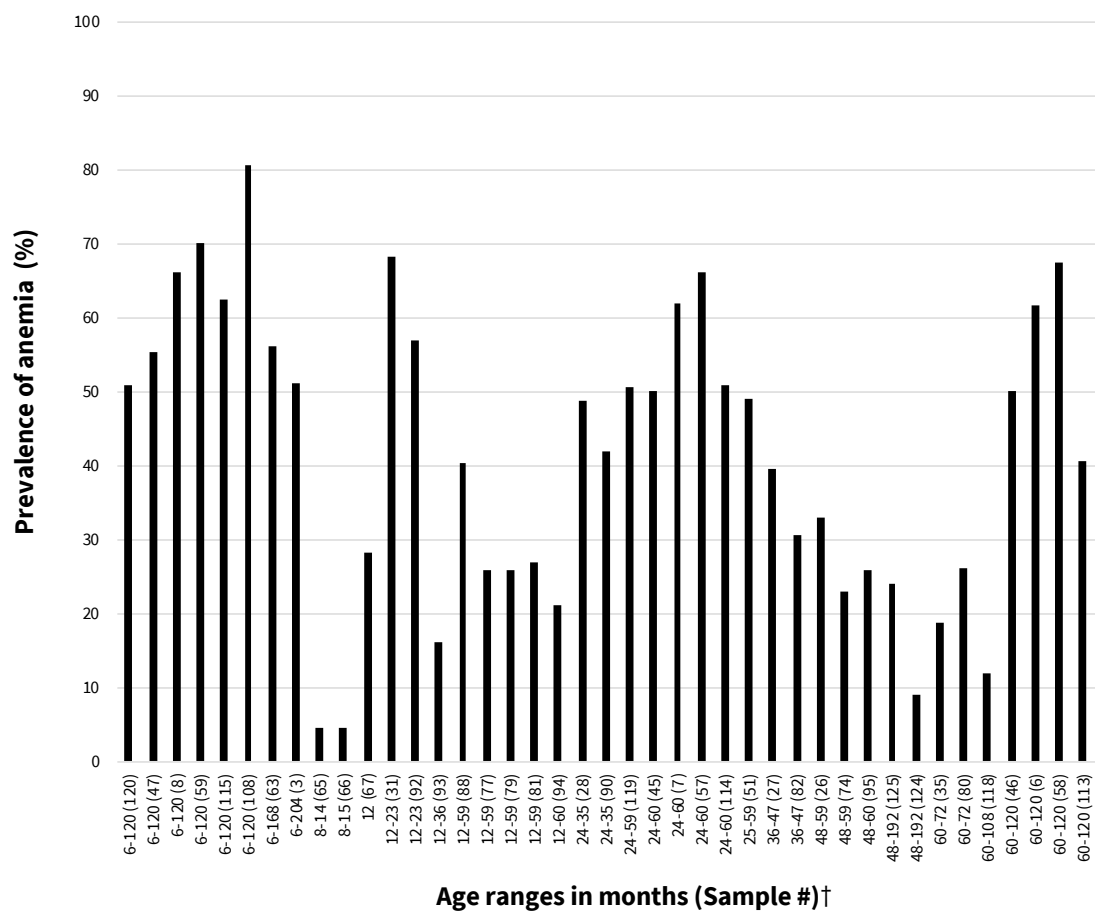
Age ranges found in this systematic review presented a wide variety. Graphs 3, 4 and 5 show values of prevalence of anemia among those age ranges. Values of prevalence of anemia for male and female were excluded from the graphs. According to these graphs, youngest children reported higher values of prevalence of anemia (age ranges

in months: 6-11; 6-23; 6-24; 6-25; 6-28; 6-29; 6-35). Some older children also showed high values of prevalence of anemia, but not as high as the youngest ones.



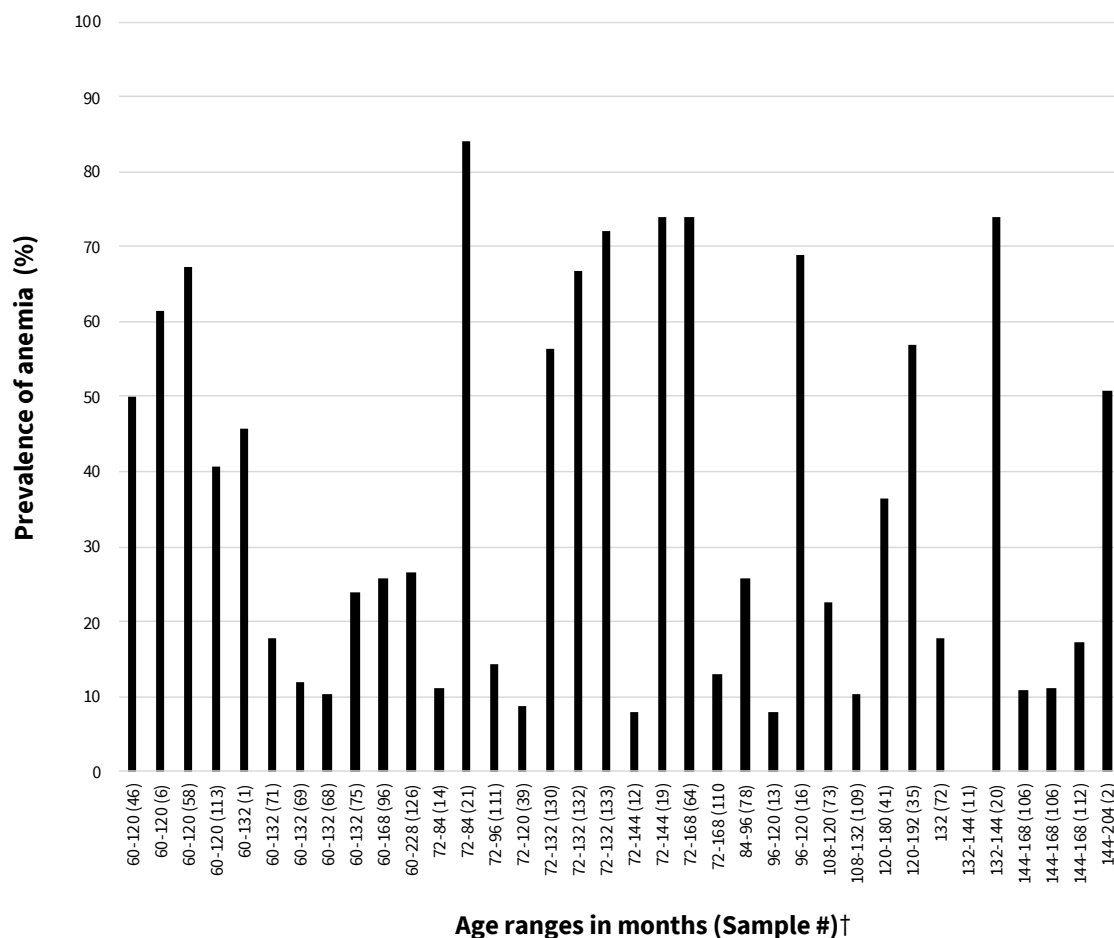
† Sample # according to the table in Appendix 4.

Graph 4. Prevalence of anemia by age ranges in months (6-120 months to 60-120 months).



† Sample # according to the table in Appendix 4.

Graph 5. Prevalence of anemia by age ranges in months (60-132 months to 144-204 months).



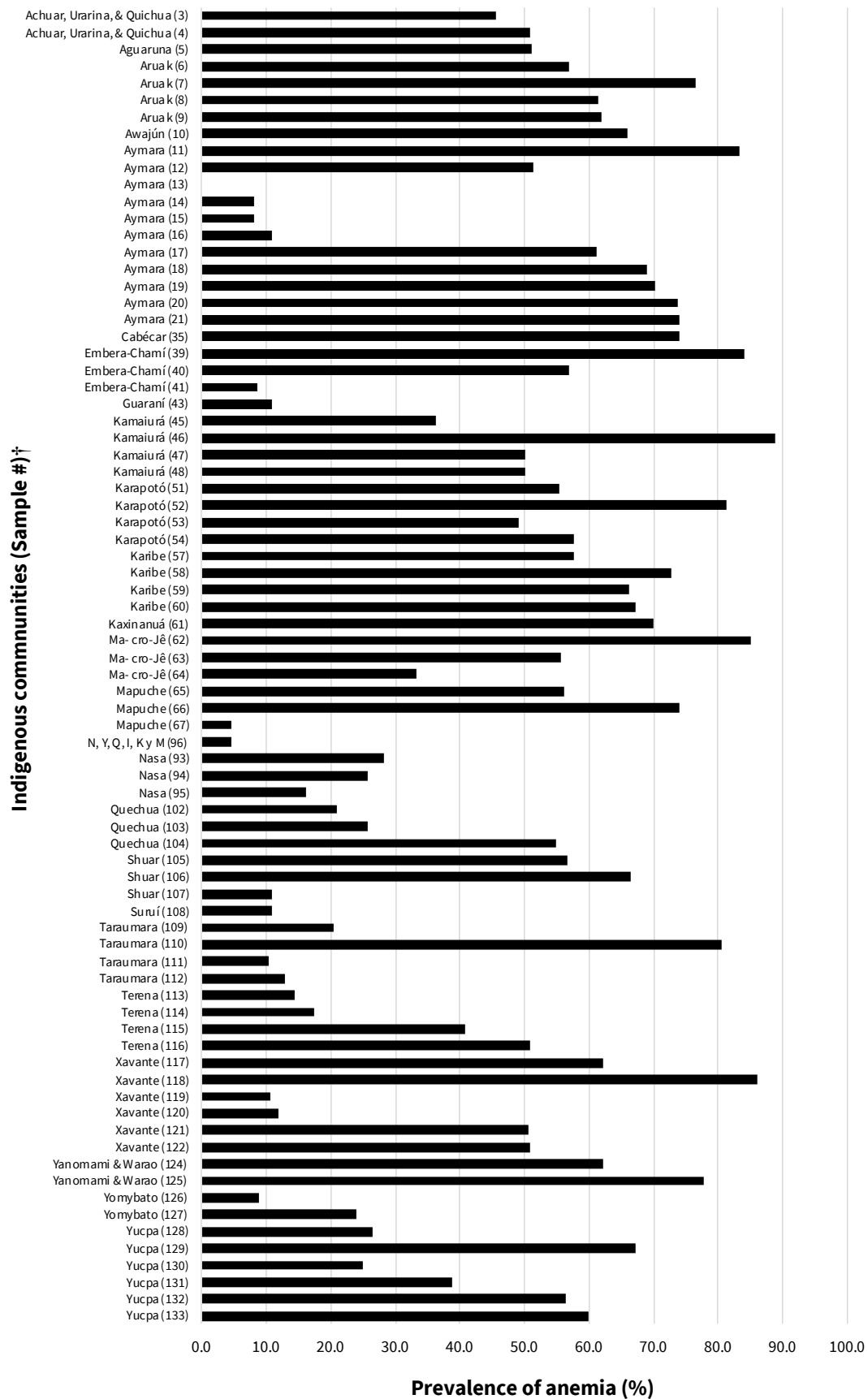
† Sample # according to the table in Appendix 4.

3.4.2.3. Prevalence of anemia by Indigenous community

Prevalence of anemia of specific Indigenous communities is presented in graph 6. Data from articles that did not specify any Indigenous community is excluded from this graph as well as the data from articles that show data at the national level which do not specify names of any Indigenous community. As observed in Graph 6, seven Indigenous communities showed values of prevalence of anemia above 80.0% (Aguaruna, Aruak, Aymara, Guaraní, Karibe, Suruí and Terena). The Aymara, Emberá-Chamí, Mapuche and Yanomami and Warao Indigenous communities showed the lowest values of prevalence of anemia below 10.0%.

Studies in this systematic review showed very low and high values of prevalence of anemia in Indigenous communities such as the Aymara and Xavante (Graph 6). Prevalence of anemia among Aymara children between 11 and 12 years old in Caranavi (Yungas), Bolivia was 0.0%; while among Aymara children between 6 and 7 years old in Taraco (Puna), Bolivia, prevalence of anemia was 84.0% (Teran *et al.*, 2018). Similarly, prevalence of anemia among Xavante children between five and nine years old in Villages, Etênhiritipá and Pimentel Barbosa, State of Mato Grosso, Brazil, was 11.8%; while among another population of Xavante children between six months and 2 years old in Pimentel Barbosa Indigenous Reserve, Matto Grosso prevalence of anemia was 77.8% (Ferreira *et al.*, 2017).

Graph 6. Prevalence of anemia by Indigenous communities.

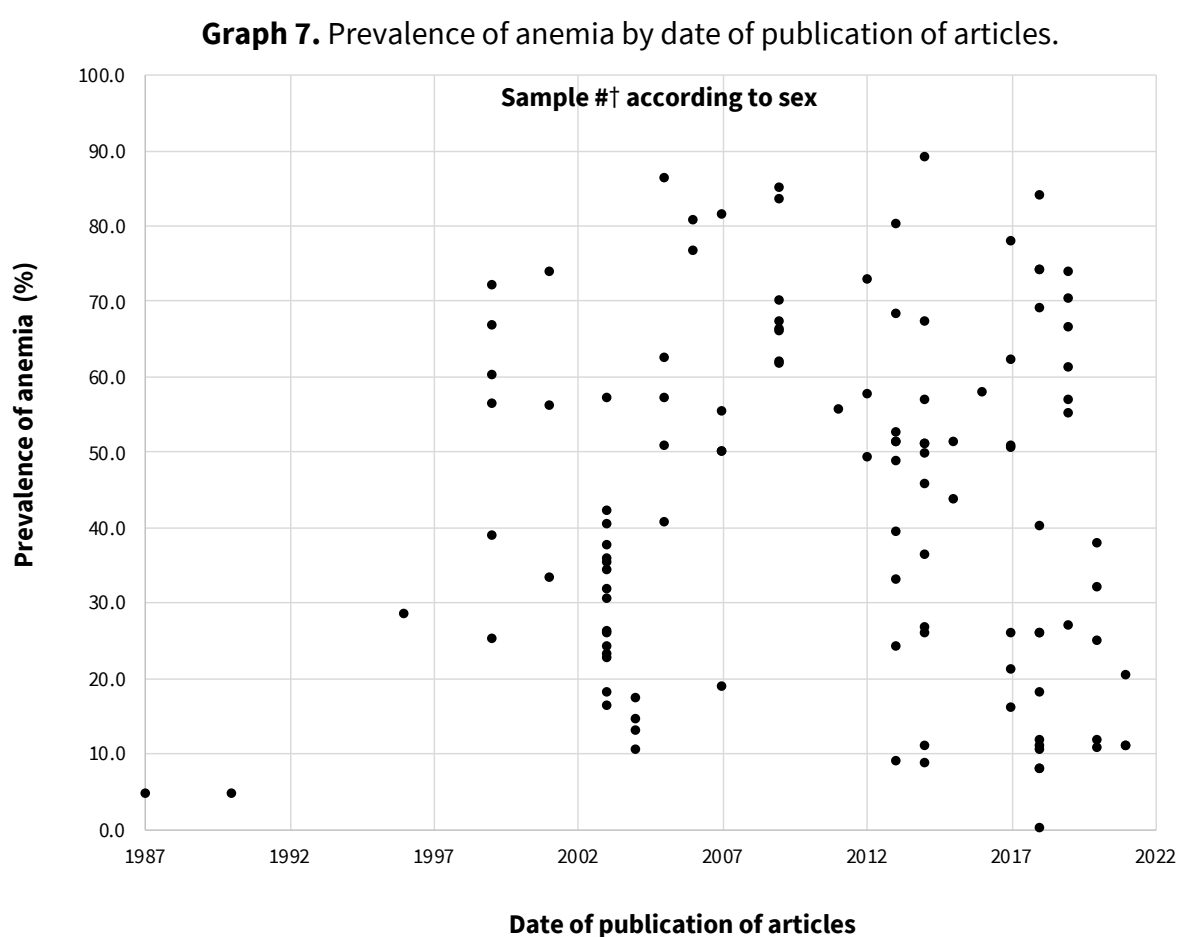


*N, Y, Q, I, K y M: Nasa, Yanacona, Inga, Kofa and Misak (Guambiano).

† Sample # according to the table in Appendix 4.

3.4.2.4. Prevalence of anemia by date of publication

Publication data is different from date of data collection. The results of research are sometimes published in peer-reviewed journals after months or some years. Therefore, publication date does not exactly reveal the situation registered in that particular year. Nonetheless, it gives a good estimate of the situation of the Indigenous communities around the year of publication. Values from studies that reported overall prevalence of anemia are shown in graph 7.



As can be seen in graph 7, from 1997 onwards, values of prevalence of anemia are scattered from 0.0% up to almost 90%. This shows the wide spectrum of values of prevalence of anemia among Indigenous children in Latin America during the last four decades.

3.4.2.4. Anemia as a severe public health problem

According to the WHO (WHO, 2017), prevalence of anemia is a severe public health problem when values are $\geq 40.0\%$. Appendix 6 shows values of prevalence of anemia as a severe public health problem of Indigenous communities in Latin America. Almost all the Indigenous communities reported in this systematic review presented values of prevalence of anemia above 40.0%; those communities were Achuar, Urarina, and Quichua, Aguaruna, Aruak, Awajún, Aymara, Cabécar, Guaraní, Kamaiurá, Karapotó, Karibe, Kaxinanuá, Ma- cro-Jê, Piaroa, Quechua, Suruí, Terena, Xavante, Yomybato, Yucpa. Studies at the national level in Brazil, Guatemala, Mexico and Peru also showed values of prevalence of anemia higher than 40.0%. From 133 samples registered in this systematic review (see Appendix 4), 75 (56.4%) samples show that anemia is a severe public health problem (see Appendix 6).

Chapter 4

4.1. Discussion of results

Our results suggest that prevalence of anemia among children is a severe public health problem in 54% (21 out of 39) of the Indigenous communities in Latin America included in this systematic review. The Indigenous communities that showed values above of prevalence of anemia above 40% were the Achuar, Urarina, Quichua, Aguaruna, Aruak, Awajún, Aymara, Cabécar, Guaraní, Kamaiurá, Karapotó, Karibe, Kaxinanuá, Ma- cro-Jê, Piaroa, Quechua, Suruí, Terena, Xavante, Yomybato, Yucpa (see Appendix 6). The Aguaruna in Peru, the Guaraní, Kamaiurá, Karibe, Suruí and Xavante in Brazil, the Aymara in Bolivia and the Yucpa in Venezuela are Indigenous communities registering values of prevalence of anemia above 70%, leading the list in terms of anemia as a severe public health problem for young children. Thus, this systematic review shows an alarming situation about anemia in Indigenous communities in these countries. The highest value of prevalence of anemia including boys and girls (88.9%) was found in Brazil, among the Guaraní children from six to 11 months old in Rio de Janeiro (Sapukai, Parati-Mirim, Araponga, Sítio Rio Pequeno e Mamanguá) and Sao Paulo (Boa Vista) (Barreto, Cardoso and Coimbra, 2014). Data obtained in this systematic review about Brazil confirm the gravity of the situation in the Indigenous population of this country, with extremely high prevalence rates among children in Brazil as described by Lício, Fávaro and Chaves (2016), who allege that it is essential that such information contribute to generate health care priorities in these communities.

It must be pointed out that even though Brazil shows the highest values of prevalence of anemia among Indigenous children in Latin America, this is the most well-studied country in the region. We found that prevalence of anemia among Indigenous children has been reported in 10 countries in Latin America. However, almost one third of the studies were from Brazil (13 studies). As Lício et al (2016) states, it is noteworthy that since 2001 there has been a significant increase in studies investigating the occurrence of anemia in Indigenous populations in Brazil, possibly due to the insertion of the Indigenous health area in the field of collective health in the country, occupying an

important space in the debate on health status and social inequalities. In this country, Indigenous communities correspond to 0.5% of the entire population in Brazil, whereas 43.6% of the population in Guatemala is considered Indigenous (CEPAL, 2014) but only one study from Guatemala was found in this systematic review. This suggests a lack of research studies about the largest population of Indigenous communities in Latin America. In addition, from the 39 Indigenous communities included in this systematic review, only four of them were part of more than one study: Aymara in Bolivia (in 2 studies), Quichua in Perú (in 1 study) and Colombia (in 1 study), the Karapotó (in 2 studies) and the Xavante (in 2 studies) in Brazil. These results suggest that the data we have from specific Indigenous communities is scarce. We suggest, as Babyar (2019) says, that a consistent, collaborative approach is crucial to the delivery of medical research and care of Indigenous communities.

The critical situation evidenced in this systematic review is not seen in other systematic reviews about the general situation in Latin America and are not reviewing specifically Indigenous communities. For example, Vázquez et al. (2019) show that the overall prevalence of anemia in children from Latin America is 28.56%. Likewise, based on the latest data available on anemia in Latin America and the Caribbean as of 2014, Mujica et al. (2015) found anemia prevalences from 4.0% and no more than 61.3% in children under six years of age. Several researchers acknowledge that they have underrepresented Indigenous populations in Latin America, with significant underrepresentation of those groups in their research (San Sebastián and Hurtig, 2007). A similar situation with Indigenous communities is analyzed by Smylie and Firestone (2015) who showed how current Indigenous data quality issues, such as misclassification errors and non-response bias, are forcing an underestimation of Indigenous equity in health determinants, health status, and health care access in Canada.

Our findings also show that studies that included national databases present lower values of prevalence of anemia among children as compared to the studies that show values from children of specific Indigenous communities. For example, in graph 2, which shows prevalence of anemia by country from articles using national databases

that include Indigenous communities, can be observed that none of the values is higher than 70%. Nevertheless, as we have mentioned above, there are eight Indigenous communities registering values of prevalence of anemia above 70%. This finding is of relevance because it suggests that governments and private organizations should be aware that national databases could be masking extreme values of prevalence of anemia.

Furthermore, more recent studies are lacking. Our findings show that the most recent data collection of prevalence of anemia from Indigenous communities was done in 2017; then, in 2016 and in 2013 (see Appendix 4). All other studies collected data before 2013, which means that up to present (2021) there are not many recent studies about prevalence of anemia among Indigenous children in Latin America. We also suggest that there is a lack of reports spanning a wide range of years. Since almost all the studies included in this systematic review were cross-sectional studies, possible causes of prevalence of anemia cannot be determined. The lack of studies making follow-ups of specific Indigenous communities makes difficult to control and give support to reduce child anemia.

Our results indicate that the youngest children reported higher values of prevalence of anemia. The highest values were observed in the following age ranges: 6-11 months; 6-23 months; 6-24 months; 6-25 months; 6-28 months; 6-29 months; 6-35 months). Older children also showed high values of prevalence of anemia, but not as high as the youngest. In fact, studies included in this systematic review that compared different age ranges found that youngest children reported the highest values of prevalence of anemia. For example, particularly among the Aruak people in Brazil, there is a very high number of children between six and 23 months old with moderate or severe anemia when compared to those between 24 and 59 months. (Mondini *et al.*, 2009). In the Peruvian Amazon, anemia was more prevalent in the 0- to 5-year age group and stunting in the 12- to 17-year group from the Achuar, Urarina, and Quichua Indigenous communities (Anticona and San Sebastian, 2014). Similar results were found by Vázquez (Vázquez *et al.*, 2019) in a systematic review about children from Latin America and the Caribbean. They found that prevalence of anemia was higher in

preschool children (32.93%; 95% CI: 29.31, 36.56) than in school-age children (17.49%; 95% CI: 12.88, 22.10). However, this data does not differentiate Indigenous from non-Indigenous children.

Articles selected in this systematic review suggest that one of the prominent risk factors for high levels of prevalence of anemia is being Indigenous. In fact, anemia is highly prevalent among Indigenous populations all over the world (Khambalia, Aimone and Zlotkin, 2011). Babyar (Babyar, 2019) affirm that Indigenous populations in Latin America continue to suffer from health disparities compared to general populations. Particularly, in Brazil, Bolivia, Colombia, Ecuador, Peru, Paraguay, and Venezuela there are approximately 200 Indigenous communities in voluntary isolation, and the pressure over natural resources on their territory or in nearby areas puts them at risk of extreme vulnerability (CEPAL, 2014). Not only does this means that further urgent studies should be done in these specific countries, but also in all the countries where Indigenous communities are present. In the case of Brazil, for example, prevalence rates of anemia in Indigenous children were approximately double than those reported for non-Indigenous children in the same age group (Leite *et al.*, 2013) and prevalence of Guaraní anemia (65.2%) is considered severe, exceeding 3.1 times the prevalence in non-Indigenous children in Brazil (20.9%) and 6.3 times that of the Northern Region, which registers the highest national prevalence (Barreto, Cardoso and Coimbra, 2014). According to Díaz Arana *et al.* (2015) living conditions, access to healthcare, and nutritional status of children under five years of age are markedly different between the Indigenous population and the non-Indigenous population in Peru. Likewise, Ferreira *et al.* (2017) found that Xavante children's high rates of anemia reveal an ethnic disparity between them and the Brazilian population in general, suggesting the causes of anemia are largely dependent on complex, variable relationships between socioeconomic, sociodemographic, and biological factors. In general, access to health services by Indigenous peoples in Latin America is very limited, they often face obstacles in accessing health services due to mistrust generated by a history of racism and

structural discrimination (United Nations Office for the Coordination of Humanitarian Affairs, 2020).

Specific nutritional causes can be considered as risk factors for high levels of prevalence of anemia. It was suggested by Franco et al. (1987) that maternal milk might have a protective biologic role in the prevention of iron deficiency anemia among the Mapuche Indigenous community in Chile. These findings from Franco are corroborated more recently by Mujica et al. (2012) who show that is very likely that the low prevalence of anemia in Chile is a result of the iron-fortified milk provided by the National Complementary Feeding Program. There is also an example of the Aguarunas in Peru, whose anemia prevalence is associated with their diet based primarily on cassava and bananas, with little animal protein (Huamán-Espino and Valladares E, 2006). On the other hand, in the case of the Yucpa Indigenous community in Venezuela, the high frequency of anemia without nutritional cause is attributed to the prevalence of infectious diseases such as hepatitis, parasitosis, and skin and respiratory tract infections (Diez-Ewald *et al.*, 1999).

Khambalia, Aimone and Zlotkin (2011) identified iron deficiency, malaria, and helminth infections as the three main causes of anemia among Indigenous populations, which can be addressed using a combination of interventions, such as fortification of staple foods with iron and other micronutrients, iron supplements targeted to at-risk groups, use of insecticide-treated materials and bed nets, deworming (anthelmintics) in at-risk groups, and prevention and treatment of malaria. Anemia can also be prevented and controlled by fully immunizing children, treating communicable diseases, managing obstetric complications, particularly excessive bleeding, and using modern family planning methods; for the first six months of a child's life, breastfeeding must be the sole basis for feeding; iron-rich foods should be given as a supplement; and sanitation facilities must be improved (Khambalia, Aimone and Zlotkin, 2011).

Several health programs and policies have been implemented in Latin American countries in the past two decades to address anemia as a public health problem (Vázquez *et al.*, 2019). However, Indigenous communities in Latin America continue

experiencing difficult situations. According to CEPAL (2020a), Guatemala has the highest proportion of Indigenous population living in municipalities with high or critical vulnerability (77.9%); Colombia (65.8%) follows the list; then Mexico (38.8%) and Peru (33%); and finally, Chile (20.9%). Beyond this variability, the common pattern is the inequality affecting Indigenous peoples, (the widest inequalities are found in Colombia and Mexico). Although inequalities are also systematic within municipalities, regardless of the overall level of vulnerability they perceive, the vulnerability index among Indigenous populations is always higher than that estimated for non-Indigenous populations (CEPAL, 2020a).

There are multiple factors that affect the success of health and nutritional interventions, especially among low socioeconomic groups; these factors include coverage, participant compliance, monitoring, and quality of reporting (WHO, 2017). The Indigenous peoples of Latin America and the Caribbean continue to experience political, social, and economic marginalization that has relegated them to conditions of poverty and extreme poverty (United Nations Office for the Coordination of Humanitarian Affairs, 2020). This is mainly expressed in the adoption of sectoral laws that subordinate Indigenous rights to business and state interests, and in implementation gaps, particularly in the delimitation, demarcation, and titling of lands (CEPAL, 2014).

Indigenous communities should be seriously considered in national programs to reduce anemia, because, as Vázquez et al. (2019) say, anemia prevalence was reduced in Latin American countries only through national programs that covered a wide geographical area, were well monitored, and were extended over time. Several factors, including low coverage rates and/or inefficiency in monitoring, surveillance, and quality control, have contributed to the failure of existing programs for the control of anemia in Latin America and the Caribbean (Pan American Health Organization, 2009). It is also true that amid the development of the recent COVID19 pandemic, as Shimabuku et al. say (2020) it is very difficult to have a strategic plan or proposals to deal with anemia in children. We do not know yet precisely what the effect of the pandemic of COVID-19 will be on the nutritional indicators in children (The Lancet

Global Health, 2020). According to the United Nations Office for the Coordination of Humanitarian Affairs (2020), the purchasing power of Indigenous peoples to access basic commodities, including food, is decreasing due to quarantine and social mobility limitation measures dictated by governments to contain the pandemic, thus increasing the risk of food insecurity, particularly in areas where subsistence activities based on traditional land-based livelihoods are not an option.

4.2. Discussion of limitations

1. This literature search was based on three important accessible scientific databases in the world. The search did not have any language barriers because included English and the two main official languages in Latin America, Spanish and Portuguese. Probably, this would have helped to cover all articles with respect to the research question, but selection bias and search limitations cannot be totally avoided.
2. Another limitation is that this systematic review included articles that mentioned that were including explicitly any Indigenous community in Latin America. There could have been some articles that did not mention that they were studying Indigenous populations and did not mention it nor in the title nor in the abstract nor in the methods section.
3. The present systematic review included mainly cross-sectional studies. A causality criterion cannot be established because of the cross-sectional nature of these studies, which makes it impossible to infer causality or directionality. As a result, the result of this systematic review is helpful if interpreted considering both inherent limitations of the original studies and the present review.
4. Values of prevalence of anemia have been presented in graphs so that the information can be visually and easily understood to have a general overview of the situation of Indigenous children in Latin America. However, there are some considerations about the information presented in those graphs. For example, this systematic review included studies with a wide variety of age

ranges of children, there were different sample sizes and different dates of data collection. Therefore, comparisons have to be done carefully.

5. As designed, the National Surveys do not provide information about specific Indigenous ethnic groups. Since there are several ethnicities within each country in Latin America, that would present a massive logistical challenge; for example, in Brazil, there are more than two hundred Indigenous communities, some of which have populations of less than 200 people residing in inaccessible and remote locations (Coimbra *et al.*, 2013).
6. This systematic review only included data about prevalence of anemia among Indigenous children. It is important to combine this data with other studies about malnutrition to better understand the relationship between prevalence of anemia and malnutrition in Indigenous children in Latin America.

Chapter 5

5. Conclusions & Recommendations

After a comprehensive systematic search and analysis of all literature, the following conclusions and recommendations have been derived regarding the prevalence of anemia among Indigenous children in Latin America.

5.1. Conclusions

1. Anemia constitutes a severe public health problem among Indigenous children in Bolivia, Brazil, Colombia, Costa Rica, Ecuador, Guatemala, Mexico, and Peru. 21 Indigenous communities in Latin America showed child anemia as a severe public health problem.
2. 39 Indigenous communities in Latin America have been reported to have child anemia as a public health problem.
3. The main risk factor for anemia among Indigenous children in Latin America is being Indigenous. There are also related risk factors, such as living conditions, and access to health services; specific nutritional causes; and the prevalence of infectious diseases such as hepatitis, parasitosis, and skin and respiratory tract infections.

4. Articles from countries like Guatemala and Bolivia, which have the highest proportion of Indigenous communities in Latin America do not exceed three articles in this systematic review (Guatemala 1, Bolivia 2). This is an indicator of how scarce studies about prevalence of anemia among Indigenous children in Latin America are.
5. Indigenous children from all ages show prevalence of anemia. However, those that are below two years old showed higher values.
6. The most recent reported date of data collection was 2017 considering all the studies included in this systematic review. Therefore, more up-to-date research is needed to provide current values of prevalence of anemia among Indigenous children in Latin America.

5.2. Recommendations

- It is crucial to conduct further studies to document prevalence of anemia of specific Indigenous communities in Latin America.
- Studies about prevalence of anemia among Indigenous children should be combined with other studies about malnutrition to have more information about how to prevent anemia.
- Governments should increase the number of community effectiveness studies to assess the impact of nutrition campaigns among Indigenous communities.
- Studies of prevalence of anemia from Indigenous communities present in different countries, such as the Aymara and Quechua, should be compared to have a better understanding of the general situation of those communities in Latin America.
- Nutrition programs directed to Indigenous communities should go along the way of living of these populations without disturbing their cultural traditions.
- It is also important to explore social acceptance, community willingness and participation of Indigenous populations in nutrition programs.
- It is necessary to assess the Indigenous community leaders' ability to get involved in research and nutrition programs.

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Appendix 1. Data extraction table of all the articles selected in this systematic review*.

#	Title	Authors	Journal	Year	Country	Indigenous community	Region	Type of study	Objectives
1	Impact of fortified maize flour supply on anemia in preschoolers in Indigenous areas of Mexico.	Aguirre Arenas, et al.	Gaceta sanitaria	2013	Mexico	Not specified	Three Indigenous rural areas of Mexico (mountain: State of Mexico; highlands: Veracruz; coast: Hidalgo)	Cross-sectional, descriptive study	To estimate changes at 9 months in the anemia status of preschoolers after feeding soy-fortified cornmeal and a special iron formula.
2	Anemia and malnutrition in Indigenous children and adolescents of the Peruvian Amazon in a context of lead exposure: a cross-sectional study.	Anticona, C., & San Sebastian, M.	Global health action	2014	Peru	Achuar, Urarina, and Quichua	Peruvian Amazon	Cross-sectional, descriptive study	This study aimed to determine the nutritional status of children and adolescents in Indigenous communities in the Corrientes river basin and examine risk factors for anemia, stunting, underweight, and wasting.
3	Nutritional status of Indigenous Guarani children in the states of Rio de Janeiro and São Paulo, Brazil.	Barreto, et al.	Cadernos de Saúde Pública	2014	Brazil	Guaraní	Paraná (Kreen-Akarôre)-village Nacipotire	Cross-sectional, descriptive study	To describe and compare the results of a nutritional survey of Guarani children < 5 years of age, residing in villages in the states of Rio de Janeiro and São Paulo, conducted using a standardized methodology, to the results of the National Survey 3.
4	Health and disease in Panará Indians (Kreen-Akarôre) after twenty-five years of contact with our world, with emphasis on the occurrence of tuberculosis (Central Brazil).	Baruzzi, et al.	Cadernos de Saúde Pública	2001	Brazil	Ma- cro-Jê.	Paraná (Kreen-Akarôre)-village Nacipotire	Cross-sectional, descriptive study	To survey the health conditions of the Panará, the nutritional status of the children, and the active search for cases of tuberculosis, with the adoption of measures to control this disease.
5	Malnutrition prevalence among children and women of reproductive age in Mexico by wealth, education level, urban/rural area and Indigenous ethnicity.	Batis, et al.	Public Health Nutr.	2020	Mexico	Not specified	National	Cross-sectional, descriptive study	To compare the prevalence of malnutrition (undernutrition and excess weight) by wealth, education level, ethnicity and urban/rural areas in Mexican children and women of reproductive age.
6	Iron nutritional state in children from aboriginal communities, Cali, Colombia	Bolaños-Gallardo, et al.	Rev. med. Risaralda	2014	Colombia	Nasa, Yanacona, Quichua, Inga, Kofan y Misak (Guambiano)	Cali	Cross-sectional, descriptive study	To establish the iron status in children between 5 and 14 years old from six Indigenous communities living in Cali-Colombia.

*Most of the information in this table was extracted literally from the original articles so that the reader can better understand the aims, results, conclusions, limitations, and recommendations of the authors. For summarized information see Appendix 4.

#	Title	Authors	Journal	Year	Country	Indigenous community	Region	Type of study	Objectives
7	Prevalence of soil-transmitted helminths after mass albendazole administration in an Indigenous community of the Manu jungle in Peru.	Cabada, et al.	Pathogens and Global Health	2014	Peru	Yomybato	Madre de Dios	Cross-sectional, descriptive study	To estimate changes at 9 months in the anemia status of preschoolers after feeding soy-fortified cornmeal and a special iron formula.
8	Short stature in children of Karapotó ethnic background, São Sebastião, Alagoas, Brazil.	Campos, et al..	Revista Paulista de Pediatria	2016	Brazil	Karapotó	Plak-Ô reservation and Terra Nova settlement, in São Sebastião, state of Alagoas	Cross-sectional, descriptive study	To describe the prevalence of short stature among children of Karapotó ethnic background.
9	Indigenous health in the 21st century: intestinal parasites, malnutrition, anemia and living conditions of children of the Indian reservation Cañamomo-Lomapieta, Caldas-Colombia	Cardona-Arias, et al.	Med. UIS	2014	Colombia	Embera-Chamí	Caldas	Cross-sectional, descriptive study	To determine the prevalence of intestinal parasites, malnutrition and anemia, and their association with living conditions in Embera-Chami children of Colombia.
10	Indigenous health in the 21st century: intestinal parasites, malnutrition, anemia and living conditions of children of the Indian reservation Cañamomo-Lomapieta, Caldas-Colombia	Cediel G, Perez E, Gaitán D, Sarmiento OL, Gonzalez L.	Public Health Nutr.	2020	Colombia	National	National	Cross-sectional, descriptive study	To examine the association of all forms of malnutrition and socioeconomic status (SES), educational level and ethnicity in children <5 years, non-pregnant adolescent women (11–19 years) and non-pregnant adult women (20–49 years) in Colombia.
11	The First National Survey of Indigenous People's Health and Nutrition in Brazil: rationale, methodology, and overview of results.	Coimbra, C.E. et al..	BMC Public Health	2013	Brazil	National	National	Cross-sectional, descriptive study	To obtain baseline information based on a nationwide representative sample. This paper presents the study's rationale, design and methods, and selected results.
12	Anemia in Bolivian children: a comparative analysis among three regions of different altitudes.	Cordero, D., Aguilar, A.M., Casanovas, C., Vargas, E., & Lutter, C.K..	Annals of the New York Academy of Sciences	2019	Bolivia	Aymara, Quechua	National	Cross-sectional, descriptive study	To understand trends in anemia in children from 6 to 59 months of age by selected sociodemographic characteristics and three categories of altitude: low, medium, and high.
13	Prevalence of anemia and consumption of iron-rich food groups in Mexican children and adolescents: Ensanut MC 2016	De la Cruz-Góngora, et al.	Salud pública Méx	2018	Mexico	National	National	Cross-sectional, descriptive study	To describe the prevalence of anemia in Mexican children and adolescents from ENSANUT 2012.

#	Title	Authors	Journal	Year	Country	Indigenous community	Region	Type of study	Objectives
14	Low prevalence of anemia among Shuar communities of Amazonian Ecuador.	DeLouize, et al.	J Hum Biol.	2021	Ecuador	Shuar	Morona-Santiago province: Upano Valley and Cross-Cutucú	Cross-sectional, descriptive study	To evaluate the nutritional status of Indigenous and non-Indigenous children under 5 years of age in two provinces of the Peruvian Amazon.
15	Health and nutrition of Indigenous and nonIndigenous children in the Peruvian Amazon.	Díaz A, Arana A, Vargas-Machuca R, Antiporta D.	Rev Panam Salud Publica.	2015	Peru	Awajún	Provinces of Bagua and Condorcanqui in the Amazon region	Cross-sectional, descriptive study	To evaluate the nutritional status of Indigenous and non-Indigenous children under 5 years of age in two provinces of the Peruvian Amazon.
16	Anemia in Indigenous population of the West of Venezuela.	Diez-Ewald, et al.	Invest Clin.	1999	Venezuela	Yucpa	Western region (Zulia state)	Cross-sectional, descriptive study	The objective of the present work was to study the frequency of nutritional anemia in the Yucpa Indians, inhabitants of the western region of Venezuela.
17	Anemia e níveis de hemoglobina em crianças indígenas Xavante, Brasil Central.	Ferreira, A.A., et al.	Revista Brasileira de Epidemiologia	2017	Brazil	Xavante	Pimentel Barbosa Indigenous Reserve	Cross-sectional, descriptive study	To evaluate the prevalence of anemia, mean hemoglobin levels, and the main nutritional, demographic, and socioeconomic factors among Xavante children in Mato Grosso State, Brazil.
18	Chronic malnutrition and anemia in children under 5 years of Indigenous households of Peru - Analysis of Demographic and Health Survey 2013.	Flores-Bendezú, J. et al.	An. Fac. Med. (Perú)	2015	Peru	Not specified	National	Cross-sectional, descriptive study	To determine the prevalence of chronic malnutrition and anemia in children under 5 years of Indigenous households in Peru.
19	Prevalence of anemia caused by iron deficiency in Mapuche infants fed breast milk.	Franco E, et al.	Rev Chil Pediatr.	1987	Chile	Mapuche	Cautín Province	Cross-sectional, descriptive study	To assess their iron nutrition status by means of hemoglobin, hematocrit, Transferrin saturation and serum ferritin values.
20	Iron nutrition in Mapuche infants fed with human milk (2d phase).	Franco E, et al.	Rev Chil Pediatr.	1990	Chile	Mapuche	Cautín Province	Cross-sectional, descriptive study	To measure blood hemoglobin, serum iron, total iron binding capacity (TIBC) and serum ferritin.
21	Iron supplementation in Chilean Mapuche infants of the Cautin Province, Chile.	Franco E, et al.	Arch Latinoam Nutr.	1996	Chile	Mapuche	Cautín Province	Cohort study	To re-evaluate the iron nutrition of a group of Mapuche infants at one year of age, and then to study their response to an iron supplementation test, up to 15 months.
22	Prevalence of anemia and deficiencies of iron, folic acid and vitamin B12 in an Indigenous community from the Venezuelan Amazon with a high incidence of malaria.	García-Casal et al.	Arch Latinoam Nutr.	2008	Venezuela	Piaroa	Atures Municipality and is located 50 kilometers north of Puerto Ayacucho	Cross-sectional, descriptive study	To determine the prevalence of anemia and deficiencies of iron, folic acid and vitamin B12 in Betania del Topocho, a Piaroa community from Estado Amazonas, Venezuela, a zone with a high incidence of malaria.

#	Title	Authors	Journal	Year	Country	Indigenous community	Region	Type of study	Objectives
23	Prevalence of intestinal parasites, anemia and malnutrition among the children of a Nasa Indigenous reservation, Cauca-Colombia, 2015.	Gaviria, et al.	Rev. Fac. Nac. Salud Pública	2017	Colombia	Nasa (Resguardo San Lorenzo, de Caldon)	Cauca Department	Cross-sectional, descriptive study	To determine the prevalence of intestinal parasitosis, anemia and malnutrition among children of a Nasa Indigenous reservation from Caldon in the Colombian department of Cauca, and their distribution according to clinical, sociodemographic and healthcare infrastructure variables.
24	Nutritional status and food consumption characteristics of the Aguaruna population. Amazonas, Peru 2004.	Huamán-Espino & Valladares	Revista Peruana de Medicina Experimental y Salud Publica	2006	Perú	Aguaruna	Districts of Aramango and Imaza in the province of Bagua; and Cenepa, Nieva and Santiago in the province of Condorcanqui.	Cross-sectional, descriptive study	To identify nutritional status and alimentary patterns in less than three-year-old children and fertile women in Aguaruna natives in Amazonas department, Peru, 2004.
25	Prevalence of anemia and associated factors among Indigenous children in Brazil: results from the First National Survey of Indigenous People's Health and Nutrition.	Leite, M.S. et al.	Nutrition Journal	2013	Brazil	Not specified	North, Northeast, Central-West and Southeast/South)	Cross-sectional, descriptive study	To assess the health and nutritional status of Indigenous children < 5 years of age based on a representative sample of major Brazilian geopolitical regions.
26	Nutritional status of Indigenous children at boarding schools in northern Mexico.	Monárrez-Espino, J., Martínez, H., Martínez, V., & Greiner, T.	European Journal of Clinical Nutrition	2004	Mexico	Taraumara	Northern Mexico (municipios de Guachochi, Balleza y Batopilas)	Cross-sectional, descriptive study	To assess the nutritional status of Tarahumara children at Indigenous boarding schools.
27	Estado nutricional e níveis de hemoglobina em crianças Aruak e Karibe: povos indígenas do Alto Xingu, Brasil Central, 2001-2002.	Mondini, et al.	Revista Brasileira De Epidemiologia	2009	Brazil	Aruak and Karibe	Upper Xingu, Central Brazil	Cross-sectional, descriptive study	To evaluate the nutritional status of Indigenous children of the Aruak and Karibe linguistic families from the Upper Xingu, Central Brazil, and study the relationship between hemoglobin levels and children's gender, age and nutritional status. In total, 470 children under age ten were studied in 2001/2002.
28	Nutrition status in Kamaiurá Indian children - Alto Xingu, Central Brazil.	Mondini, et al.	Rev. bras. Epidemiol	2007	Brazil	Kamaiurá	Alto Xingu, Mato Grosso	Cross-sectional, descriptive study	To evaluate nutritional and anemic status of 112 Indian children (Kamaiurá), aged from 0 to 119.9 months, from the Alto Xingu region of central Brazil were studied in 2000/2001.

#	Title	Authors	Journal	Year	Country	Indigenous community	Region	Type of study	Objectives
29	Biochemical Indicators of Nutritional Status and Dietary Intake in Costa Rican Cabécar Indian Adolescents.	Monge-Rojas, R. et al.	Food and Nutrition	2005	Costa Rica	Cabécar	Indian reservation of Ujarrás, Puntarenas	Cross-sectional, descriptive study	To determine the blood levels of selected nutritional status indicators and the dietary intake of Costa Rican Cabécar Indians aged 10 to 16 years.
30	Nutritional status of Terena indian children from Mato Grosso do Sul, Brazil: follow up of weight and height and current prevalence of anemia.	Morais, et al.	J. pediater. (Rio J.)	2005	Brazil	Terena	Terenas villages of Limão Verde and Córrego Seco, located in the district of Aquidauana, in Mato Grosso do Sul state.	Cross-sectional, descriptive study	This study of Terena Indian children less than 10 years old was undertaken in order to compare weight and height in 1995 and 2002 and to evaluate anemia prevalence in 2002.
31	Anemia in children aged 6 to 59 months and associated factors in Jordão, Acre State, Brazil.	Oliveira, et al.	Cadernos de Saúde Pública	2011	Brazil	Kaxinanuá	Município de Jordão, in the valley of Juruá	Cross-sectional, descriptive study	Investigate anemia prevalence and associated factors using a cross-sectional approach with 429 children 6 to 59 months of age in Jordão, Acre State, Brazil.
32	Nutritional status and anemia in Suruí Indian children, Brazilian Amazon	Orellana, et al.	J. pediater. (Rio J.)	2006	Brazil	Suruí	National	Cross-sectional, descriptive study	To assess the nutritional status of Suruí Indian children aged less than 10 years by means of anthropometric measurements and determination of hemoglobin concentration levels.
33	Household food insecurity and its association with anaemia in Mexican children: National Health and Nutrition Survey 2012.	Palacios-Rodríguez, et al.	International Journal of Public Health	2019	Mexico	Not specified	Aldeia Plak-Ô and povoado Terra Nova, located in the municipality of São Sebastião, Alagoas	Cross-sectional, descriptive study	To assess the association between household food insecurity (FI) and the presence of anaemia among Mexican children who were between 12 and 59 months old, and to determine whether this association differs by geographical regions.
34	Anemia em crianças indígenas da etnia Karapotó / Anemia in Indigenous children of Karapotó ethnic backgrounds.	Pereira, et al.	Rev. bras. saúde matern. Infant	2012	Brazil	Karapotó	National	Cross-sectional, descriptive study	To identify the prevalence and factors associated with anemia in children of karapotó ethnic backgrounds.
35	Malnutrition inequalities in Ecuador: differences by wealth, education level and ethnicity.	Ramírez-Luzuriaga, et al.	Public Health Nutr.	2020	Ecuador	Not specified	National	Cross-sectional, descriptive study	To describe and quantify the magnitude and distribution of stunting, wasting, anaemia, overweight and obesity by wealth, level of education and ethnicity in Ecuador.

#	Title	Authors	Journal	Year	Country	Indigenous community	Region	Type of study	Objectives
36	The double burden of malnutrition in Indigenous and nonIndigenous Guatemalan populations.	Ramirez-Zea, et al.	The American Journal of Clinical Nutrition	2014	Guatemala	Not specified	National	Cross-sectional, descriptive study	To describe and analyze the prevalence of DBM over time (1998–2008) in Indigenous and nonIndigenous Guatemalan populations.
37	Nutritional status of Indigenous children younger than five years of age in Mexico: results of a national probabilistic survey.	Rivera, et al.	Salud Publica Mex.	2013	Mexico	Not specified	National	Cross-sectional, descriptive study	To compare the prevalence of undernutrition and anemia in Indigenous and non-Indigenous children <5 years of age at the national level, by region and by urban and rural areas, and to evaluate the degree to which the socio- economic condition of the family predicts the differences.
38	Anthropometric and hematological tests to diagnose nutritional deficiencies in schoolchildren of Indigenous communities living in the Andean region of Ecuador	Robalino, et al.	Rev. Nutr. (Online)	2017	Ecuador	Not specified	Riobamba canton of Chimborazo province	Cross-sectional, descriptive study	To carry out the anthropometric and biometric-hematological assessments in schoolchildren of the Andean region of Ecuador, in order to improve the diagnosis of nutritional deficiencies.
39	Differences in Nutritional and Health Status in School Children from the Highlands and Lowlands of Bolivia.	Terán, et al.	The American Journal of Tropical Medicine and Hygiene	2018	Bolivia	Aymara	Taraco district (shores of Lake Titicaca)	Cross-sectional, descriptive study	To measure key determinants of health in school children from Taraco, a rural district typical of the Bolivian highlands (Puna at 4,000 masl) and compared them to de- terminants from children living in Caranavi, a semi-urban area in the Yungas at lower altitude (600 masl).
40	High Malnutrition Rate in Venezuelan Yanomami Compared to Warao Amerindians and Creoles: Significant Associations WITH Intestinal Parasites and Anemia.	Verhagen, et al.	Plos One	2013	Venezuela	Yanomami and Warao	Amazon Region, Orinoco Delta and Carabobo State	Cross-sectional, descriptive study	Investigate the prevalence of and associations between intestinal helminth and protozoan infections, malnutrition and anemia in school-age Venezuelan children.
41	Prevalence of anemia in children 1 to 12 years of age: results from a nationwide probabilistic survey in Mexico.	Villalpando, et al.	Salud Pública de México	2003	Mexico	Not specified	National	Cross-sectional, descriptive study	To describe the epidemiology and analyze fac- tors associated with iron deficiency anemia in a probabilistic sample of the Encuesta Nacional de Nutrición 1999 (ENN-99) [National Nutritional Survey 1999 (NNS-99)].
42	The Xavante Longitudinal Health Study in Brazil: Objectives, design, and key results.	Welch, et al.	American Journal of Human Biology	2020	Brazil	Xavante	Villages, Pimentel Barbosa and Etênhriritipá, State of Mato Grosso, Central Brazil	Cohort study	To permit granular tracking of contemporary health challenges faced by Indigenous communities in Brazil, taking into consideration ongoing historical processes that may be associated with increases in child undernutrition, adult obesity, and cardiovascular disease risks.

#	Dataset	Sampling technique (e.g. random or convenience)	Date of data collection	Sample size	Age group	Exposure	Outcome	Type of measurement (Percentage / Odds ratio/Risk ratio)	Statistical methods used
1	-	Not specified	Sep 2007 – Jun 2008	194	6-24 months	Provision of soy -(3%) and iron-fortified flour	Malnutrition, anemia	Percentage	Estimate of absolute and absolute frequencies for categorical variables. Median used for continuous variables. Chi-square and Wilcoxon tests applied to identify differences between the pre- and post-test groups.
2	-	Not specified	Nov-Dec 2010	330	0-17 years	Lead exposure	Malnutrition, anemia	Percentage, odds ratio	Univariate, bivariate, and logistic regression
3	-	Not specified	Nov 2008-Mar 2009	115	<5 years	None	Malnutrition, anemia	Percentage	Average, prevalence, calculation of anthropometric indices
4	-	Not specified	Jul 1998	181	6 months - 14 years	Tuberculosis	Malnutrition, anemia, tuberculosis	Percentage	Average, prevalence, calculation of anthropometric indices
5	Mexican National Health and Nutrition Survey 2012.	Random	Oct 2011-May 2012	1302	<5 years	None	Overweight, obesity, wasting/underweight, stunting/short stature and anemia	Percentage	Proportions or means of age, sex, (only among children <5 years), education level (only among women 20–49 years), ethnicity and household characteristics and goods in the whole sample and by wealth tertiles. Prevalence ratios (PR) adjusted by all other socioeconomic and ethnic indicators. Performed a ‘chunk test’ to jointly test the inter- action terms in the case of sociodemographic variables with dummies.
6	-	Random	Not given	551	5-14 years	None	Iron deficiency	Percentage	A normality analysis of quantitative variables by means of the Shapiro-Wilk test. Averages and standard deviation were calculated for quantitative variables and proportions and simple frequency distribution were calculated for qualitative variables. For comparisons between communities, if the variables had a normal distribution, Student's t and Bonferroni parametric tests were used to determine whether there were differences and the level of statistical significance of these differences. Comparisons between variables that did not have a normal distribution were made using nonparametric tests such as the median test and the Mann-Whitney U test.
7	-	Not specified	Nov 2012	225	All ages	None	Malnutrition, anemia	Percentage, odds ratio	The prevalence of malnutrition, anemia, and STH infections were calculated. Means (6SD) were calculated for continuous variables and compared using t-tests. The Chi square test and Odds ratios were used to evaluate categorical variables. A P<0.05 was considered statistically significant.
8	-	Random	2008-2009	97	6-59 months	None	Malnutrition, anemia	Percentage	To compare categorical variables, we used the chi-square test or chi-square test with Yates correction.

#	Dataset	Sampling technique (e.g. random or convenience)	Date of data collection	Sample size	Age group	Exposure	Outcome	Type of measurement (Percentage / Odds ratio/Risk ratio)	Statistical methods used
9	-	Convenience	Not given	184	<15 years	None	Prevalence of intestinal parasites, malnutrition and anemia, and their association with living conditions.	Percentage	Frequencies, summary measures, Pearson's chi-square, Fisher's exact, Mann Whitney U and t Student.
10	The 2010 Colombian Demographic and Health Survey and the National Nutritional Survey	Random	Not given	2606	<5 years	None	Malnutrition, anemia	Percentage	Sociodemographic characteristics were described as a percentage and prevalence (95 % CIs) by age groups. To analyze household characteristics by SES, a linear trend test was used. We compared the prevalence of over- and undernutrition indicators by SES, educational level and race/ethnicity using linear adjusted combinations of the estimates (lincom function on Stata).
11	-	Random	Not given	6583	<5 years	None	Malnutrition, anemia, hypertension and diabetes mellitus, diarrhea and acute respiratory infections.	Percentage	A principal component analysis was carried out for 19 durable goods, considering the suitability of the data for this statistical tool. Before applying this technique, the correlation matrix between the quantities of the 19 items was calculated.
12	Databases from the demographic and health surveys (DHS) for the years 1998, 2003, and 2008, and a 2016 population-based nutrition and health survey	Not specified	1998, 2003, 2008, 2016	8197	<5 years	None	Anemia	Percentage	Bivariate analysis using odds Ratios with the DHS or EDSA sampling weights, with a confidence interval of 95%, to identify the sociodemographic characteristics related to any degree of anemia in children 6–59 months of age, according to the altitude.
13	Databases from three nationally, regionally, and urban-rural representative national nutrition surveys from 1999, 2006 and 2012.	Not specified	1999, 2006, 2012	1999: 587; 2006: 356; 2012: 909	12-59 Months	None	Anemia	Frequency, percentage	Calculate frequencies. Logistic regression models were used to estimate the risk of anemia from the 2012 ENSANUT adjusting for confounders (sex, age, BCI, BMI, urban/rural area, geographic region, indigeneity, Oportunidades and Liconsa beneficiary, and affiliation to health services).

#	Dataset	Sampling technique (e.g. random or convenience)	Date of data collection	Sample size	Age group	Exposure	Outcome	Type of measurement (Percentage / Odds ratio/Risk ratio)	Statistical methods used
14	-	Random	Aug 2008-Nov 2017	1650	6 months - 86 years	None	Anemia	Percentage	To estimate the Z scores of the weight / height, weight / age and height / age indices, the WHO Anthro v3.1.0 program was used. The prevalences and the respective confidence intervals (95% CI) of the main health and nutrition indicators were estimated. Bivariate and multivariate analyzes were performed, by means of generalized linear models (GLM) using the analysis for complex samples.
15	-	Random	Not given	496	<5 years	None	Malnutrition, anemia	Percentage	The prevalences and the respective confidence intervals (95% CI) of the main health and nutrition indicators were estimated. Bivariate and multivariate analyses were performed by means of generalized linear models (GLM) using the analysis for complex samples, in order to determine the strength of association of the determinants of anemia and chronic child malnutrition in the Indigenous population and in the non-Indigenous population.
16	-	Not specified	Not given	399	2-70 years	None	Anemia	Percentage	Xi square and correlation
17	-	Convenience	Jul 2009	257	<10 years	None	Anemia	Percentage	Two models were constructed in the adjusted multivariate analysis: one with hemoglobin concentration as the outcome, using linear regression coefficient (β), and the other with anemia occurrence as the outcome, using Poisson regression with robust variance. The statistical significance of Poisson regression was determined with the Wald test estimating adjusted prevalence ratios and respective 95% confidence intervals (95%CI). Multivariate stepwise analysis was used to adjust for potentially confounding variables retained from bivariate analysis.
18	Demographic and Health Survey (DHS) 2013, National Institute of Statistics and Informatics.	Random	Mar-Dec 2013	334	<5 years	None	Malnutrition, anemia	Percentage	To analyze the level of association between chronic malnutrition and anemia in relation to sex and age of the child, the chi-square test of independence was used.
19	-	Random	Not given	110 (54 boys, 56 girls)	8-14 months	None	Malnutrition, anemia	Percentage	For statistical analysis, arithmetic and geometric means, standard deviation, Student's t-test and Xi square. A $p < 0.05$ was considered statistically significant.

#	Dataset	Sampling technique (e.g. random or convenience)	Date of data collection	Sample size	Age group	Exposure	Outcome	Type of measurement (Percentage / Odds ratio/Risk ratio)	Statistical methods used
20	-	Random	Not given	140	8-15 months	Fed with breast milk to which solids were added after the fourth month.	Iron deficiency, anemia	Percentage	Arithmetic and geometric means, standard deviation, Student's t-tests and Chi-square tests. Differences with a value of $p < 0.05$ were considered statistically significant.
21	-	Random	Not given	76	12-15 months	A 1.8 ml iron supplementation of ferrous sulfate is administered for 90 days.	Iron deficiency, anemia	Percentage	Average, prevalence, Xi square and t student to make the inferences.
22	--	Not specified	Not given	184	All ages	None	Anemia and deficiencies of iron, folic acid and vitamin B12.	Percentage	Analyses of results were performed calculating the prevalence of anemia and deficiencies of iron, folic acid and vita- min B12 separately and then correlating these deficiencies as causes of anemia, according to age and gender. ANOVA with Bonferroni as a post-test was used to compare differences in biochemical variables by age and gender.
23	-	Convenience	Not given	62	1-5 years	None	Anemia, intestinal parasitism and infection by commensal parasites, pathogens, protozoa, helminths and identified species.	Percentage	The frequency of intestinal parasitism, anemia and malnutrition was compared with parental schooling by means of a linear trend chi-square test (for ordinal data), with the characteristics of sanitary infrastructure, living with animals and felt morbidity with Pearson's chi-square test (for nominal data), and with the age group (categorized into 1-3 years and 4-5 years) and sex with Fisher's exact test (for dichotomous variables and expected frequency less than 5). The strength of the association was determined with prevalence ratios and their 95% confidence interval.
24	-	Random	Sep-Oct 2004	4572 women; 9160 children	Women 15-49 years; children <3 years	None	Malnutrition, anemia and food consumption patterns.	Percentage	The prevalence of nutritional status in the target populations, their 95% confidence intervals, the frequency of consumption of the main foods, the relationship between sex, age, district of origin and the variables nutritional status, anemia and consumption, and the association between chronic malnutrition, anemia and factors such as age, districts of origin and educational level were quantified using the chi-square test.

#	Dataset	Sampling technique (e.g. random or convenience)	Date of data collection	Sample size	Age group	Exposure	Outcome	Type of measurement (Percentage / Odds ratio/Risk ratio)	Statistical methods used
25	-	Random	2008-2009	5397	<5 years	None	Anemia	Percentage	Prevalence rates of anemia were calculated according to independent variables (geo-political region, demographic variables, socioeconomic variables, characteristics of the household environment, and maternal and child characteristics). Estimates were corrected for the complex sampling design of the study. Chi-square tests for linear trend were used to evaluate differences in proportions. The multivariate analysis followed a hierarchical conceptual framework based on Poisson regression with robust adjustment of the variance for dichotomous outcomes (anemic or not anemic).
26	-	Convenience	2001	331	6-14 years	None	Malnutrition (wasting, overweight, anemia, iron deficiency, erythropoiesis, folic acid, vitamin B12 zinc concentrations).	Percentage	Analyses included descriptive statistics for the micronutrient data. Logarithmic transformation was used to normalize skewed vitamin B12 and folic acid distributions before statistical testing. Mean and s.d. were calculated for capillary Hb and serum vitamin B12, folic acid and zinc. Data were stratified by sex and age group (6–8, 9–11 and 12–14 y) and by school (only for Hb). SF, TfS and Hb data were combined and presented as proportions falling within each specific iron nutrition category. One-way analysis of variance (ANOVA) was used for multiple comparisons of means and Newman-Keuls tests were used to investigate differences between means. w2 tests were conducted to identify differences in proportions. Statistical significance was set at $P<0.05$.
27	-	Not specified	2001-2002	112	6-120 months	None	Malnutrition, anemia	Percentage	The descriptive analysis was presented according to the children's age range for the Aruak and the Karibe groups. The differences observed between mean hemoglobin values and the prevalence of each outcome (anemia and moderate/severe anemia) were calculated for independent variable categories and tested by the Student's t-test and Chi-square test, respectively.
28	-	Random	Jul 2000 in Ipavu and Apr 2001 in Morena	470 children (201 Aruak, 269 Karibe)	<10 years (0-119,9 months)	None	Malnutrition, anemia	Percentage	Descriptive statistics. The differences found between the hemoglobin averages according to sex and age group, as well as the average values of anthropometric indices in the strata mentioned, were analyzed using the Student's t-test. The proportions of nutritional deviations in the different strata analyzed were tested using the chi-square statistic.

#	Dataset	Sampling technique (e.g. random or convenience)	Date of data collection	Sample size	Age group	Exposure	Outcome	Type of measurement (Percentage / Odds ratio/Risk ratio)	Statistical methods used
29	-	Random	Not given	10-16 years	10-16 years	None	Malnutrition, anemia	Percentage	Descriptive statistics, percentiles, Student's t-test and the chi-square test. For between-gender nutrient intake comparison, dietary intakes were adjusted per 1,000 kcal. Partial Spearman correlation coefficients adjusted for energy intake were calculated to determine associations between dietary variables and serum biochemical parameters
30	-	Not specified	2002	6-5 years	6-5 years	None	Malnutrition, anemia	Percentage	The majority of the variables involved do not present standard deviation and, for this reason, the Mann-Whitney test was used to compare continuous variables for the two independent groups. Categorical variables were analyzed using the chi-square test or Fisher's exact test using Epi-Info version 6.2.15. The level of statistical significance was defined as 5% (alpha error = 0.05).
31	-	Convenience	Jun 2005	429	6-59 months	None	Malnutrition, anemia	Percentage	Pearson's chi-square test was used to verify the association between variables, considering the significance level $p < 0.05$. The prevalence ratio (PR) was calculated by multiple Poisson regression models.
32	-	Not specified	Feb-Mar 2005	293	<10 years	None	Malnutrition, anemia	Percentage	Calculation of z scores (ESZ) of the indices height/age (E/I), weight/age (P/E) and weight/age (P/I). Comparison of means was done using Student's t-test, and of proportions, using the χ^2 test.
33	Mexican National Health and Nutrition Survey 2012.	Random	2012	7468	12-59 months	None	Malnutrition, anemia	Percentage	Prevalence of anemia. An ordinal logistic regression model was developed to assess the relationship between food insecurity and anemia. The final model was adjusted by age, head of household gender, parental educational level, Indigenous status, region of residence and tertiles of well-being conditions. The effect of interactions between geographical regions and food insecurity was checked. The level of significance was defined as $P < 0.05$. Estimates were adjusted for complex survey design (use of sampling weights and clustered samples).
34	-	Not specified	Aug-Oct 2008	106	6-59 months	None	Malnutrition, anemia	Percentage	Descriptive statistics. Prevalence of anemia. Data were categorized into frequencies; the chi-square test or the Fisher's exact test was applied. To compare frequencies the chi square test or Fisher's exact test was applied. For all analyses, the significance level was set at $p < 0.05$.

#	Dataset	Sampling technique (e.g. random or convenience)	Date of data collection	Sample size	Age group	Exposure	Outcome	Type of measurement (Percentage / Odds ratio/Risk ratio)	Statistical methods used
35	Ecuadorian National Health and Nutrition Survey (ENSANUT-ECU)	Random	2012	8580 children (1236 Indigenous)	<5 years	None	Malnutrition, anemia	Percentage	Descriptive statistics. Differences in means and proportions between subgroup categories were tested using the test for linear combinations, $P < 0.05$.
36	National Maternal and Child Health Surveys; ENSMI, 1998, 2002, 2008	Random	1998, 2002, 2008	4545, 7525, and 10,775	0-59 months		Malnutrition, anemia	Percentage	Estimated the prevalence and CIs for underweight, stunting, overweight, and obesity in children 0–59 mo and underweight, anemia, short stature, overweight, and obesity. performed a Student's t test to assess the differences between Indigenous and nonIndigenous populations within the ENSMI 2008, and P values were obtained. A chi-square test was also conducted to obtain trends in stunting, overweight, and obesity in children and for short stature, overweight, and obesity.
37	Second national nutrition survey	Random	Oct 1998 - Mar 1999	605	6-59 months		Malnutrition, anemia	Percentage, relative risk, odd ratio	The general methodological background on generalized linear model analyses of complex survey data was applied. Wald statistics for complex samples were used to test the differences between prevalences (chi-squared values) and the differences between continuous variables. The second objective was addressed through logistic regression models.
38	-	Random	Not given	36	5-6 years		Malnutrition, anemia	Percentage	The differences between variables were determined based on sex, using the Univariate General Linear Model, which is applied for quantitative variables, and the Chi-square test, which is used for qualitative variables. For all analyses, a bilateral significance was determined at $p < 0.05$.
39	-	Not specified	Oct-Nov 2004	120 in Taraco; 96 in Caranavi	6-12 years		Malnutrition, anemia	Percentage	Descriptive statistics. A χ^2 test was used to compare frequencies between different categories (e.g., severe or moderate anemia) or to compare frequencies of events in the case of noncontinuous variables. For comparisons of different parameters stratified by age or gender between the locations a two-way analysis of variance (ANOVA) was used. The Spearman rank correlation test was used to test the correlation between parameters.

#	Dataset	Sampling technique (e.g. random or convenience)	Date of data collection	Sample size	Age group	Exposure	Outcome	Type of measurement (Percentage / Odds ratio/Risk ratio)	Statistical methods used
40	--	Not specified	2010-2011	390	4-16 years		Malnutrition and parasitic infections	Percentage	Categorical variables were analyzed using Chi-square test or Fisher's exact test, as appropriate. For continuous variables, the one-way analysis of variance (ANOVA) and unpaired Student's t tests or the nonparametric Kruskal-Wallis and Mann-Whitney's tests were used depending on whether or not the variables were normally distributed (Kolmogorov-Smirnov's test, $p > 0.05$). When the variances across groups were not equal (Levene's test $p < 0.05$), Welch correction for non-homogeneity of variance was applied.
41	National Nutritional Survey 1999 (NNS-99)	Random	1999	8111	1-12 years		Malnutrition, anemia	Percentage, odds ratio	The association of anemia with potential explanatory variables such as those indicative of nutritional status, dietary, and socioeconomic characteristics, maternal education, employment status, and literacy, was assessed by the odds ratio derived from a logistic regression model adjusted for complex sampling to minimize the effects of clustering. In a second series of regressions, hemoglobin concentration was introduced to the model as a dependent variable; the dietary intake of iron, folic acid, vitamin B12, and calcium were entered as independent variables. After prevalences were calculated, they were expanded to represent the original population
42	-	Convenience	Jul-Aug 2009	656			Child malnutrition, anemia, adult obesity, and cardiovascular disease risks	Percentage	Descriptive statistics.

#	Control group	Results	Prevalence of anemia	Conclusions	Limitations	Recommendations
1	No	During the 9-month period, the hemoglobin level increased from 11.0 to 11.9 mg/dL ($p<0,001$). The prevalence of anemia (hemoglobin < 11.0 mg/dL) decreased from 52.6% to 25.3% ($p<0,001$). The estimated prevalences by age group were reduced to 40.8% (6-12 months), 34.7% (12.1-18 months) and 24.5% (>18 months). The prevalence of mild anemia represented the highest percentage (40.8% in girls and 25.0% in boys), rising to 22.5% in girls and 14.6% in boys. Severe anemia in boys decreased from 5.2% to 1.0% at the end of the study. The most affected were children under one year of age and girls.	Children 6-24 months: 52.6%	The decreased prevalence of anemia suggests that the provision of soy - (3%) and iron-fortified flour is a viable alternative for combating childhood anemia. Despite the short intervention time and the evaluation of the results, it is possible that this study is one of the most demonstrative that the enrichment of a cereal with the special iron formula will work quickly, and in 9 months, the average increase of 1 g of hemoglobin will reduce the anemia to a moderate level and improve the health status of the children.	The main limitation of the study was the absence of a comparison group to contrast the information, which prevented us from assessing other differences that could influence the results.	It is vital to provide better nutritional conditions for children, promoting their intellectual abilities in the first years of life, reducing their anemia and ensuring their integral development.
2	No	Overall, anemia prevalence was 51.0%, stunting (proxy for chronic malnutrition) 50.0%, and underweight 20.0%. Bivariate analysis showed that anemia and underweight prevalence was higher in the 04 years group ($pB0.05$). No association was found between anemia, stunting, or underweight with gender, community exposure to oil activity, or consumption of river water. Stunting prevalence was higher in the group whose BLLs were 5mg/dL ($pB0.05$). In the logistic regression analysis, no variable was associated with anemia or underweight. The group 511 years and 12 years had 1.9 and 3.1 times higher risk of stunting than the group under five years, respectively. Children and adolescents with BLLs 5mg/dL had twice the risk of stunting compared to those with lower BLLs.	Overall: 51%, 0-4 years (56.9%), 5-11 (45.6%), >12 (50.9%) / Boys (54.8%), Girls (47,4)	Half of the study population was found with anemia and stunting. Anemia was more prevalent in the 0- to 5-year age group and stunting in the 12- to 17-year group. The association between stunting and BLLs might be attributed to a direct effect of lead on human growth. Also, poor nutrition and other socioeconomic-related factors may contribute to the simultaneous existence of stunting and elevated BLLs.	First, they did not examine other risk factors for nutritional indicators that have been reported in other studies in the Amazon such as low maternal height, low birth weight, diarrhea episodes, and geohelminth infection (33). Second, the small sample size and missing data from some participants might have contributed to finding a low variability of other factors explored and explain why we did not find other associations. Third, the cross-sectional design did not allow for the identification of the direction of the association between stunting and BLLs. Finally, there were some limitations on samples and data collection. First, they used finger-prick blood samples to measure Hb and BLLs. This involves a procedure that can dilute the sample and thus introduce a systematic error into the results (54). Second, they used the LeadCare instrument for the analysis of BLLs. This method has been criticized because of its greater percentage of error and sensitivity to environmental conditions when compared to the gold standard method (graphite furnace atomic absorption). Third, they used a questionnaire to collect information on risk factors. This may have introduced recall bias from respondents when answering about past events of the child's history and reporting bias, bearing in mind that respondents might have answered in ways that may be more socially acceptable.	Not given

#	Control group	Results	Prevalence of anemia	Conclusions	Limitations	Recommendations
3	No	Anthropometric measurements to 128 children; hemoglobin: 115. The prevalences of malnutrition, according to various anthropometric indices were: 50.4% (short stature for age), 7.9% (low weight for age) and 0.8% (low weight for stature). The height deficit found in Guarani children was 96% greater than that of Indigenous children in Brazil (25.7%) and 7.2 times greater than that of children in the general population (7%). The prevalence of anemia was 65.2%, 3.1 times the corresponding prevalence in non-Indigenous children (20.9%).	Overall: 65,2%, 6-11 months: 88,9%; 12-23 months: 75,0%; 24-35 months: 66,7%; 36-47: 51,9%; 48-59 months: 59,3%.	The prevalence of Guarani anemia (65.2%) is considered severe considered severe, exceeding 3.1 times the prevalence in non-Indigenous children in Brazil (20.9%) and 6.3 times that of the Northern Region, which registers the highest national prevalence. The prevalence of Guarani anemia also exceeds the average values for all Indigenous children in Brazil (51.2%) and for those in the South/Southeast (48%) and is close to that reported for Indigenous children in the North (66.4%).	Not given	The results reinforce the need for investments in maternal and childcare among the Guarani. Basic sanitation measures and food security and subsistence strategies must be implemented, with extensive discussion with the communities.
4	No	Anemia, according to the criteria adopted, was observed in 56.1% of the children under 14 years of age, in the mild and moderate forms.	Overall: 56,1%; 6 months - 5 years: 33,3%; 6 years - 14 years: 73,9%.	The nutritional assessment of the Panará children showed the presence of chronic forms of malnutrition and anemia in smaller proportions than observed in some surveys conducted in other Indigenous groups, and there are not enough elements to affirm that there is an association between the high prevalence of tuberculosis and nutritional status in that tribe.	Not given	Not given
5	No	In most age groups, belonging to non-Indigenous households, with high wealth, high education and in urban areas were inversely associated with stunting or short stature (PR ranging from 0.40 to 0.83), and wealth and education were inversely associated with anemia (PR ranging from 0.53 to 0.78). The prevalence of overweight was similar across subgroups among children <5 years; however, among women 11–19 years, wealth, non-Indigenous household and urban areas were positively associated (PR ranging from 1.16 to 1.33); and among women 20–49 years, education was inversely associated (PR 0.83).	Overall: 24,8%	Socially disadvantaged populations have a higher prevalence of undernutrition, whereas the prevalence of excess weight is either equal (children <5 years), slightly lower (women 11–19 years) or even higher (women 20–49 years) with lower education. These results highlight the need for specific actions to address social inequalities in malnutrition in the Mexican population.	The cross-sectional nature of the survey, which did not enable us to infer causality among socioeconomic and ethnicity indicators and malnutrition. Additionally, they did not analyze men 11–49 years, subjects >49 years old from both sexes, or abdominal adiposity.	Not given

#	Control group	Results	Prevalence of anemia	Conclusions	Limitations	Recommendations
6	No	Biochemical variables did not show normal distribution in contrast to hematological variables. Statistically significant differences were found in hemoglobin and hematocrit between two Indigenous councils. Transferrin levels were similar in all councils, while ferritin levels showed statically significant differences. Low iron supply anemia prevalence was 25.8% and Inga and Yanacona were the most affected.	Overall: 25,8%	The Indigenous children have iron deficiency, which may affect their physical and cognitive development. This guides in considering an opportune intervention to establish the causes and to take corrective measures.	Not given	It is recommended that strategies for the detection of at-risk populations be designed as a follow-up tool that will have an impact on the well-being and health of children without disregarding the cultural patterns of these vulnerable groups.
7	No	Half of the participants had helminth infections. Trichiuris (30.2%), hookworm (19.1%), Ascaris (17.7%), and Strongyloides (5.6%) were the most common helminths. Other helminth ova included Capillaria hepatica and Fasciola-like eggs. Subjects of 5–19 years (51.8 %) and 20–35 years (68.6 %) old had helminths more often than those under 5 years (38%) and older than 35 years (41.5%) (P5 0.02). Anemia was detected in 41% of children and this was more common in children under 5 years that in those of 5–19 years [odd ratio (OR) 5 5.68; 95% CI: 2.71–11.88]. Overall, 72.1% of children were malnourished. Stunting was common in children (70.7%), but wasting was not (2.9%).	Children <5 years: 67,3%; 5-19 years: 26,6%	Despite repeated albendazole administration, this population continued to have a high prevalence of STHs, anemia, and malnutrition. In addition, we detected unusual organisms and organisms that do not respond to albendazole.	Not given	Nor given
8	No	The prevalence of short stature was 15.6% for children from the Terra Nova settlement statistically significant p-values≤0.05. and 9.1% for those from Plak-Ô native village. The prevalence of short stature among the Karapotó ethnicity was 13.4%. The variables: maternal literacy, family income and low birth weight were statistically associated with short stature.	Overall: 57,7%	The observed short stature prevalence rates are significant, being characterized as a public health problem. Among the associated factors, the following are noteworthy: unfavorable conditions of maternal literacy, family income and low birth weight. The planning of strategies to reverse the situation must take such factors into consideration.	Its cross-sectional design, an aspect that prevents cause-and-effect inferences.	Not given

#	Control group	Results	Prevalence of anemia	Conclusions	Limitations	Recommendations
9	No	Biochemical variables did not show normal distribution in contrast to hematological variables. Statistically significant differences were found in hemoglobin and hematocrit between two Indigenous councils. Transferrin levels were similar in all councils, while ferritin levels showed statically significant differences. Low iron supply anemia prevalence was 25.8% and Inga and Yanacona were the most affected.	Overall: 25,8%	The Indigenous children have iron deficiency, which may affect their physical and cognitive development. This guides in considering an opportune intervention to establish the causes and to take corrective measures.	Not given	It is recommended that strategies for the detection of at-risk populations be designed as a follow-up tool that will have an impact on the well-being and health of children without disregarding the cultural patterns of these vulnerable groups.
10	No	In children <5 years, a low SES and maternal educational level were significantly associated with a lower prevalence of overweight/obesity compared with high levels of SES and maternal education, that is, the prevalence of overweight/obesity was 1-4 and 1-6 times lower in categories of low SES and educational levels, respectively. In contrast, the prevalence of wasting, stunting and anemia was higher in the lowest SES and maternal educational categories (the prevalence was between 1-1 and 1-8 times higher for these indicators). In women, the lowest SES (11 and 19 years) and educational levels (20 and 49 years) exhibited a higher prevalence in all forms of malnutrition compared with their counterparts in the highest categories (i.e. overweight/obesity, stunting and anemia). Additionally, Indigenous or Afro-Colombian children and women had the highest prevalence of malnutrition in comparison with other ethnicities.	Children < 5 years: 31,9%	These results suggest that public policies should address all forms of malnutrition that occur in the most vulnerable populations in Colombia using multiple strategies.	The cross-sectional nature of the study, which does not enable us to infer causality / directionality of the association between sociodemographic status and malnutrition.	Current policies require adequate implementation with the coordination of entities working both sides of the problem to optimize resources and ensure that specific policies are not contributing to worsening other health problems.
11	No	The study obtained data for 113 villages (91.9% of the planned sample), 5,305 households (93.5%), 6,692 women (101.3%), and 6,128 children (93.1%). Multiple household variables followed a pattern of greater economic autonomy and lower socioeconomic status in the North as compared to other regions. For non-pregnant women, elevated prevalence rates were encountered for overweight (30.3%), obesity (15.8%), anemia (32.7%), and hypertension (13.2%). Among children, elevated prevalence rates were observed for height-for-age deficit (25.7%), anemia (51.2%), hospitalizations during the prior 12 months (19.3%), and diarrhea during the prior week (23.6%).	Children < 60 months: 51,2%	The clinical-epidemiological parameters evaluated for Indigenous women point to the accentuated occurrence of nutrition transition in all regions of Brazil. Many outcomes also reflected a pattern whereby Indigenous women's and children's health indicators were worse than those documented for the national Brazilian population, with important regional variations. Observed disparities in health indicators underscore that basic healthcare and sanitation services are not yet as widely available in Brazil's Indigenous communities as they are in the rest of the country.	the results of the National Survey do not permit the conclusion that the Indigenous component of the Brazilian population has equal access to these important advances The design of the National Survey does not allow characterization of health conditions for specific Indigenous ethnic groups. Although desirable, doing so would be a logistical challenge of enormous scale, considering that there are more than two hundred Indigenous ethnicities in Brazil, some of which have populations of less than 200 people residing in remote and in- accessible locations.	Not given

#	Control group	Results	Prevalence of anemia	Conclusions	Limitations	Recommendations
12	No	We did not identify a single consistent risk factor for anemia in children living at high altitude compared with those living at medium or low altitude. The most consistent characteristic associated with childhood anemia across the three altitude categories was diarrhea in the last 2 weeks. Low length/height for age, an adolescent or anemic mother, a mother with no or little education, and a mother who speaks Quechua or Aymara were also risk factors.	Children 6-59 months: 2016: Quechua: 55%; Aymara: 73,8%; 2008: Quechua: 66,4%; Aymara: 70,2%; 2003: Quechua: 56,7%; Aymara: 61,1%	They conclude that it is necessary to review anemia policies and programs and prioritize children who are at greatest risk of developing anemia, particularly those living at high altitude. As iron deficiency appears to explain only a small part of childhood anemia, there is also a need to better understand its other causes and develop appropriate interventions.	They were not able to evaluate trends in the coverage of anemia prevention programs as the definition of coverage differed across the different surveys. Therefore, they could not examine the relationship between anemia and coverage of prevention programs. They were also not able to use findings from the 2012 population- based survey, referred to above, as it used different cutoff values for anemia.	As iron deficiency appears to explain only a small part of childhood anemia, it is imperative to better understand its other causes and develop appropriate interventions.
13	No	The prevalence of anemia in 2012 was: in children 1-4 y, 23.3%; 5-11y, 10.1%, and 12-19 y, 5.6%. The prevalence in female adolescents was 7.7% and 3.6% in males. Reductions in the prevalence of anemia from 1999 was 8.3pp in <5y, 5.1pp in children 5-11y and 3.6pp from 2006 in adolescents.	1999: 40,2%; 2006: 25,8%; 2012: 25,9%	Despite the decrease in the prevalence of anemia in children 1-4 y in the last 13 years, it still is of great concern. There is a need of awareness among social and medical communities about this, to extend the distribution of micronutrient supplements in children <3 y, and to promote nutritional education to incentive mothers to provide foods rich in iron.	Not given	It is important to educate mothers to encourage the consumption of foods with bioavailable iron, particularly in children under 2 years of age. It is necessary to improve social welfare conditions in the poorest communities, as this will have a positive impact on the health and nutritional conditions of their members. It is necessary to motivate and encourage mothers to comply with the recommendations for the consumption of fortified foods distributed by Oportunidades and Liconsa, since they have contributed to a significant reduction in the prevalence of anemia in children.
14	No	The prevalence of chronic malnutrition was higher in the Indigenous population compared to the non-Indigenous population (56.2% versus 21.9%), as was anemia (51.3% versus 40.9%). The determinants of chronic malnutrition were different in both populations. In Indigenous people, age over 36 months (OR 2.21; 95% CI 1.61-3.04) and inadequate housing (OR 2.9; 95% CI 1.19-7.11) prevailed, while in the non-Indigenous people, extreme poverty (OR 2.31; 95% CI 1.50 - 3.55) and institutional delivery (OR 3.1; 95% CI 2.00-4.83).	Children <15 years: 12,2%; 0-4 years: 20,4%; 5-11 years: 10,9%; 12-14: 11%	There are marked gaps between the Indigenous population and the non-Indigenous population with respect to living conditions, access to health services, and nutritional status of children under 5 years of age. Particular attention must be given to the Indigenous population in order to adapt the delivery modalities of the programs and services offered by the State in these contexts.	Not given	Future research will consider the relative contributions of dietary factors, infection rates, and infra- structure as contributors to the relatively low anemia prevalence among Shuar.

#	Control group	Results	Prevalence of anemia	Conclusions	Limitations	Recommendations
15	No	A total of 986 families and 1,372 children were evaluated. The prevalence of chronic malnutrition was higher in the Indigenous population than in the non-Indigenous population (56.2% versus 21.9%), as was anemia (51.3% versus 40.9%). The determinants of chronic malnutrition were different in both populations. In the Indigenous population, age older than 36 months (OR 2.21; 95%CI 1.61-3.04) and inadequate housing (OR 2.9; 95%CI 1.19-7.11) prevailed, while in the non-Indigenous population, extreme poverty (OR 2.31; 95%CI 1.50-3.55) and institutional delivery (OR 3.1; 95%CI 2.00-4.83) prevailed.	Children 6-59 months: 51,3%; boys: 51,8%; Girls: 48,2%	There are marked gaps between the Indigenous population and the non-Indigenous population with respect to living conditions, access to health services and nutritional status of children under 5 years of age. Particular attention should be paid to the Indigenous population in order to adapt the delivery modalities of the programs and services offered by the State in these contexts.	1. The present study corresponds to a cross-sectional design, so a causality criterion cannot be established. 2. Due to the nature of the survey, there are memory biases that can affect the data, especially those referring to diet and diseases that occurred in the past. 3. The language used in the surveys directed at the Indigenous population can affect the comprehension of the questions and the quality of the responses.	Significantly increase water and sanitation infrastructure, design differentiated intervention strategies that are adjusted to the geographic and cultural reality of the area, promote inter-cultural dialogue to improve the use of health services, and coordinate these actions with those of other key sectors such as education, agriculture, production, etc. New qualitative and quantitative studies are also required to contribute to an in-depth knowledge of the sociocultural and epidemiological situation, as well as to the design and implementation of programs adapted to the local reality.
16	No	Hemoglobin concentrations and serum levels of iron, transferrin saturation capacity, folic acid and vitamin B12 were determined in each individual. In addition, the frequency of anemia and nutrient deficiency in each community was established. Anemia was found in 71.1% of the individuals of Aroy, 52.2% of the inhabitants of Marewa and 74.4% of Peraya. Iron, folate or vitamin B12 deficiency was found in 48.1% of the cases of anemia; however, 39% of the individuals studied had iron deficiency anemia and 12.9% had anemia due to folate and/or vitamin B12 deficiency.	Aroy: <6 years: 25%; 6-11 years: 66,7%; 12-17 years (girls): 57,1%; 12-17 (boys): 62,5% / Marewa: <6 years: 38,9%; 6-11 years: 56,4%; 12-17 years (girls): 0%; 12-17 (boys): 68,7% / Peraya: <6 years: 60%; 6-11 years: 72%; 12-17 years (girls): 100%; 12-17 (boys): 100%	The high frequency of anemia without nutritional cause among the Yucpa Indians is attributed to the prevalence of infectious diseases such as hepatitis, parasitosis, and skin and respiratory tract infections.	Not given	Not given
17	No	Lower mean hemoglobin values were observed in children under 2 years of age, without a significant difference between sexes. Anemia was observed among 50.8% of children overall, with the highest prevalence among children under 2 years of age (77.8%). Age of the child was inversely associated with the occurrence of anemia (adjusted PR = 0.60; 95%CI 0.38–0.95) and mean hemoglobin values increased significantly with age. Greater height-for-age z-score values reduced the probability of having anemia by 1.8 times (adjusted PR = 0.59; 95%CI 0.34–1.00). Presence of another child with anemia within the household increased the probability of the occurrence of anemia by 52.9% (adjusted PR = 1.89; 95%CI 1.16–3.09)	Overall: 50,8%; <2 years: 77,8%; <5 years: 62,2%	Elevated levels of anemia among Xavante children reveal a disparity between this Indigenous population and the national Brazilian population. Results suggest that anemia is determined by complex and variable relationships between socioeconomic, sociodemographic, and biological factors.	Not given	Not given

#	Control group	Results	Prevalence of anemia	Conclusions	Limitations	Recommendations
18	No	Chronic malnutrition affected 43% and anemia 43.5% of children under 5 years of Indigenous households. There was no statistically significant association between chronic malnutrition and sex or age of the child, nor between anemia and gender of the child; however, an association between the child's age and anemia was found ($p < 0.001$).	Children <5 years: 43,5%; boys: 45,6%; girls 41% / <12 months: 100%; 12-23 months: 50%; 24-35: 29,4%; 36-47: 35,5%; 48-59%: 32,4%	Chronic malnutrition and anemia were high in children under 5 years of Indigenous households in the Amazon region of Peru, evidencing the large disparities in poverty, basic services and health in Indigenous children.	By using DHS data, it provides reliable information only for large geographic domains, so it can provide information at the national level for the central government, but with less reliability for regional governments and no data for local governments.	It is necessary to strengthen the registry systems for a set of key variables to provide information at least up to the provincial and district levels, without leaving out the Indigenous population.
19	No	Subjects were basically milk fed: 78,4% of them were exclusively breast fed (A) and 21,6% consumed maternal and cow milk simultaneously (B). No early weanings occurred in this particular population and solid foods were seldom consumed on the first six months of life. When the study was carried out only 50% of the infants had occasionally ingested meat. Anemia was present in only 4.5% of infants, iron deficient erythropoiesis occurred also in 4.5% of the cases, and 76.4% of the children showed evidence of depleted iron storages. Iron nutrition was not different among both groups (A and B), nor was related to the infant's birth weight.	Children 8-14 months: 4,5%	It is suggested that maternal milk might have a protective biologic role in the prevention of iron deficiency anemia in this ethnic group.	Not given	Not given
20	Yes	Anemia was detected in 4.5% of breast-fed infants and in 38% of controls. Evidence of iron deficient erythropoiesis was found in 5% and 81% of cases and controls, respectively. Human milk apparently protects this ethnic group from iron deficiency anemia and this protection seems to be better in Mapuche infants than in other groups of Chilean infants, because these have shown 30% incidence of anemia around the first year of life in other studies.	4.5% breastfed infants; 38.8% received cow's milk.	Human milk protects this ethnic group from the development of iron deficiency anemia throughout the first year of life, a longer period than in non-Mapuche Chilean infants. The reasons for this difference have not yet been elucidated. They could lie in the different hemoglobin values typical of this ethnic group and in the later introduction of solid foods, with the favorable consequence of not providing iron absorption inhibitors in breast milk before 6 months of life.	Not given	Not given

#	Control group	Results	Prevalence of anemia	Conclusions	Limitations	Recommendations
21	Yes	At 12 months before starting the supplementation, the anemia prevalence was of 28.3 %, but it disappears as a result of the intervention. Also 65.3 % of the infants showed an increase of 1 g or more on their hemoglobin, which indicates that they were anemic at the beginning of the iron supplementation. By means of this therapeutic test it was find 31 % more of anemic infants, indicating more sensibility of this method. The high levels of anemia prevalence are due to the low iron intake, characteristic of the non-lacteous foods, which according results of the RI reaches an average of 2.8 ± 1.2 mg of Fe/day, versus 4.8 ± 4.0 mg of Fe/day according to PCHA.	Overall: At the beginning 28,3%; at the end of the intervention: 0%	The observed difference between both test showed that there is a process of food environmental contamination, by the use of iron utensils and great soil contact. The high environmental contamination could also be proved by the high iron excretion stools (140 mg of Fe/100 g of stools). This method used to measure the Fe excretion of the supplement, would not be valid in rural population groups with similar characteristics to those of the studied group, because it does not discriminate between the intake and the extremely high environmental contamination. To prevent anemia due to iron absence in infants, it is absolutely necessary to have some iron fortified food starting at 6 months of age, as a complement for breast milk.	Not given	The need to introduce a food fortified with iron from 6 months of age as a complement to breast milk, since the nutritional needs of this mineral in the group studied are not covered with the extra milk dietary iron.
22	No	It was found that the prevalence of anemia was 89.6% and deficiencies of iron, folic acid and vitamin B12 affected 37.1, 70.3 and 12.4% of the population studied, respectively. Plasmodium infection was detected by molecular diagnosis in 53.2% of the cases, and 86% of them were anemic. The highest incidence of anemia was found in children, with a prevalence of 100% in infants of both sexes.	Boys: 1-3 years: 100%; 4-10 years: 91%; 11-20 years: 83% / Girls: 1-3 years: 100%; 4-10 years: 100%; 11-20 years: 90%	The high prevalence of anemia, iron and folic acid deficiencies found, indicates an important health and nutrition problem that should be immediately and properly addressed. The number of cases of anemia due to iron deficiency could be underestimated, since ferritin concentration increased as a acute phase protein, although prevalence data was also analyzed with a cutoff point of 30 µg/L for ferritin concentration.	Not given	Not given
23	No	The prevalence values were: 95.2% for intestinal parasites, 21% for anemia and 35.5% for chronic malnutrition. Although there was no statistical association with sociodemographic and health conditions in the study group, a high frequency of risk factors for intestinal parasites, anemia and malnutrition was found. These factors were: parents with low schooling levels, low availability of aqueducts and sewerage and high perceived morbidity.	Children 1-5 years: 21%	The evaluated Indigenous community had a high prevalence of intestinal parasites, anemia and malnutrition. This has practical implications for the direction that healthcare programs targeting Indigenous populations should take. Exploring the associations requires further studies with larger sample sizes which guarantee greater statistical power.	The low sample size, which resulted in low statistical power in the bivariate analysis. Added to this is the temporal bias of the cross-sectional studies, the exploratory nature of the bivariate associations and the problems of external validity due to the lack of probability sampling.	Complement epidemiological designs with qualitative approaches in all types of work with Indigenous communities that intend to take action against the disease. In this sense, it is necessary to include, in this type of studies, elements that account for "the ways of relationships, production and social organization of the aboriginal territories".

#	Control group	Results	Prevalence of anemia	Conclusions	Limitations	Recommendations
24	No	The prevalence of chronic malnutrition was 33,4%. A statistical association between district of residence and chronic malnutrition in children was found. The prevalence of anemia was 76,5%. 89% of fertile women had an ideal body mass index; however, average height in Aguaruna women was 148 cm. The prevalence of anemia in fertile women was 50,2%. A list comprising more than 100 local and foreign foods eaten by Aguaruna people as part of their usual diet was elaborated; however, only cassava and bananas are eaten daily; and rice, carachama (a river fish), worms, eggs and certain native vegetables (chonta and sachaculantro) are eaten weekly.	Overall: 76,5%; <1 year: 86,5%; 24-35 months: 67,1%	This assessment indicates there are nutritional deficits in children; and iron deficiency anemia affects half of fertile women and two of every three children. This situation may be attributed to consumption of diet based mainly in cassava and bananas, with insufficient poor animal protein contents.	Small population samples were obtained from the district of Aramango, as well as for certain age groups of the MEF and children, thus limiting the results for these groups.	Not given
25	No	Evaluation of hemoglobin levels was conducted for 5,397 children (88.1% of the total sample). The overall prevalence of anemia was 51.2%. Higher risk of presenting anemia was documented for boys, lower maternal schooling, lower household socioeconomic status, poorer sanitary conditions, presence of maternal anemia, and anthropometric deficits. Regional differences were observed, with the highest rate being observed in the North.	Overall: 51,2%; North (66.4%), Central-West (51.5%), South/Southeast (48.0%), Northeast (41.1%) // Moderate - severe anemia (16.4%), North (25.4%), Central-West (14.8%), South/Southeast (15.9%) and Northeast (10.1%)	The prevalence rates of anemia in Indigenous children were approximately double than those reported for non-Indigenous Brazilian children in the same age group. Similarly notable differences in the occurrence of anemia in Indigenous and non-Indigenous children have been reported for other countries. Deeper knowledge about the etiology of anemia in Indigenous children in Brazil is essential to its proper treatment and prevention.	The cross-sectional nature of the research design does not allow causal relationships to be established. In addition, the absence of infant feeding data precludes analysis of dietary sources of bioavailable iron, which is important for understanding the epidemiology of anemia in the population studied. The use of capillary blood instead of venous samples may constitute a source of bias due to the possibility of dilution of hemoglobin with extracellular fluid through manipulation of the subject's finger at the time the technician pricks the skin and collects the drop of blood.	Deeper knowledge about the etiology of anemia in Indigenous children in Brazil is essential to its proper treatment and prevention. It is necessary to develop control and prevention strategies that attend to the sociocultural and nutritional specificities of anemia in Indigenous children in Brazil.
26	No	The prevalence of wasting and overweight (children 6–9 y) was 1.1 and 4.6%, respectively, and of underweight, risk of overweight and overweight (10–14 y) was 3.2, 5.1 and 0.6%, respectively. Stunting (6–12 y) was present in 22.3% of the children. The total goiter rate was 5.4%. The prevalence of anemia was 13% (boys 11.4, girls 14.5%). Overall, 24.2% of the children were iron deficient (depletion 11.1%, deficient erythropoiesis 3%, iron deficiency anemia 10.1%). No child had folic acid values >3 ng/ml, but 20.2% had low (<200mg/dl) and 27.3% marginal (200–300 mg/dl) vitamin B12 levels, and 80.2% had low zinc concentrations (<60mg/dl).	Overall: 13%; Boys: 11.4%; Girls: 14.5%; 6-8 years: 14,4%; 9-11 years: 10,4%; 12-14 years: 17,3%	Nutritional underweight and stunting were similar to those reported in rural localities at the national level, but overweight was less prevalent in children aged 10–14 y. Various micronutrient deficiencies was identified including zinc and vitamin B12, but the prevalence of iron and folic acid deficiency was lower than expected. These results suggest that Tarahumara children attending boarding schools may be the better-off children from these extremely poor and marginalized areas.	The study was not based on a probabilistic sample, thus limiting the generalizability of the results to other schools in the area,	Not given

#	Control group	Results	Prevalence of anemia	Conclusions	Limitations	Recommendations
27	No	Growth deficit was highly prevalent among the Indian children. Low weight-for-height was a very rare condition and overweight was significant among the younger and the older children. About 70% of the children were anemic, and age seems to be the main factor associated with low hemoglobin concentrations.	Aruak children Overall: 65,95%; <24 months: 83,33%; 24-60: 61,97%; 60-120: 61,54%; <60 months (Boys: 72,22%, Girls: 66,04%) // Karibe children Overall: 70,09%; <24 months: 84,62%; 24-60: 66,22%; 60-120: 67,33%; <60 months (Boys: 70%, Girls: 74,6%)	Even more alarming is the rate of anemia observed among the Aruak and Karibe children: almost 70%. Interestingly, age seems to be closely associated with the severity of anemia, since the number of children with moderate or severe anemia and ages between 6 and 23 months is very high when compared with that of children between 24 and 59 months old, especially among the Aruak people.	The lack of information on the frequency and type of intestinal parasitosis among the children.	The findings of this study suggest the monitoring of children's growth and hemoglobin status, particularly for those under two years old, in order to reduce health damage or minimize its severity in older ages.
28	No	Stunting was observed in 1/3 of the children and neither wasting nor obesity were observed. The anemic status was diagnosed by hemoglobin values below 11 g/dl for children from 6 to 59 months of age, and below 11.5 g/dl, for children from 60 to 119.9 months. About 50% of the Indian children were anemic and 15% were affected by severe anemia.	6-199 months: Boys: 64,4%, Girls: 47,5%; total: 55,3% // 6-24 months: 81,3%; 24-60 months: 50%; 60-120 months: 50	There is a particular need to ensure efforts to implement environment, health and nutrition programs addressed to Kamaiurá children.	Not given	Progress in reducing the magnitude of nutritional deficiencies of Indigenous peoples should be contemplated by means of goals defined from the effective implementation of policies and programs aimed at improving socio-environmental and health conditions, considering their cultural specificities.
29	No	The results showed that 65% of the adolescents had an adequate body mass index (BMI) for their age, and 32% had a BMI < 5th percentile. Like- wise, the study revealed a high prevalence of anemia (57%), deficient serum folate levels (54%), deficient vitamin B12 levels (31%), and subclinical vitamin A deficiency (10%). Additionally, the youngsters had elevated prevalences of high triglyceride levels (77%), borderline high-density lipoprotein (HDL) cholesterol levels (46%), homocysteine levels > 10 µmol/L (29%), and homozygous mutation of methylenetetrahydrofolate reductase (MTHFR) (49%). The diet was poor, being high in saturated fat and low in polyunsaturated fat, fiber, and several micronutrients. The dietary intakes of more than 55% of the adolescents did not meet 50% of the estimated average requirements (EAR) for zinc, vitamin A, vitamin C, vitamin B12, vitamin B2, and folate. Furthermore, a high prevalence of parasitosis was found (68%).	Overall: 52%; Boys: 69%; Girls: 45%	Results show an adolescent Cabécar population with a mosaic of nutritional deficiencies and cardiovascular risk factors. The deficient status of ferritin, hemoglobin, folic acid, and vitamins A and B12 in Cabécar adolescents may be associated with a low-energy-density diet.	First, their results are based on cross-sectional data and the sample included only adolescents enrolled in schools. Therefore, youngsters deserting the educational system for social or economic reasons were not included. Second, the 24-hour recall in the population studied may have generated an underestimation of the intake of some nutrients. Third, The influence of genetic and environmental factors on the Indigenous population studied may cause an underestimation of the prevalence of underweight adolescents.	It is necessary for governments to assign greater importance to primary health care and prevention in health-determining sectors, such as employment, income maintenance, social welfare, housing, and education, as proposed by the Toronto Declaration, 2002.

#	Control group	Results	Prevalence of anemia	Conclusions	Limitations	Recommendations
30	No	The percentages of children with weight for age deficit (z score < -2 standard deviations) were 4 and 2.9% in 1995 and 2002 respectively. Percentages of weight for height deficits were 3.6 and 0.8% respectively. Percentages of height for age deficits were 15 and 11.1% respectively. The median z scores for weight, age and weight, and height showed a statistically significant increase during the period between 1995 and 2002 in infants. Between 24 and 60 months, there were increments in median z scores for weight for age and height for age. There was no statistically significant decrease in any of the anthropometric indicators, with reference to z scores. The prevalence rates of anemia were 86.1% for infants 6 to 24 months old (n = 43), 50.8% for those 24 to 60 months (n = 65) and 40.7% for children aged 60 to 120 months (n = 59)	Children 6-120 months Overall: 62,3%; 6-24 months: 86,1%; 24-60 months: 50,8%; 60-120 months: 40,7%	Weight and height both increased during period from 1995 to 2002. Anemia was highly prevalent, calling for immediate corrective measures.	Not given	The prevalence of anemia was extremely elevated, indicating the need for measures to combat it with alacrity.
31	No	Overall anemia prevalence was 57.3% (95%CI: 52.5%-2.1%). Age under 24 months [prevalence ratio – PR (95%CI): 1.40 (1.09-1.74)], living in rural areas [PR: 1.23 (1.04-1.44)], house- holds with 5-14 children [PR: 1.23 (1.04-1.44)], stunting [PR: 1.19 (1.01-1.39)], maternal anemia [PR: 1.18 (1.00-1.39)], and smoking during pregnancy [PR: 1.29 (1.09-1.53)] were associated with increased risk of anemia. Children of working mothers were at lower risk of anemia [PR: 0.78 (0.64-0.94)].	Overall: 55,6%	Anemia prevalence in childhood was found to be a serious public health problem in this municipality. Multi-sector prevention strategies should be implemented, addressing poverty and maternal-infant healthcare.	Due to logistical difficulties, it was not possible to use a random sample in the rural area, which may compromise the extrapolation of estimates for this area of the municipality. Due to the sample size, the elaboration of separate analyses for urban and rural areas is compromised due to the reduced number of individuals in each category. Moreover, the introduction of the dwelling zone variable in the elaboration of the model for the identification of associated factors promotes its adjustment. The lack of accurate information regarding pregnancy and delivery conditions, such as birth weight and gestational age, precluded a more comprehensive analysis of the determinants of anemia in the region. With regard to the assessment of nutritional status, due to transportation difficulties and financial limitations of the project, it was not possible to obtain hematimetric and biochemical indicators necessary for the diagnosis and estimation of the magnitude of iron deficiency. Unfortunately, data on dietary intake, which are needed to estimate the level of biodeposable iron in the diet, are not available; in addition, the race/color variable, which has more accurate potential for ethnic characterization of the population, was not included.	Greater coverage of basic health actions with emphasis on prenatal care and childcare. Although it is a small municipality, the reality observed is shared by several other municipalities in the interior of the Amazon that still have a large portion of the people living in rural areas, where the difficulties of access to essential services such as health care and sanitation are even greater.

#	Control group	Results	Prevalence of anemia	Conclusions	Limitations	Recommendations
32	No	The percentages of children ≤ -2 z scores for height for age, weight for age and weight for height were 25.4, 8.1 and 0%, respectively. For children aged less than 5 years, the percentages were 31.4, 12.4 and 0%. Most children had anemia (80.6%), with a rate of up to 84.0% among those aged 6 to 59 months.	6-12 months: 95% (Boys: 100%, girls: 90%); 6-199 months: 80,6% (Boys: 79,2%, girls: 82,3%)	There is a high prevalence of protein-energy undernutrition and anemia among Suruí children. Comparison with a previous survey indicated that the prevalence of height for age deficit significantly decreased between 1987 and 2005 (from 46.3 to 26.7% in children younger than 9 years). On the other hand, 3.9% of the children were overweight in 2005, a finding that had not been reported in 1987. The prevalence of anemia did not change remarkably between these years. Despite the improvement in anthropometric parameters, the prevalence of nutritional deficit has been persistently higher than that observed in the Brazilian population at large. It is therefore necessary that systematic and regular monitoring of Indigenous children's growth and development be implemented, focusing mainly on nutritional surveillance.	Not given	There is a need to implement activities aimed at monitoring the growth and development of Indigenous children, as well as anemia, with emphasis on nutritional surveillance.
33	No	The highest proportion of anemia occurred in children with severe household FI (24.3%), compared to those from households with food security (21.2%). Children from severe FI households have a higher adjusted prevalence of anemia than those from households with food security. FI and anemia were associated mainly among children residing in the southern region of Mexico.	Overall: 27%	Our findings can contribute to a better understanding of FI and anaemia in children and to strengthen interventions to address these problems.	They did not include dietary consumption as a control variable in statistical models, because dietary data were collected from a sub-sample of the surveyed population and were unable to include measurements for other iron status indicators that might have contributed to a better understanding of the relationship between food insecurity and iron deficiency anemia. Also, they did not have complete information about the mothers of the analyzed children, among other variables, for example their interest in childcare and other sociocultural aspects.	More research is required to understand the relationship between food insecurity and anemia, considering these socioeconomic factors at a contextual level.
34	No	The prevalence of anemia in the children was 57.6%, the prevalences of low height for age range, low weight-to-height ratios and low weight for age range in the children were 15.6%, 3.0% and 2.0% respectively. The occurrence of anemia was associated with younger children, those that spent less studying time with their mother, a large number of family members, those with fewer personal possessions and those that lived outside the group's home area or village ("desaldeados").	6-59 months 57,6% (Boys: 58,4%, girls: 56,5%); 6-24 months: 72,7%; 25-59 months: 49,1%	The results show that anemia is a serious health problem among Karapotó children, especially the "desaldeados", coinciding with problems of childhood obesity and stunted growth.	Although the dietary survey was contemplated in the original project, for the present study dietary factors related to the children's diet were not analyzed, thus constituting a limitation in the discussion of the determinants of anemia in the studied group.	It is essential that there is adequate prenatal care for the control of anemia in pregnancy with educational actions aimed at promoting healthy eating and encouraging breastfeeding, intensification of food and nutritional surveillance actions, implementation and/or enhancement of the iron supplementation program, among other actions.

#	Control group	Results	Prevalence of anemia	Conclusions	Limitations	Recommendations
35	No	Among children <5 years, stunting and anemia disproportionately affected low-wealth, low-education and Indigenous groups. Among adolescent and adult women, higher rates of stunting, overweight and obesity were observed in the low-education and low-wealth groups. Stunting and short stature rates were higher in Indigenous women, whereas overweight and obesity rates were higher in Afro-Ecuadorian women.	Overall: 37,8%	Malnutrition differs significantly across sociodemographic groups, disproportionately affecting those in the low wealth tertile and ethnic minorities. Rates of stunting remain high compared with other countries in the region with similar economic development. The effective implementation of double-duty actions with the potential to impact both sides of the double burden is urgently required.	Limited capacity to infer causality between socio-economic disparities and malnutrition indicators based on the cross-sectional nature of the data and the type of analysis conducted	Current interventions designed to address undernutrition must not inadvertently increase the risk of excess weight. For instance, initiatives to address micronutrient deficiencies through the fortification of staple foods that have the potential to produce further overweight and obesity should be discouraged.
36	No	Between 1998 and 2008, the prevalence of childhood stunting decreased in both Indigenous and nonIndigenous populations, whereas overweight and obesity in women increased faster in Indigenous populations than in nonIndigenous populations (0.91% compared with 0.38%/y; P-trend, 0.01). In 2008, the prevalence of stunted children was 28.8 percentage points higher and of overweight women 4.6 percentage points lower in Indigenous compared with nonIndigenous populations (63.7% compared with 34.9% and 46.7% compared with 51.3%, respectively). DBM at the household and individual levels was higher in Indigenous populations and was higher in geographic areas in which most of the population was Indigenous, where there was also a greater prevalence of stunting and DBM at the individual level, both in women and children.	Overall: 49,6%	In Guatemala, DBM is more prevalent in Indigenous than in nonIndigenous populations at the household and individual levels. To enhance effectiveness, current strategies of national policies and programs should consider DBM and focus on Indigenous populations.	Not given	Implementation strategies of current and new national policies and plans should include DBM and establish early and timely preventive actions with a particular focus on Indigenous populations, primarily those living in the Western Highlands, to be more effective.
37	No	The prevalences of stunting and underweight were greater in Indigenous than in non-Indigenous children. At the national level and in urban areas the prevalences were three times greater and in rural areas ~2 times greater ($p<0.05$). No differences were found in the prevalence of wasting ($p>0.05$). The prevalence of anemia in Indigenous children was one third greater than in non-Indigenous children at the national level ($p<0.05$) and was between 30 and 60% greater in urban areas and in the regions studied ($p<0.05$) but was not statistically significant ($p>0.05$) in rural areas. These differences were reduced to about half when adjusting for SES but remained significantly higher in Indigenous children ($p<0.05$).	National: 35,2%; Rural: 31,5%; Urban: 40,3%; South: 34,3%; other regions: 37,5% // socioeconomic level 0-10: 24,2%; 10-20: 37,6%; 20-40: 38,1%; 40-100: 43,8%	Indigenous children have higher probabilities of stunting and underweight than non-Indigenous children. The differences are larger in urban areas and in higher socioeconomic geographic regions and are explained mostly by socioeconomic factors. The overall difference in the probability of anemia is small, is higher only in urban relative to rural areas, and is explained to a lesser degree by socioeconomic factors. Policy and programs should be designed and implemented to reduce the dramatic differences in nutritional status between Indigenous and non-Indigenous children in Mexico.	Not given	Current efforts to improve the nutritional status of Indigenous children should be expanded and strengthened substantially in order to achieve an impact in the short term. The result of the proposed research should be incorporated into planning interventions for improving the nutrition of Indigenous children. policy and programs should be designed and implemented to eliminate the gap in nutritional status between Indigenous and non-Indigenous children in Mexico.

#	Control group	Results	Prevalence of anemia	Conclusions	Limitations	Recommendations
38	No	The schoolchildren showed high prevalence of stunting (44%). The values of hematocrit ($p=0.001$) and hemoglobin ($p=0.003$) were higher in girls. It should be highlighted that using the normal value of hemoglobin, anemia was not detected. However almost a fifth of the schoolchildren studied were diagnosed with anemia when we applied the correction factors adapted to the altitude.	Overall: 18,8%	The use of correction factors adapted to the altitude is considered essential to do the hematology test in populations that live in high altitude in order to avoid a false diagnosis. Moreover, it is necessary to establish the environmental factors related to the stunted growth of this population of the Andean region.	Not given	Not given
39		Eleven percent of Taraco children were undernourished compared with 3% in Caranavi. Instead, 41% of the children in Caranavi were obese or overweight, compared with 8% in Taraco. Anemia was found in 74% of the children in Taraco compared with 7% in Caranavi. Albumin levels were normal in all samples, albeit lower in Taraco. Similar and normal serum zinc levels were measured in both groups. Approximately 60% of the children in both locations showed insufficient vitamin D levels, with lower levels in Taraco children. Hymenolepis nana and Entamoeba coli, parasites determinant of poor hygienic conditions, were respectively detected in 78% and 21% of fecal samples from Taraco, and in 29% and 8% of samples from Caranavi.	Taraco: Overall: 74%; (Boys: 78%, girls: 70%); 6-7 years: 84%; 8-10: 69%; 11-12: 74% // Caranavi: Overall: 8%; (Boys: 7%, girls: 8%); 6-7 years: 11%; 8-10: 8%; 11-12: 0%	We show increased anemia, nutritional deficiencies, and indications of poor hygienic conditions in highlands compared with lowlands. The prevalence of obesity in the lowlands demands addressing diverse nutritional deficiencies in the regions of Bolivia.	Future studies comparing rural and urban locations in lowlands and highlands will contribute to the understanding of the relative importance of altitude versus socioeconomic and cultural conditions in the differences observed. Better defined individual socio-demographic information would have improved the study. It was not possible to collect the samples at the same time in both locations; despite this, samples were collected at the same season in consecutive years. The nutritional questionnaire used, although adapted to local conditions, has not been validated, although we believe is appropriate for the study.	Not given
40		Hookworm and Strongyloides stercoralis prevalences were highest in children from the Amazon rainforest (respectively 72% and 18%) while children from the Orinoco Delta and Carabobo State showed higher rates of Ascaris lumbricoides (respectively 28% and 37%) and Trichuris trichiura (40% in both regions). The prevalence of Giardia lamblia infection was not significantly different between regions (average: 18%). Anemia prevalence was highest in the Amazon Region (24%). Hemoglobin levels were significantly decreased in children with a hookworm infection. Malnutrition was present in respectively 84%, 30% and 13% of children from the Amazon Region, Orinoco Delta and Carabobo State. In multivariate analysis including all regions, G. lamblia and helminth infections were significantly and negatively associated with respectively height-for-age and weight-for-height/BMI-for-age Z scores. Furthermore, hemoglobin levels were positively associated with the height-for-age Z score (0.11, 95% CI 0.02 - 0.20).	Overall: Yanomami (Amazon region) 24%; Warao (Orinoco Delta): 9%	In rural populations in Venezuela helminthiasis and giardiasis were associated with acute and chronic nutritional status respectively. These data highlight the need for an integrated approach to control transmission of parasites and improve the health status of rural Venezuelan children.	Not given	Additional studies investigating the association between intestinal parasitic infections and nutritional status in preschool children in Venezuela are needed.

#	Control group	Results	Prevalence of anemia	Conclusions	Limitations	Recommendations
41	No	The prevalence of anemia was 50% in infants <2 years of age, with no significant differences between urban and rural strata or among regions. It varied between 14 and 22% in 6–11-year-old children and was higher in the South region and among the Indigenous children. Dietary intake of iron was 50% of the recommended daily allowance in children <2 years of age, but not in older children. Phytate ($\approx$ 500–800 mg/d) and tannin ($\approx$ 19 mg/d) intakes were very high in children over 7 years of age. Hemoglobin was positively associated with nutritional status of children ($p=0.01$), socio-economic status (p range 0.05–0.001), duration of lactation in children under 2 years of age ($p=0.1$), and iron and calcium intake ($p=0.02$), but not with folic acid or vitamin B12 intake. Hemoglobin was negatively associated with maternal education ($p=0.01$) in older children, but not in those under 2 years of age.	Overall children <5 years: 35,8%; 6–11 months: 16,2%; 12–23 months: 57,9%; 24–35: 42%; 36–47 months: 30,5%; 48–59 months: 23% // Overall children >5 years: 24%; 5–6 years: 26,1%; 7–8 years: 25,8%; 9–10 years: 22,16%; 11 years: 17,9%	We present evidence of an alarming national epidemic of anemia, particularly marked in children 12 to 24 months of age. The control of anemia should be considered as an urgent national concern given its grave consequences on the physical and mental development of these children and on their long-term health.	Not given	Not given
42	No	Baseline data collection began in July/August 2009 with a population census (656 individuals). Between the first and final waves, the study population increased by 17%. At baseline, stunting and wasting was elevated for most age groups <10 years. Overweight, obesity, and increased risk of metabolic complications were expressive among individuals >17 years, disproportionately affecting females. Anemia was elevated in most age groups, especially among females. Mean systolic and diastolic blood pressure was moderate. The overall prevalence of high blood pressure was relatively low.	Children <10 years: Mild anemia: 23,6% (Boys: 24,8%, Girls: 22,4%); Moderate anemia: 22,8% (Boys: 22,4%, Girls: 23,1%); Severe anemia: 0,4% (Boys: 0,8%, Girls: 0%) // Children 10–17 years: Mild anemia: 23,3% (Boys: 19,4%, Girls: 26,9%); Moderate anemia: 11,6% (Boys: 1,6%, Girls: 20,9%); Severe anemia: 0,8% (Boys: 0%, Girls: 1,5%)	Our findings reveal marked health disparities relative to the Brazilian national population and a complex dietary health epidemiology involving the double burden of malnutrition, rapidly changing nutritional indicators, and elevated metabolic disease risk. The topically broad multidisciplinary focus permitted construction of the richest longitudinal data set of socio-epidemiological information for an Indigenous population in Brazil.	it was not possible to organize a local nursing team to systematically register common morbidities, such as diarrhea and respiratory infections. Also, intravenous blood samples were not collected considering local politics involving biological samples and challenging fieldwork conditions, which made it impossible to perform biochemical tests necessary for characterizing metabolic syndrome.	The Xavante Longitudinal Health Study marks a shift beyond the study of health inequities toward more sophisticated epidemiological understandings of health processes through time. This advance also has the potential to affect public policy by providing sorely needed information about health and disease processes among Indigenous peoples that can be used to formulate innovative solutions and formulate new models for effective health services in Brazil and elsewhere.

Appendix 2. Quality analysis according to the STROBE statement – cross-sectional studies

Article	TITLE AND ABSTRACT		OBJECTIVES			METHODS								
	Indicate the study's design with a commonly used term in the title or the abstract	Provide in the abstract an informative and balanced summary of what was done and what was found	Explain the scientific background and rationale for the investigation being reported	State specific objectives, including any prespecified hypotheses	Present key elements of study design early in the paper	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Give the eligibility criteria, and the sources and methods of selection of participants	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one	Describe any efforts to address potential sources of bias	Explain how the study size was arrived at	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Describe all statistical methods, including those used to control for confounding	Describe any methods used to examine subgroups and interactions
Aguirre Arenas, J. et al. (2013)	1	1	1	1	1	1	1	1	1	0	1	1	1	1
Anticona & San Sebastian (2014)	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Barreto, et al. (2014)	1	1	1	1	1	1	1	1	1	0	1	1	1	1
Baruzzi et al. (2001)	1	1	1	1	1	1	1	1	1	0	1	1	1	1
Batset al. (2020)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bolaños-Gallardo et al. (2014)	1	1	1	1	1	1	1	1	1	0	1	1	1	0
Cabada et al. (2014)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Campos et al. (2016)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cardona-Arias, et al. (2014)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cediel et al. (2020)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Coimbra et al. (2013)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cordero et al. (2019)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
De La Cruz-Góngora et al. (2018)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
DeLouize et al. (2021)	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Díazet al. (2015)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Diez-Ewald et al. (1999)	1	1	1	1	1	1	1	1	1	0	1	1	1	0
Ferreira et al. (2017)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Flores Bendezú, et al. (2015)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
García-Casal et al. (2008)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Gaviria et al. (2017)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Huamán-Espino & Valladares (2006)	1	1	1	1	1	1	1	1	1	0	1	1	1	0
Leite, et al. (2013)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Monárrez-Espino (2004)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mondini et al. (2007)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mondini et al. (2009)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Monge-Rojas et al. (2005)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Morais et al. (2005)	1	1	1	1	1	1	1	1	1	0	1	1	1	1
Óliveira et al. (2011)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Orellana et al. (2006)	1	1	1	1	1	1	1	1	1	0	1	1	1	1
Palacios-Rodríguez et al. (2019)	1	1	1	1	1	1	1	1	1	0	1	1	1	1
Pereira et al. (2012)	1	1	1	1	1	1	1	1	1	0	1	1	1	1
Ramírez-Luzuriaga et al. (2020)	1	1	1	1	1	1	1	1	1	0	1	1	1	1
Ramírez-Zea et al. (2014)	1	1	1	1	1	1	1	1	1	0	1	1	1	1
Rivera et al. (2003)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Robalino Flores et al. (2017)	1	1	1	1	1	1	1	1	1	0	1	1	1	1
Terán et al. (2018)	1	1	1	1	1	1	1	1	1	0	1	1	1	1
Verhagen et al. (2013)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Villalpando et al. (2003)	1	1	1	1	1	1	1	1	1	0	1	1	1	1

Article	METHODS				RESULTS									
	Explain how missing data were addressed	Describe all statistical methods, including those used to control for confounding	If applicable, describe analytical methods taking account of sampling strategy	Describe any sensitivity analyses	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Give reasons for non-participation at each stage	Consider use of a flow diagram	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Indicate number of participants with missing data for each variable of interest	Report numbers of outcome events or summary measures	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Report category boundaries when continuous variables were categorized	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Aguirre Arenas, J. et al. (2013)	0	1	0	0	1	0	0	1	1	1	1	1	0	1
Anticona & San Sebastian (2014)	0	1	0	0	1	0	0	1	1	1	1	1	0	0
Barreto, et al. (2014)	0	1	0	0	1	0	0	1	1	1	1	1	0	0
Banuzzi et al. (2001)	0	1	0	0	1	0	0	1	1	1	1	1	0	0
Batiset et al. (2020)	1	1	0	1	1	0	0	1	1	1	1	1	1	1
Bolaños-Gallardo et al. (2014)	0	1	0	0	1	0	0	1	1	1	1	1	0	0
Cabada et al. (2014)	0	1	0	1	1	0	0	1	1	1	1	1	1	1
Campos et al. (2016)	0	1	0	0	1	0	0	1	1	1	1	1	0	0
Cardona-Arias, et al. (2014)	0	1	1	0	1	0	0	1	1	1	1	1	0	0
Cediel et al. (2020)	0	1	0	0	1	0	0	1	1	1	1	1	0	0
Coimbra et al. (2013)	1	1	1	1	1	0	0	1	1	1	1	1	1	1
Cordero et al. (2019)	0	1	0	1	1	0	0	1	1	1	1	1	1	1
De La Cruz-Góngora et al. (2018)	0	1	0	1	1	0	0	1	1	1	1	1	1	1
DeLouize et al. (2021)	0	1	0	0	1	0	0	1	1	1	1	1	1	0
Díaz et al. (2015)	0	1	1	1	1	0	0	1	1	1	1	1	1	1
Diez-Ewald et al. (1999)	0	1	0	0	1	0	0	1	1	1	1	1	0	0
Ferreira et al. (2017)	1	1	0	1	1	0	0	1	1	1	1	1	1	1
Flores Bendezu, et al. (2015)	0	1	0	0	1	0	0	1	1	1	1	1	0	0
García-Casal et al. (2008)	0	1	0	0	1	0	0	1	1	1	1	1	0	0
Gaviria et al. (2017)	0	1	0	0	1	0	0	1	1	1	1	1	0	0
Huamán-Espino & Valladares (2006)	0	1	0	0	1	0	0	1	1	1	1	1	0	0
Leite. et al. (2013)	0	1	1	1	1	0	0	1	1	1	1	1	1	1
Monárrez-Espino (2004)	0	1	0	1	1	0	0	1	1	1	1	1	0	0
Mondini et al. (2007)	0	1	0	0	1	0	0	1	1	1	1	1	0	0
Mondini et al. (2009)	0	1	0	0	1	0	0	1	1	1	1	1	0	0
Monge-Rojas et al. (2005)	0	1	0	0	1	0	0	1	1	1	1	1	0	0
Morais et al. (2005)	0	1	0	0	1	0	0	1	1	1	1	1	0	0
Olíveira et al. (2011)	0	1	0	1	1	0	0	1	1	1	1	1	0	1
Orellana et al. (2006)	0	1	0	0	1	0	0	1	1	1	1	1	0	0
Palacios-Rodríguez et al. (2019)	0	1	0	0	1	0	0	1	1	1	1	1	0	0
Pereira et al. (2012)	0	1	0	0	1	0	0	1	1	1	1	1	0	0
Ramírez-Luzuriaga et al. (2020)	0	1	0	0	1	0	0	1	1	1	1	1	0	0
Ramírez-Zea et al. (2014)	0	1	0	0	1	0	0	1	1	1	1	1	0	0
Rivera et al. (2003)	0	1	0	1	1	0	0	1	1	1	1	1	0	0
Robalino Flores et al. (2017)	0	1	1	0	1	0	0	1	1	1	1	1	0	0
Terán et al. (2018)	0	1	0	0	1	0	0	1	1	1	1	1	0	0
Verhagen et al. (2013)	0	1	0	0	1	0	0	1	1	1	1	1	1	1
Villalpando et al. (2003)	0	1	1	0	1	0	0	1	1	1	1	1	0	0

	DISCUSSION				OTHER INFORMATION	
Article	Summarise key results with reference to study objectives	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Discuss the generalisability (external validity) of the study results	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	TOTAL
Aguirre Arenas, J. et al. (2013)	1	1	1	1	0	16
Anticona & San Sebastian (2014)	1	1	1	1	1	16
Barreto, et al. (2014)	1	0	1	1	0	14
Baruzzi et al. (2001)	1	0	1	1	0	14
Batiset al. (2020)	1	1	1	1	0	20
Bolaños-Gallardo et al. (2014)	1	0	1	1	0	13
Cabada et al. (2014)	1	0	1	1	1	19
Campos et al. (2016)	1	1	1	1	1	17
Cardona-Arias, et al. (2014)	1	1	1	1	1	18
Cediel et al. (2020)	1	1	1	1	0	16
Coimbra et al. (2013)	1	1	1	1	0	21
Cordero et al. (2019)	1	1	1	1	0	19
De La Cruz-Góngora et al. (2018)	1	0	1	1	0	18
DeLouize et al. (2021)	1	0	1	1	1	16
Díaz et al. (2015)	1	1	1	1	0	20
Diez-Ewald et al. (1999)	1	0	1	1	0	13
Ferreira et al. (2017)	1	0	1	1	0	19
Flores BendeZú, et al. (2015)	1	1	1	1	0	16
García-Casal et al. (2008)	1	0	1	1	0	15
Gaviria et al. (2017)	1	1	1	1	1	17
Huamán-Espino & Valladares (2006)	1	1	1	1	0	14
Leite. et al. (2013)	1	1	1	1	0	20
Monárrez-Espino (2004)	1	1	1	1	0	17
Mondini et al. (2007)	1	0	1	1	0	15
Mondini et al. (2009)	1	1	1	1	0	16
Monge-Rojas et al. (2005)	1	1	1	1	0	16
Morais et al. (2005)	1	0	1	1	0	14
Oliveira et al. (2011)	1	1	1	1	0	18
Orellana et al. (2006)	1	0	1	1	0	14
Palacios-Rodríguez et al. (2019)	1	1	1	1	1	16
Pereira et al. (2012)	1	1	1	1	0	15
Ramírez-Luzuriaga et al. (2020)	1	1	1	1	1	16
Ramírez-Zea et al. (2014)	1	0	1	1	1	15
Rivera et al. (2003)	1	0	1	1	0	16
Robalino Flores et al. (2017)	1	0	1	1	0	15
Terán et al. (2018)	1	1	1	1	0	15
Verhagen et al. (2013)	1	0	1	1	1	18
Villalpando et al. (2003)	1	0	1	1	0	15

Appendix 3. Quality analysis according to the STROBE statement – cohort studies

Section	Item	Franco et al. (1996)	Welch et al. (2020)
Title and abstract	Indicate the study's design with a commonly used term in the title or the abstract	1	1
	Provide in the abstract an informative and balanced summary of what was done and what was found	1	1
Introduction	Explain the scientific background and rationale for the investigation being reported	1	1
	State specific objectives, including any prespecified hypotheses	1	1
Methods	Present key elements of study design early in the paper	1	1
	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	1	1
	Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	1	1
	For matched studies, give matching criteria and number of exposed and unexposed	1	1
	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	1	1
	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	1	1
	Describe any efforts to address potential sources of bias	0	1
	Explain how the study size was arrived at	1	1
	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	1	1
	Describe all statistical methods, including those used to control for confounding	1	1
	Describe any methods used to examine subgroups and interactions	0	1
	Explain how missing data were addressed	0	1
	If applicable, explain how loss to follow-up was addressed	0	1
	Describe any sensitivity analyses	0	1
Results	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	1	1
	Give reasons for non-participation at each stage	0	1
	Consider use of a flow diagram	0	1
	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	1	1
	Indicate number of participants with missing data for each variable of interest	0	1
	Summarise follow-up time (eg, average and total amount)	1	1
	Report numbers of outcome events or summary measures over time	1	1
	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	0	1
	Report category boundaries when continuous variables were categorized	1	1
	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	0	1
Discussion	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	0	1
	Summarise key results with reference to study objectives	1	1
	Discuss limitations of the study, taking into account sources of potential bias or imprecision.	0	1
	Discuss both direction and magnitude of any potential bias	0	1
	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	1	1
	Discuss the generalisability (external validity) of the study results	1	1
	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	0	1
	Total score	21	35

Appendix 4. Prevalence of anemia by Indigenous community showing the different samples taken in each study numbered from 1 to 133.

#	Indigenous community	Country	Region	Data collection (year)	Diagnostic resource	Diagnostic criteria (Hb mg/dl)	Sample size	Age	Male (%)	Female (%)	Total (%)	(CI 95%)*	Author
1	Achuar, Urarina, and Quichua	Perú	Peruvian Amazon	2010	Hemocue	<11.5	Not given	5-11 years			45.6		Anticona & San Sebastian (2014)
2	Achuar, Urarina, and Quichua	Perú	Peruvian Amazon	2010	Hemocue	<13.0	Not given	12-17 years			50.9		Anticona & San Sebastian (2014)
3	Achuar, Urarina, and Quichua	Perú	Peruvian Amazon	2010	Hemocue	<11.0 (0-4 years) <11.5 (5-11 years) <13.0 (12-years)	330	0-17 years			51.0		Anticona & San Sebastian (2014)
4	Achuar, Urarina, and Quichua	Perú	Peruvian Amazon	2010	Hemocue	<11.0	Not given	0-4 years			56.9		Anticona & San Sebastian (2014)
5	Aguaruna	Perú	Districts of Aramango and Imaza in the province of Bagua; and Cenepa, Nieva and Santiago in the province of Condorcanqui	2004	Hemocue	<11.0	Not given	<3 years			76.5		Huamán-Espino & Valladares (2006)
6	Aruak	Brazil	Alto Xingu, Mato Grosso state	2001-2002	Hemocue	<11.5	78	60-120 months			61.5		Mondini et al. (2009)
7	Aruak	Brazil	Alto Xingu, Mato Grosso state	2001-2002	Hemocue	<11.0	71	24-60 months			62.0		Mondini et al. (2009)
8	Aruak	Brazil	Alto Xingu, Mato Grosso state	2001-2002	Hemocue	<11.0 (6-59 months) <11.5 (60-120 months)	201	6-120 months			66.0		Mondini et al. (2009)
9	Aruak	Brazil	Alto Xingu, Mato Grosso state	2001-2002	Hemocue	<11.0	52	<24 months			83.3		Mondini et al. (2009)

#	Indigenous community	Country	Region	Data collection (year)	Diagnostic resource	Diagnostic criteria (Hb mg/dl)	Sample size	Age	Male (%)	Female (%)	Total (%)	(CI 95%)*	Author
10	Awajún	Perú	Provinces of Bagua and Condorcanqui in the Amazon region	2007	Hemocue	<11.0	638	<5 years			51.3	(47.4 – 55.1)	Díaz et al. (2015)
11	Aymara	Bolivia	Caranavi (Yungas)	2004	Hemocue	<14.5	12	11-12 years			0.0		Terán et al. (2018)
12	Aymara	Bolivia	Caranavi (Yungas)	2004	Hemocue	<14.5	93	6-12 years			8.0		Terán et al. (2018)
13	Aymara	Bolivia	Caranavi (Yungas)	2004	Hemocue	<14.5	53	8-10 years			8.0		Terán et al. (2018)
14	Aymara	Bolivia	Caranavi (Yungas)	2004	Hemocue	<14.5	28	6-7 years			11.0		Terán et al. (2018)
15	Aymara	Bolivia	National level	2003	Hemocue	<11.0	2692	6-59 months			61.1	(54.9-66.9)	Cordero et al. (2019)
16	Aymara	Bolivia	Taraco (Puna)	2004	Hemocue	<14.5	59	8-10 years			69.0		Terán et al. (2018)
17	Aymara	Bolivia	National level	2008	Hemocue	<11.0	2337	6-59 months			70.2	(63.6–76.1)	Cordero et al. (2019)
18	Aymara	Bolivia	National level	2016	Hemocue	<11.0	1513	6-59 months			73.8	(63.1–82.2)	Cordero et al. (2019)
19	Aymara	Bolivia	Taraco (Puna)	2004	Hemocue	<14.5	119	6-12 years			74.0		Terán et al. (2018)
20	Aymara	Bolivia	Taraco (Puna)	2004	Hemocue	<14.5	35	11-12 years			74.0		Terán et al. (2018)
21	Aymara	Bolivia	Taraco (Puna)	2004	Hemocue	<14.5	25	6-7 years			84.0		Terán et al. (2018)
22	Aymara	Bolivia	Taraco (Puna)	2004	Hemocue	<14.5	59	11-12 years	78.0				Terán et al. (2018)
23	Aymara	Bolivia	Taraco (Puna)	2004	Hemocue	<14.5	60	11-12 years		70.0			Terán et al. (2018)
24	Aymara	Bolivia	Caranavi (Yungas)	2004	Hemocue	<14.5	42	6-12 years	7.0				Terán et al. (2018)
25	Aymara	Bolivia	Caranavi (Yungas)	2004	Hemocue	<14.5	51	6-12 years		8.0			Terán et al. (2018)

#	Indigenous community	Country	Region	Data collection (year)	Diagnostic resource	Diagnostic criteria (Hb mg/dl)	Sample size	Age	Male (%)	Female (%)	Total (%)	(CI 95%)*	Author
26	Brazilian indigenous	Brazil	North, Northeast, Central-West and Southeast/South)	2008-2009	Hemocue	<11.0	1117	48-59 months			32.9	(0.36-0.47)	Leite et al. (2013)
27	Brazilian indigenous	Brazil	North, Northeast, Central-West and Southeast/South)	2008-2009	Hemocue	<11.0	1239	36-47 months			39.4	(0.44-0.55)	Leite et al. (2013)
28	Brazilian indigenous	Brazil	North, Northeast, Central-West and Southeast/South)	2008-2009	Hemocue	<11.0	1170	24-35 months			48.8	(0.55-0.67)	Leite et al. (2013)
29	Brazilian indigenous	Brazil	National level	Not given	Hemocue	<11.0	5397	<60 months			51.2	(47.9-54.6)	Coimbra et al. (2013)
30	Brazilian indigenous	Brazil	North, Northeast, Central-West and Southeast/South)	2008-2009	Hemocue	<11.0	5397	6-59 months			51.2		Leite et al. (2013)
31	Brazilian indigenous	Brazil	North, Northeast, Central-West and Southeast/South)	2008-2009	Hemocue	<11.0	1198	12-23 months			68.2	(0.78-0.92)	Leite et al. (2013)
32	Brazilian indigenous	Brazil	North, Northeast, Central-West and Southeast/South)	2008-2009	Hemocue	<11.0	673	6-11 months			80.2		Leite et al. (2013)
33	Brazilian indigenous	Brazil	North, Northeast, Central-West and Southeast/South)	2008-2009	Hemocue	<11.0	2635	6-59 months		49.6			Leite et al. (2013)
34	Brazilian indigenous	Brazil	North, Northeast, Central-West and Southeast/South)	2008-2009	Hemocue	<11.0	2761	6-59 months	52.8				Leite et al. (2013)
35	Cabécar	Costa Rica	Indian reservation of Ujarrás, Puntarenas province	Not given	Cyanmetahe moglobin method	<12.0 female; <13.0 male	84	10-16 years	69.0	45.0	57.0		Monge-Rojas et al. (2005)
36	Colombian indigenous	Colombia	National level	Not given	Hemocue	<11.0	2606	6-59 months			31.9		Cediel et al. (2020)
37	Ecuadorian indigenous	Ecuador	Riobamba canton of Chimborazo province	Not given	Cyanmetahe moglobin method	<11.5	36	5-6 years			18.8		Robalino et al. (2007)
38	Ecuadorian indigenous	Ecuador	National level	2012	Automated biometry (SysmexXe - 2100)	<11.0	1236	6-59 months			37.8	(27.9-48.9)	Ramírez-Luzurriaga et al. (2020)

#	Indigenous community	Country	Region	Data collection (year)	Diagnostic resource	Diagnostic criteria (Hb mg/dl)	Sample size	Age	Male (%)	Female (%)	Total (%)	(CI 95%)*	Author
39	Embera-Chamí	Colombia	Caldas	Not given	Haemogram test	<11.5 (5-11 years)	82	6-10 years			8.6		Cardona et al. (2014)
40	Embera-Chamí	Colombia	Caldas	Not given	Haemogram test	<11.0 (6-59 months) <11.5 (5-11 years)	80	0-5 years			11.0		Cardona et al. (2014)
41	Embera-Chamí	Colombia	Caldas	Not given	Haemogram test	<11.5 (5-11 years) <12.0 (12-14 years)	22	10-15 years			36.4		Cardona et al. (2014)
42	Embera-Chamí	Colombia	Caldas	Not given	Haemogram test	<11.5 (5-11 years) <12.0 (12-14 years)	184	0-15 years	12.0	14.3			Cardona et al. (2014)
43	Guaraní	Brazil	Rio de Janeiro (Sapukai, Parati-Mirim, Araponga, Sítio Rio Pequeno e Mamanguá) and Sao Paulo (Boa Vista)	2008-2009	Hemocue	<11.0	128	6-11 months	100.0	80.0	88.9		Barreto et al. (2014)
44	Guatemalan indigenous	Guatemala	National level	2008	Hemocue	<11.0	5735	6-59 months			49.6	(46.4, 52.8)	Ramírez-Zea et al. (2014)
45	Kamaiurá	Brazil	Alto Xingu, Mato Grosso state	2000-2001	Hemocue	<11.0	38	24-60 months			50.0		Mondini et al. (2007)
46	Kamaiurá	Brazil	Alto Xingu, Mato Grosso state	2000-2001	Hemocue	<11.5	50	60-120 months			50.0		Mondini et al. (2007)
47	Kamaiurá	Brazil	Alto Xingu, Mato Grosso state	2000-2001	Hemocue	<11.0 (6-59 months); <11.5 (5-10 years)	104	<10 years			55.3		Mondini et al. (2007)
48	Kamaiurá	Brazil	Alto Xingu, Mato Grosso state	2000-2001	Hemocue	<11.0	16	6-24 months			81.3		Mondini et al. (2007)
49	Kamaiurá	Brazil	Alto Xingu, Mato Grosso state	2000-2001	Hemocue	<11.0 (6-59 months); <11.5 (5-10 years)	45	<10 years	64.4				Mondini et al. (2007)
50	Kamaiurá	Brazil	Alto Xingu, Mato Grosso state	2000-2001	Hemocue	<11.0 (6-59 months); <11.5 (5-10 years)	59	<10 years		47.5			Mondini et al. (2007)
51	Karapotó	Brazil	Aldeia Plak-Ô and povoado Terra Nova, located in the municipality of São Sebastião, Alagoas	2008	Hemocue	<11.0	61	25-59 months			49.1		Pereira et al. (2012)

#	Indigenous community	Country	Region	Data collection (year)	Diagnostic resource	Diagnostic criteria (Hb mg/dl)	Sample size	Age	Male (%)	Female (%)	Total (%)	(CI 95%)*	Author
52	Karapotó	Brazil	Aldeia Plak-Ô and povoado Terra Nova, located in the municipality of São Sebastião, Alagoas	2008	Hemocue	<11.0	103	6-59 months			57.6		Pereira et al. (2012)
53	Karapotó	Brazil	Plak-Ô reservation and Terra Nova settlement, in São Sebastião, state of Alagoas	2008-2009	Hemocue	<11.0	97	6-59 months			57.7		Campos et al. (2016)
54	Karapotó	Brazil	Aldeia Plak-Ô and povoado Terra Nova, located in the municipality of São Sebastião, Alagoas	2008	Hemocue	<11.0	33	6-24 months			72.7		Pereira et al. (2012)
55	Karapotó	Brazil	Aldeia Plak-Ô and povoado Terra Nova, located in the municipality of São Sebastião, Alagoas	2008	Hemocue	<11.0	46	6-59 months		56.5			Pereira et al. (2012)
56	Karapotó	Brazil	Aldeia Plak-Ô and povoado Terra Nova, located in the municipality of São Sebastião, Alagoas	2008	Hemocue	<11.0	53	6-59 months	58.4				Pereira et al. (2012)
57	Karibe	Brazil	Alto Xingu, Mato Grosso state	2001-2002	Hemocue	<11.0	85	24-60 months			66.2		Mondini et al. (2009)
58	Karibe	Brazil	Alto Xingu, Mato Grosso state	2001-2002	Hemocue	<11.5	116	60-120 months			67.3		Mondini et al. (2009)
59	Karibe	Brazil	Alto Xingu, Mato Grosso state	2001-2002	Hemocue	<11.0 (6-59 months) <11.5 (60-120 months)	269	6-120 months			70.1		Mondini et al. (2009)
60	Karibe	Brazil	Alto Xingu, Mato Grosso state	2001-2002	Hemocue	<11.0	68	6-24 months			85.0		Mondini et al. (2009)
61	Kaxinanuá	Brazil	Município de Jordão, in the valley of Juruá	2005	Hemocue	<11.0	171	6-59 months			55.6		Oliveira et al. (2011)
62	Ma- cro-Jê	Brazil	Paraná (Kreen-Aka-rôre)-village Nacipotire	1998	Hemocue	<11.0	36	6-59 months			33.3		Baruzzi et al. (2001)
63	Ma- cro-Jê	Brazil	Paraná (Kreen-Aka-rôre)-village Nacipotire	1998	Hemocue	<11.0	82	6 months - 14 years			56.1		Baruzzi et al. (2001)
64	Ma- cro-Jê	Brazil	Paraná (Kreen-Aka-rôre)-village Nacipotire	1998	Hemocue	<12.0	46	6-14 years			73.9		Baruzzi et al. (2001)

#	Indigenous community	Country	Region	Data collection (year)	Diagnostic resource	Diagnostic criteria (Hb mg/dl)	Sample size	Age	Male (%)	Female (%)	Total (%)	(CI 95%)*	Author
65	Mapuche	Chile	Cautín province	Not given	Ultralogic 800	<11.0	110	8-14 months			4.5		Franco et al. (1987)
66	Mapuche	Chile	Cautín province	Not given	Cyanmetahe moglobin method	<11.0	140	8-15 months			4.5		Franco et al. (1990)
67	Mapuche	Chile	Cautín province	Not given	Cyanmetahe moglobin method	<11.0	76	12 months			28.3		Franco et al. (1996)
68	Mexican indigenous	Mexico	National level	2012	Hemocue	<11.5	918	5-11 years			10.4	(8.2-13.2)	De la Cruz-Góngora et al. (2018)
69	Mexican indigenous	Mexico	National level	2006	Hemocue	<11.5	647	5-11 years			11.8	(8.9-15.4)	De la Cruz-Góngora et al. (2018)
70	Mexican indigenous	Mexico	National level	1999	Hemocue	<9.5	27	6-11 months			16.2	(9.2, 23.2)	Villapando et al. (2003)
71	Mexican indigenous	Mexico	National level	1999	Hemocue	<11.5	1067	5-11 years			17.9	(15.6-20.6)	De la Cruz-Góngora et al. (2018)
72	Mexican indigenous	Mexico	National level	1999	Hemocue	<12.0	127	11 years			17.9	(13.5, 22.2)	Villapando et al. (2003)
73	Mexican indigenous	Mexico	National level	1999	Hemocue	<12.0	294	9-10 years			22.6	(19.1, 26.1)	Villapando et al. (2003)
74	Mexican indigenous	Mexico	National level	1999	Hemocue	<11.0	155	48-59 months			23.0	(15.4, 30.6)	Villapando et al. (2003)
75	Mexican indigenous	Mexico	National level	1999	Hemocue	<11.0 (12-71 months) <12.0 (6-11 years)	1068	5-11 years			24.0	(21.3, 26.7)	Villapando et al. (2003)
76	Mexican indigenous	Mexico	National level	2011-2012	Hemocue	<11.0	1032	6-59 months			24.8		Batis et al. (2020)
77	Mexican indigenous	Mexico	National level	2006	Hemocue	<11.0	356	12-59 months			25.8		De la Cruz-Góngora et al. (2018)
78	Mexican indigenous	Mexico	National level	1999	Hemocue	<12.0	312	7-8 years			25.8	(21.6, 30.0)	Villapando et al. (2003)
79	Mexican indigenous	Mexico	National level	2012	Hemocue	<11.0	909	12-59 months			25.9		De la Cruz-Góngora et al. (2018)

#	Indigenous community	Country	Region	Data collection (year)	Diagnostic resource	Diagnostic criteria (Hb mg/dl)	Sample size	Age	Male (%)	Female (%)	Total (%)	(CI 95%)*	Author
80	Mexican indigenous	Mexico	National level	1999	Hemocue	<11.0 (12-71 months) <12.0 (6-11 years)	335	5-6 years			26.1	(21.4, 30.4)	Villapando et al. (2003)
81	Mexican indigenous	Mexico	National level	2012	Hemocue	<11.0	902	12-59 months			27.0		Palacios-Rodríguez et al. (2019)
82	Mexican indigenous	Mexico	National level	1999	Hemocue	<11.0	163	36-47 months			30.5	(24.6, 36.5)	Villapando et al. (2003)
83	Mexican indigenous	Mexico	Urban	1998-1999	Hemocue	<11.0	385	6-59 months			31.6		Rivera et al. (2003)
84	Mexican indigenous	Mexico	South	1998-1999	Hemocue	<11.0	429	6-59 months			34.3		Rivera et al. (2003)
85	Mexican indigenous	Mexico	National level	1998-1999	Hemocue	<11.0	605	6-59 months			35.2		Rivera et al. (2003)
86	Mexican indigenous	Mexico	National level	1999	Hemocue	<9.5 (6-11.9 months) <11.0 (12-71 months)	614	6-59 months			35.8	(32.0, 39.5)	Villapando et al. (2003)
87	Mexican indigenous	Mexico	Other regions	1998-1999	Hemocue	<11.0	176	6-59 months			37.5		Rivera et al. (2003)
88	Mexican indigenous	Mexico	National level	1999	Hemocue	<11.0	587	12-59 months			40.2		De la Cruz-Góngora et al. (2018)
89	Mexican indigenous	Mexico	Rural	1998-1999	Hemocue	<11.0	220	6-59 months			40.3		Rivera et al. (2003)
90	Mexican indigenous	Mexico	National level	1999	Hemocue	<11.0	149	24-35 months			42.0	(35.5, 48.5)	Villapando et al. (2003)
91	Mexican indigenous	Mexico	Mountain: State of Mexico; highlands: Veracruz; coast: Hidalgo	2007-2008	Hemocue	<11.0	194	6-24 months			52.6		Aguirre-Arenas et al. (2013)
92	Mexican indigenous	Mexico	National level	1999	Hemocue	<11.0	120	12-23 months			57.0	(50.6, 65.2)	Villapando et al. (2003)
93	Nasa (Resguardo San Lorenzo, de Caldon)	Colombia	Cauca department	Not given	Hemocue	<11.0	Not given	1-3 years			16.1		Gaviria et al. (2017)
94	Nasa (Resguardo San Lorenzo, de Caldon)	Colombia	Cauca department	Not given	Hemocue	<11.0	62	1-5 years			21.0		Gaviria et al. (2017)

#	Indigenous community	Country	Region	Data collection (year)	Diagnostic resource	Diagnostic criteria (Hb mg/dl)	Sample size	Age	Male (%)	Female (%)	Total (%)	(CI 95%)*	Author
95	Nasa (Resguardo San Lorenzo, de Caldon)	Colombia	Cauca department	Not given	Hemocue	<11.0	Not given	4-5 years			25.8		Gaviria et al. (2017)
96	Nasa, Yanacona, Quichua, Inga, Kofan y Misak (Guambiano)	Colombia	Cali	Not given	Hemocue	<11.0	551	5-14 years			25.8		Bolaños et al. (2014)
97	Peruvian indigenous	Perú	National level	2013	Hemocue	<11.0	172	6-59 months	45.6	41.0	43.5		Flórez-Bendezú et al. (2015)
98	Piaroa	Venezuela	Atures Municipality and is located 50 kilometers north of Puerto Ayacucho	Not given	Coulter counter	<11.0	9	1-3 years		100.0			García-Casal et al. (2008)
99	Piaroa	Venezuela	Atures Municipality and is located 50 kilometers north of Puerto Ayacucho	Not given	Coulter counter	<11.0	10	1-3 years	100.0				García-Casal et al. (2008)
100	Piaroa	Venezuela	Atures Municipality and is located 50 kilometers north of Puerto Ayacucho	Not given	Coulter counter	<11.5	31	4-10 years		100.0			García-Casal et al. (2008)
101	Piaroa	Venezuela	Atures Municipality and is located 50 kilometers north of Puerto Ayacucho	Not given	Coulter counter	<11.5	23	4-10 years	91.0				García-Casal et al. (2008)
102	Quechua	Bolivia	National level	2016	Hemocue	<11.0	1513	6-59 months			55.0	(49.3–60.5)	Cordero et al. (2019)
103	Quechua	Bolivia	National level	2003	Hemocue	<11.0	2692	6-59 months			56.7	(51.8-61.6)	Cordero et al. (2019)
104	Quechua	Bolivia	National level	2008	Hemocue	<11.0	2337	6-59 months			66.4	(61.4–71.1)	Cordero et al. (2019)
105	Shuar	Ecuador	Morona-Santiago province: Upano Valley and Cross-Cutucú	2008-2017	Hemocue	<11.5	653	5-11 years			10.9		De Louize et al. (2021)
106	Shuar	Ecuador	Morona-Santiago province: Upano Valley and Cross-Cutucú	2008-2017	Hemocue	<12.0	164	12-14 years			11.0		De Louize et al. (2021)

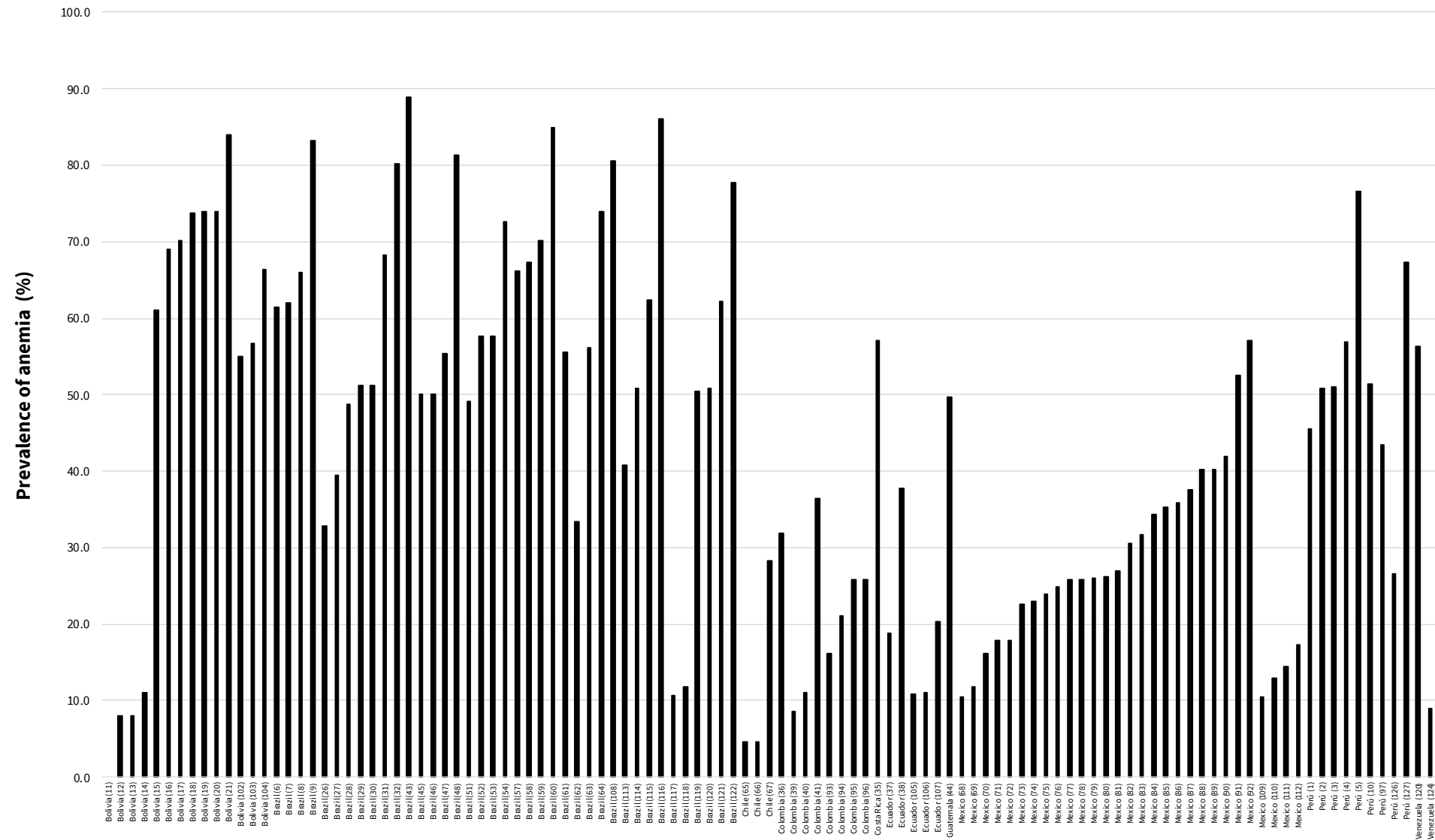
#	Indigenous community	Country	Region	Data collection (year)	Diagnostic resource	Diagnostic criteria (Hb mg/dl)	Sample size	Age	Male (%)	Female (%)	Total (%)	(CI 95%)*	Author
107	Shuar	Ecuador	Morona-Santiago province: Upano Valley and Cross-Cutucú	2008-2017	Hemocue	<11.0	127	0-4 years			20.4		De Louize et al. (2021)
108	Suruí	Brazil	Sete de Setembro Indigenous Land, in Rondônia and Mato Grosso	2005	Hemocue	<11.0 (6-59 months) <11.5 (60-119 months)	293	6-119 months	79.2	82.3	80.6		Orellana et al. (2006)
109	Taraumara	Mexico	Northern Mexico (municipios de Guachochi, Balleza y Batopilas)	2001	Hemocue	<11.5	154	9-11 years			10.4		Monarrez-Espino et al. (2004)
110	Taraumara	Mexico	Northern Mexico (municipios de Guachochi, Balleza y Batopilas)	2001	Hemocue	<11.5 (6-11 years); <12.0 (12-13 years and female 14 years); <13.0 (boys 14 years)	331	6-14 years	11.4	14.5	13.0		Monarrez-Espino et al. (2004)
111	Taraumara	Mexico	Northern Mexico (municipios de Guachochi, Balleza y Batopilas)	2001	Hemocue	<11.5	125	6-8 years			14.4		Monarrez-Espino et al. (2004)
112	Taraumara	Mexico	Northern Mexico (municipios de Guachochi, Balleza y Batopilas)	2001	Hemocue	<12.0 (12-13 years and female 14 years); <13.0 (boys 14 years)	52	12-14 years			17.3		Monarrez-Espino et al. (2004)
113	Terena	Brazil	Terenas villages of Limão Verde and Córrego Seco, district of Aquidauana, in Mato Grosso do Sul state	2002	Hemocue	<11.0 (6-72 months) <11.5 (73-120 months)	59	60-120 months			40.7		Morais et al. (2005)
114	Terena	Brazil	Terenas villages of Limão Verde and Córrego Seco, district of Aquidauana, in Mato Grosso do Sul state	2002	Hemocue	<11.0	65	24-60 months			50.8		Morais et al. (2005)
115	Terena	Brazil	Terenas villages of Limão Verde and Córrego Seco, district of Aquidauana, in Mato Grosso do Sul state	2002	Hemocue	<11.0 (6-72 months) <11.5 (73-120 months)	167	6-120 months			62.3		Morais et al. (2005)

#	Indigenous community	Country	Region	Data collection (year)	Diagnostic resource	Diagnostic criteria (Hb mg/dl)	Sample size	Age	Male (%)	Female (%)	Total (%)	(CI 95%)*	Author
116	Terena	Brazil	Terenas villages of Limão Verde and Córrego Seco, district of Aquidauana, in Mato Grosso do Sul state	2002	Hemocue	<11.0	43	6-24 months			86.1		Morais et al. (2005)
117	Xavante	Brazil	Villages, Pimentel Barbosa and Etênheritipá, State of Mato Grosso, Central Brazil	2009	Not given	<10.9	166	6-59 months			10.6		Welch et al. (2020)
118	Xavante	Brazil	Villages, Pimentel Barbosa and Etênheritipá, State of Mato Grosso, Central Brazil	2009	Not given	<11.4	118	5-9 years			11.8		Welch et al. (2020)
119	Xavante	Brazil	Pimentel Barbosa Indigenous Reserve	2009	Hemocue	<11.0	89	2 to <5 years	22.0	23.0	50.5		Ferreira et al. (2017)
120	Xavante	Brazil	Pimentel Barbosa Indigenous Reserve	2009	Hemocue	<11.0 (6-59 months; <11.5 (5-11 years)	257	>6 months to <10 years			50.8		Ferreira et al. (2017)
121	Xavante	Brazil	Pimentel Barbosa Indigenous Reserve	2009	Hemocue	<11.0	143	<5 years			62.2		Ferreira et al. (2017)
122	Xavante	Brazil	Pimentel Barbosa Indigenous Reserve	2009	Hemocue	<11.0	54	>6 months to <2 years	37.0	40.7	77.8		Ferreira et al. (2017)
123	Xavante	Brazil	Pimentel Barbosa Indigenous Reserve	2009	Hemocue	<11.5	115	5-10 years	23.0	21.0			Ferreira et al. (2017)
124	Yanomami and Warao	Venezuela	Orinoco Delta	2010-2012	EDTA tube	<11.5 (<8 years) <11.9 (8-11 years) <12.5 (males 12-14 years) <11.8 (females 12-14 years) <13.3 (males >14 years) <12 (females >14 years)	152	4-16 years			9.0		Verhagen et al. (2013)

#	Indigenous community	Country	Region	Data collection (year)	Diagnostic resource	Diagnostic criteria (Hb mg/dl)	Sample size	Age	Male (%)	Female (%)	Total (%)	(CI 95%)*	Author
125	Yanomami and Warao	Venezuela	Amazon Region	2010-2011	EDTA tube	<11.5 (<8 years) <11.9 (8-11 years) <12.5 (males 12-14 years) <11.8 (females 12-14 years) <13.3 (males >14 years) <12 (females >14 years)	133	4-16 years			24.0		Verhagen et al. (2013)
126	Yomybato	Perú	Madre de Dios	2012	Hemocue	<11.5 (5-11 years); <12.0 (12-14 years); <13.0 (above 15 years)	117	5-19 years			26.6		Cabada et al. (2014)
127	Yomybato	Perú	Madre de Dios	2012	Hemocue	<11.0	62	6-59 months			67.3		Cabada et al. (2014)
128	Yucpa	Venezuela	Zulia state (Aroy)	Not given	Chromogenic method	<10.7 (1-2 years); <10.9 (3-5 years)	Not given	<6 years			25.0		Diez et al. (1999)
129	Yucpa	Venezuela	Zulia state (Marewa)	Not given	Chromogenic method	<10.7 (1-2 years); <10.9 (3-5 years)	Not given	<6 years			38.9		Diez et al. (1999)
130	Yucpa	Venezuela	Zulia state (Marewa)	Not given	Chromogenic method	<11.5	Not given	6-11 years			56.4		Diez et al. (1999)
131	Yucpa	Venezuela	Zulia state (Peraya)	Not given	Chromogenic method	<10.7 (1-2 years); <10.9 (3-5 years)	Not given	<6 years			60.0		Diez et al. (1999)
132	Yucpa	Venezuela	Zulia state (Aroy)	Not given	Chromogenic method	<11.5	Not given	6-11 years			66.7		Diez et al. (1999)
133	Yucpa	Venezuela	Zulia state (Peraya)	Not given	Chromogenic method	<11.5	Not given	6-11 years			72.0		Diez et al. (1999)

*Confidence intervals for the total value of prevalence of anemia.

Appendix 5. Prevalence of anemia by country.



† Sample # according to the table in Appendix 4.

Appendix 6. Prevalence of anemia as a severe public health problem.

Indigenous community	Country	Sample size	Age	Male (%)	Female (%)	Total (%)	(CI 95%)*	Author
Achuar, Urarina, and Quichua	Perú	Not given	0-4 years			56.9		Anticona & San Sebastian (2014)
Achuar, Urarina, and Quichua	Perú	330	0-17 years			51.0		Anticona & San Sebastian (2014)
Achuar, Urarina, and Quichua	Perú	Not given	5-11 years			45.6		Anticona & San Sebastian (2014)
Achuar, Urarina, and Quichua	Perú	Not given	12-17 years			50.9		Anticona & San Sebastian (2014)
Aguaruna	Perú	Not given	<3 years			76.5		Huamán-Espino & Valladares (2006)
Aruak	Brazil	52	<24 months			83.3		Mondini et al. (2009)
Aruak	Brazil	201	6-120 months			66.0		Mondini et al. (2009)
Aruak	Brazil	71	24-60 months			62.0		Mondini et al. (2009)
Aruak	Brazil	78	60-120 months			61.5		Mondini et al. (2009)
Awajún	Perú	638	<5 years			51.3	(47.4 – 55.1)	Díaz et al. (2015)
Aymara	Bolivia	2692	6-59 months			61.1	(54.9-66.9)	Cordero et al. (2019)
Aymara	Bolivia	2337	6-59 months			70.2	(63.6–76.1)	Cordero et al. (2019)
Aymara	Bolivia	1513	6-59 months			73.8	(63.1–82.2)	Cordero et al. (2019)
Aymara	Bolivia	25	6-7 years			84.0		Terán et al. (2018)
Aymara	Bolivia	119	6-12 years			74.0		Terán et al. (2018)
Aymara	Bolivia	59	8-10 years			69.0		Terán et al. (2018)
Aymara	Bolivia	35	11-12 years			74.0		Terán et al. (2018)
Aymara	Bolivia	59	11-12 years	78.0				Terán et al. (2018)
Aymara	Bolivia	60	11-12 years		70.0			Terán et al. (2018)
Brazilian indigenous	Brazil	673	6-11 months			80.2		Leite et al. (2013)
Brazilian indigenous	Brazil	5397	<60 months			51.2	(47.9-54.6)	Coimbra et al. (2013)
Brazilian indigenous	Brazil	5397	6-59 months			51.2		Leite et al. (2013)
Brazilian indigenous	Brazil	2635	6-59 months		49.6			Leite et al. (2013)
Brazilian indigenous	Brazil	2761	6-59 months	52.8				Leite et al. (2013)
Brazilian indigenous	Brazil	1198	12-23 months			68.2	(0.78-0.92)	Leite et al. (2013)
Brazilian indigenous	Brazil	1170	24-35 months			48.8	(0.55-0.67)	Leite et al. (2013)
Cabécar	Costa Rica	84	10-16 years	69.0	45.0	57.0		Monge-Rojas et al. (2005)

Indigenous community	Country	Sample size	Age	Male (%)	Female (%)	Total (%)	(CI 95%)*	Author
Guaraní	Brazil	128	6-11 months	100.0	80.0	88.9		Barreto et al. (2014)
Guatemalan indigenous	Guatemala	5735	6-59 months			49.6	(46.4, 52.8)	Ramírez-Zea et al. (2014)
Kamaiurá	Brazil	16	6-24 months			81.3		Mondini et al. (2007)
Kamaiurá	Brazil	104	<10 years			55.3		Mondini et al. (2007)
Kamaiurá	Brazil	45	<10 years	64.4				Mondini et al. (2007)
Kamaiurá	Brazil	59	<10 years		47.5			Mondini et al. (2007)
Kamaiurá	Brazil	38	24-60 months			50.0		Mondini et al. (2007)
Kamaiurá	Brazil	50	60-120 months			50.0		Mondini et al. (2007)
Karapotó	Brazil	33	6-24 months			72.7		Pereira et al. (2012)
Karapotó	Brazil	97	6-59 months			57.7		Campos et al. (2016)
Karapotó	Brazil	103	6-59 months			57.6		Pereira et al. (2012)
Karapotó	Brazil	46	6-59 months		56.5			Pereira et al. (2012)
Karapotó	Brazil	53	6-59 months	58.4				Pereira et al. (2012)
Karapotó	Brazil	61	25-59 months			49.1		Pereira et al. (2012)
Karibe	Brazil	68	6-24 months			85.0		Mondini et al. (2009)
Karibe	Brazil	269	6-120 months			70.1		Mondini et al. (2009)
Karibe	Brazil	85	24-60 months			66.2		Mondini et al. (2009)
Karibe	Brazil	116	60-120 months			67.3		Mondini et al. (2009)
Kaxinanuá	Brazil	171	6-59 months			55.6		Oliveira et al. (2011)
Ma- cro-Jê	Brazil	82	6 months - 14 years			56.1		Baruzzi et al. (2001)
Ma- cro-Jê	Brazil	46	6-14 years			73.9		Baruzzi et al. (2001)
Mexican indigenous	Mexico	194	6-24 months			52.6		Aguirre-Arenas et al. (2013)
Mexican indigenous	Mexico	220	6-59 months			40.3		Rivera et al. (2003)
Mexican indigenous	Mexico	120	12-23 months			57.0	(50.6, 65.2)	Villapando et al. (2003)

Indigenous community	Country	Sample size	Age	Male (%)	Female (%)	Total (%)	(CI 95%)*	Author
Mexican indigenous	Mexico	587	12-59 months			40.2		De la Cruz-Góngora et al. (2018)
Mexican indigenous	Mexico	149	24-35 months			42.0	(35.5, 48.5)	Villapando et al. (2003)
Peruvian indigenous	Perú	172	6-59 months	45.6	41.0	43.5		Flórez-Bendezú et al. (2015)
Piaroa	Venezuela	9	1-3 years		100.0			García-Casal et al. (2008)
Piaroa	Venezuela	10	1-3 years	100.0				García-Casal et al. (2008)
Piaroa	Venezuela	31	4-10 years		100.0			García-Casal et al. (2008)
Piaroa	Venezuela	23	4-10 years	91.0				García-Casal et al. (2008)
Quechua	Bolivia	2692	6-59 months			56.7	(51.8-61.6)	Cordero et al. (2019)
Quechua	Bolivia	2337	6-59 months			66.4	(61.4-71.1)	Cordero et al. (2019)
Quechua	Bolivia	1513	6-59 months			55.0	(49.3-60.5)	Cordero et al. (2019)
Suruí	Brazil	293	6-119 months	79.2	82.3	80.6		Orellana et al. (2006)
Terena	Brazil	43	6-24 months			86.1		Morais et al. (2005)
Terena	Brazil	167	6-120 months			62.3		Morais et al. (2005)
Terena	Brazil	65	24-60 months			50.8		Morais et al. (2005)
Terena	Brazil	59	60-120 months			40.7		Morais et al. (2005)
Xavante	Brazil	54	>6 months to <2 years	37.0	40.7	77.8		Ferreira et al. (2017)
Xavante	Brazil	143	<5 years			62.2		Ferreira et al. (2017)
Xavante	Brazil	257	>6 months to <10 years			50.8		Ferreira et al. (2017)
Xavante	Brazil	89	2 to <5 years	22.0	23.0	50.5		Ferreira et al. (2017)
Yombyato	Perú	62	6-59 months			67.3		Cabada et al. (2014)
Yucpa	Venezuela	Not given	<6 years			60.0		Diez et al. (1999)
Yucpa	Venezuela	Not given	6-11 years			56.4		Diez et al. (1999)
Yucpa	Venezuela	Not given	6-11 years			66.7		Diez et al. (1999)
Yucpa	Venezuela	Not given	6-11 years			72.0		Diez et al. (1999)

*Confidence intervals for the total value of prevalence of anemia.