Hamburg University of Applied Sciences
Faculty Life Sciences
Department of Health Sciences
Nutrition and Home Economics

The determining factors of anemia in children – understanding the divergence between Peru and Bolivia

Bachelor Thesis

Submission Date 03/29/2019

Submitted by
Vanessa Zweifel

Thesis Supervisors
Prof. Dr. Joachim Westenhöfer
Prof. Dr. Anja Carlsohn

Foreword

The interest in this report's topic was initiated by an internship that I did in Peru on the outskirts of the beautiful city of Cusco. In cooperation with an NGO, I helped fight against the prevalence and incidence of anemia in children below the age of five. It became clear to me that disease prevention, hygiene, and knowledge in regard to the prevalence of anemia are of high importance. All of these factors, when limited, can have large impacts on anemia. After my internship in Peru I travelled further through South America. During my travels, I noticed the stark differences in eating habits as well as health and social stratification between neighboring countries and within social classes. Whereas in Chile, one of the wealthiest countries in South America, obesity is of great concern to policy makers, Bolivia, considered as one of the poorest states in South America, suffers from high numbers of undernutrition and anemia in children resulting in great physical and mental impairments and a stagnant economy. It was the latter that catalyzed the topic of this thesis. Many people around the world, specifically children, suffer from anemia as a result of poverty, a lack of education and knowledge, unsanitary life spaces, bacterial infections and further determinants. This adversely affects a country's people and further perpetuates the environment. Witnessing the positive changes Peru has been undergone in regard to the prevalence of anemia I wanted to know which factors were most influential.

I am thanking all the people that have accompanied me on my journey through South America. Especially, I want to thank CEDNA for the outstanding support and introduction during and to my work with children of impoverished families in Peru, which was the key factor for developing the idea of this report. I thank Jamal Russell Black for the insights into the world of development statistics and data. The experience has humbled me and led the way for important future decisions.

Table of Contents

List of Abbreviations

BOL – Bolivia
GDP – Gross Domestic Product
g/L – Grams (of haemoglobin) per Liter (of blood)
GNPR – Global Nutrition Policy Review
GNT – Global Nutrition Target
LBW – Low Birth Weight
NCD – Non-Communicable Disease
NGO – Non-Governmental Organization
PER – Peru
RCT – Randomized Controlled Trial
SDGs – Sustainable Development Goals
SES – Socio Economic Status
UHC – Universal Health Care
UN – United Nations
WHO – World Health Organization
YLD – Years Lived with Disability

List of Tables

List of Figures

1. Introduction

Anemia is defined as a reduction of the hemoglobin concentration in the blood, falling below normal values and causing subsequent impairment in meeting the oxygen demands of body tissues (Kassebaum, et al., 2014, p. 615). It remains a major public health issue, affecting roughly one third of our world's population, including over 800 million women and children (WHO, 2017a, p. 2).

Anemia has huge negative impacts on people's health status, life, and a country's economy. Consequences of morbidity display low productivity due to impaired work capacity and fatigue, cognitive impairment, and increased susceptibility to infections. When occurring during pregnancy it is associated with poor birth outcomes and maternal and perinatal mortality. (Balarajan, et al., 2011, p. 2123)

Pertaining to the economic development of a country, anemia poses negative effects on human capital outcomes, resulting in the loss of billions of dollars annually. The burden of those living with anemia, defined as death and loss of health due to the disease, is estimated to be higher than for major depression, chronic respiratory diseases, and injuries combined. More specifically, morbidity related to anemia accounted for more than 68 million Years Lived with Disability (YLDs), globally in 2010. The age group where the impacts of anemia are most acutely felt, and, therefore, the focus of this report, are children below the age of five. Adverse health impacts, like impaired motor and brain development, can greatly affect and jeopardize their future as they are generally more severe within this age group (WHO, 2017a, pp. 2-7). This is compounded by the fact that children below the age five represent the group with the highest prevalence of anemia globally (WHO, 2015, p. 17).

Anemia is most prevalent in developing countries throughout Africa, Asia, and Latin America, the latter of which this report will be focused on. More specifically, anemia affects between 22.5 and 36.5 percent of the population in Latin America. This equates to roughly 15.5 million children below the age of five suffering from anemia in 2011, of which 200,000 showed severe cases. (WHO, 2015, p. 17)

Yet over the last 26 years, some poor performing countries in the region have been experiencing drastic improvements. From 1990 to 2016, Peru was more successful than its' neighbors in decreasing the prevalence of anemia, as can be seen in figure 1. Over this time period, Peru was able to reduce its' numbers from 55 percent of the children below the age of five being affected by anemia to 32 percent. Conversely, though Bolivia started at similar levels of prevalence, it has remained high nationally, with a percentage of 47. As such, it represents the country with the highest anemia prevalence in children under the age of five in all continental South America. (World Bank, 2016a)

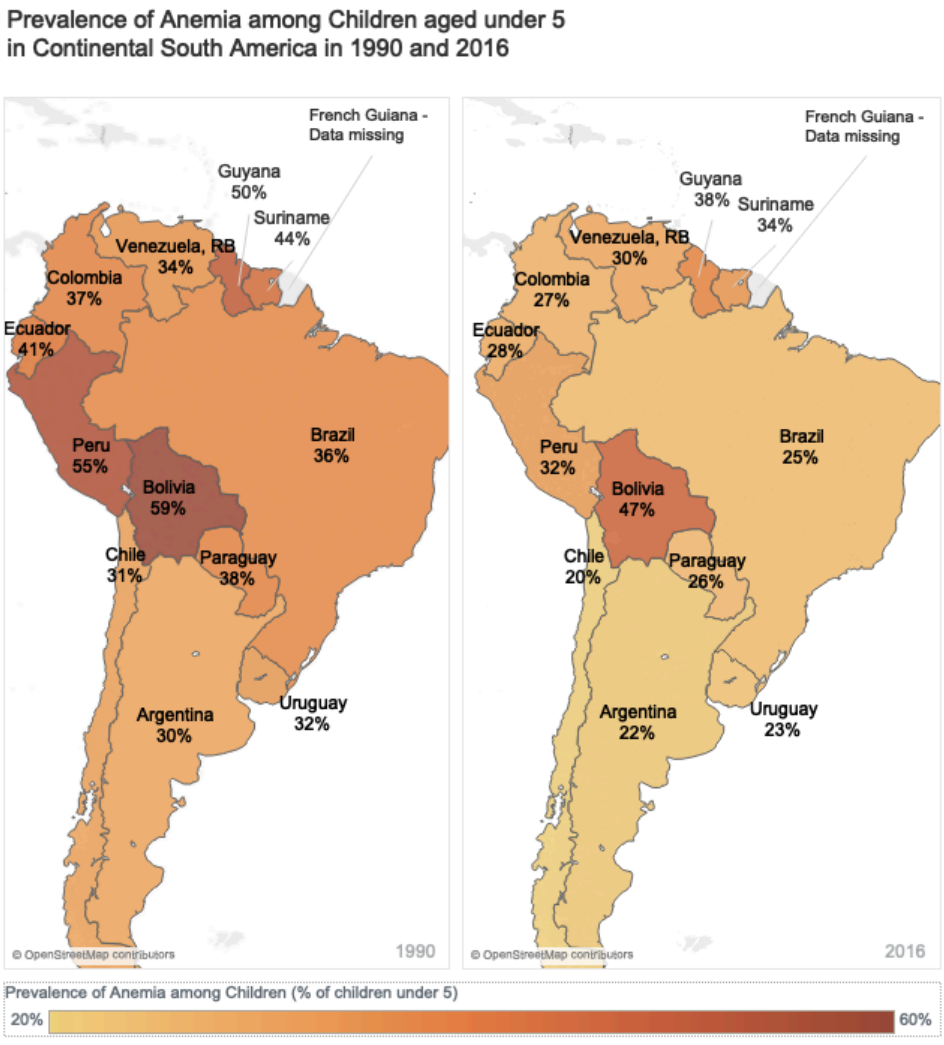

Figure 1: Prevalence of anemia in children below the age of five in continental South America in 1990 and 2016

Source: Wor d Bank, 2016a. Se f-generated

The overall objective of this report is to identify the most prominent and influential factors in efforts to combat anemia in children under the age of five. It will present the understanding of the epidemiology and the consequences of anemia for children under five years of age and focus on the economic and biological determinants of anemia. More specifically, it aims to conduct both, a continent-wide analysis, focusing on South America, and a comparative analysis, highlighting differences between Peru and Bolivia.

Indicators contributing to the development of anemia overlap with many indicators highlighted in the Sustainable Development Goals (SDGs) for 2030. This report will explore these indicators and their corresponding SDGs, using them to help contextualize Peru's and Bolivia's respective development throughout the given time period. Further, they will help to inform readers as to ways in which the eradication of anemia in children below the age of five may be achieved.

2. Previous Research

In the following section both, the classification of anemia and the consequences of anemia in children below the age of five will be explained. Finally, it will detail determinants and several indicators which have an impactful role in the prevalence of anemia.

2.1 Classification of anemia

Anemia is characterized as a condition in which the concentration of hemoglobin is reduced and falls below established cut-off values. The capacity of blood carrying oxygen to tissues is therefore compromised and tissue demands cannot be met. For children from six to 59 months, these cut-off hemoglobin levels are greater than or equal to 110 g/L for no anemia, between 100 and 109 g/L for mild anemia, between 70 and 99 g/L for moderate anemia and hemoglobin levels under 70 g/L represent severe anemia. (WHO, 2017a, p. 2)

Anemia develops through three main mechanisms. The first one is ineffective erythropoiesis, a condition in which the body produces insufficient red blood cells.
The second is hemolysis, which develops when red blood cells are destroyed. The third mechanism is due to blood loss. All of these processes are broadly impacted by nutrition, infectious diseases, and genetic disorders. (Balarajan, et al., 2011, p. 2126)

2.2 Children carrying the highest burden

The World Health Organization (WHO) identifies children below the age of five representing the highest risk group for the onset of anemia. Children are especially vulnerable to develop iron-deficiency anemia. During periods of rapid growth and development, particularly during the first two years of life, iron requirements are high but oftentimes not met. A contributing factor to this is the nature of complementary foods that are commonly fed to children. Oftentimes they contain only low iron contents and, at the same time, have a high number of inhibitors of iron absorption. (WHO, 2017a, p. 4)

Mothers' anemia statuses are among the strongest predictors of anemia in children (Balarajan, et al., 2011, p. 2124). Low birth weight and prematurity, which are consequences of maternal anemia, put further strain on children's iron stores at birth. As a result, iron statuses of very young children are often compromised. (WHO, 2017a, p. 4)

One reason children aged under five represent the highest risk group is related to the fact that they account for the highest prevalence of anemia, globally. In 2011 42.6 percent of children under the age of five suffered from anemia, resulting in around 273 million affected children. Latin America and the Caribbean accounted for about one-third of the total, with around 15 million affected children. (WHO, 2015, p. 17) In 2016, the percentage of children suffering from anemia globally remains at 41 percent, higher than prevalence percentages of women of reproductive age, as well as pregnant and non-pregnant women. (World Bank, 2016a; 2016b)

Moreover, in 2014, anemia in all age groups was quantified to be responsible for up to nine percent of the total global disability burden.
Children accounted for the highest total Years Lived with Diseases (YLDs) amongst all age groups both, female and male children, reaching numbers of YLDs well over eight million. (Kassebaum, et al., 2014, pp. 615-621)

2.3 Consequences of anemia in children

Iron deficiency is the most significant contributor to anemia, accounting for around 50 percent of all anemia cases (WHO, 2015, p. 1). Studies have shown links between iron-deficiency, iron-deficiency anemia and poor cognitive and motor development outcomes in children. Iron-deficiency causes alterations to brain structure and function, which may be irreversible even with iron treatment. It particularly causes damage if anemia is occurring during infancy when neurogenesis and differentiation of different brain regions are occurring. (WHO, 2017a, p. 6) Furthermore malnutrition, another major determinant of anemia, can be a cause for permanent damage to children's cerebral development and irreversible losses of human capital formation (World Bank, 2018).

In addition, hemoglobin concentrations below 50 g/L are linked to increased child morbidity (WHO, 2017a, p. 6). Consequences of anemia in children might therefore not only incorporate a compromised neurological development and increased infant mortality but also a reduction in activity in school (Mujica-Coopman, et al., 2015, p. 125).

If anemia occurs during adolescence and adulthood, it does not only have severe impacts on the intellectual development of those affected, but it can result in a reduction in work productivity. Physical performance is impaired as a result of decreased oxygen capacity of affected tissues and the capacity of red blood cells to carry oxygen to tissues. In countries in which physical labor is particularly prevalent this can result in significant economic consequences. (WHO, 2017a, p. 6)

Impacts of anemia in regard to income and wage loss are obvious. The median physical and cognitive losses associated with anemia and iron-deficiency have been estimated at 3.64 US Dollars (USD) per head or a loss of 0.81 percent of the gross domestic product (GDP) in several developing countries. (Kassebaum, et al., 2014, p. 2131)

2.4 Determinants of anemia

The determinants of the prevalence of anemia in populations all over the world have been widely studied. They involve a complex interplay of political social and biological factors. (Balarajan, et al., 2011, p. 2123) In this report determinants are divided into two main groups, defined as biological determinants and social, behavioral, and environmental determinants. Indicators of determinants for anemia often have huge impacts on the developmental status of a country and are incorporated as a measurement of the for 2030 targeted SDGs and the Global Nutrition Targets (GNTs) for 2025.

2.4.1 Biological Determinants

Anemia can be determined by several biological factors (WHO, 2017a, p. 14). These factors are broadly determined by nutrition, infectious diseases, and genetics and share a causal relationship with a decreased erythrocyte production or the increase of erythrocyte loss, two conditions that result in anemia (Balarajan, et al., 2011, p. 2126). After the identification of indicators for each of the aforementioned determinants, this report found several indicators to be crucial in the understanding of anemia in children aged under five in continental South America.

2.4.1.1 Undernutrition

Good nutrition is crucial for survival, human's health and development.
Well-nourished children show better performance in school and grow into healthy adults. Well-nourished women face fewer risks during pregnancy and childbirth and, therefore, contribute to a better foundation for their children's development, both physically and mentally. (World Bank, 2015a)

Undernutrition is incorporated into Goal Two of the SDG's agenda for 2030. It aims to end hunger, achieve food security, and improved nutrition. It will achieve this, in part, through the promotion of sustainable agriculture. (United Nations, 2019a)

Undernutrition can be considered a medical and social disorder. It is caused by an inadequate dietary intake, infections, or diseases that affect children. Indicators for an inadequate dietary intake can be the prevalence of undernourishment and the depth of food deficit. Consequences are not only the development of anemia but also include high morbidity and mortality. (Ghosh-Jerath, et al., 2017, p. 2)

There are four broad sub-forms of undernutrition which are defined as a deficit of minerals and vitamins, underweight, stunting and wasting (WHO, 2016). All forms, globally, play an important role in the onset of anemia (WHO, 2017a, pp. 14-17). They will be further explained in the following sections.

2.4.1.1.1 Nutrient Deficiencies

Nutritional anemias occur when the demands of nutrients that are crucial for the synthesis of hemoglobin and erythrocytes are not met, resulting in anemia (WHO, 2017a, p. 14). Limited access to food, especially for vulnerable groups, leads to a diet short of macro- and, more importantly, micronutrients (Balarajan, et al., 2011, p. 2127). In 2017, 39.37 percent of all children under age five in the Andean region of Latin America were affected by nutritional deficiencies which accounted for 19.7 percent of the total number of YLDs for this age group (Institute for Health Metrics and Evaluation, 2019).

In the following, nutritional deficiencies that have shown some kind of impact on the onset of anemia will be mentioned and explained.

2.4.1.1.1.1 Iron Deficiency

Iron-deficiency is the top cause for the onset of anemia amongst females and males in the Andean regions of Latin America, accounting for 50 percent of all cases (Kassebaum, et al., 2014, p. 620).

An iron-deficiency anemia usually occurs when the intake of bioavailable iron is insufficient and therefore does not meet dietary iron requirements over a larger period of time (Mujica-Coopman, et al., 2015, p. 120). This can be due to a poor diet, an impaired iron absorption or great blood loss mainly caused by parasites, or in women during childbirth and menstruation (WHO, 2017a, p. 14).

Iron is a crucial nutrient required for hemoglobin, as it is an essential part of the hemoglobin molecule and red blood cell production. Growth of tissue of an infant or growth of the fetus in a woman's womb requires a high level of red blood cells and, thus, an increased availability of iron. (Balarajan, et al., 2011, p. 2127)
A poor iron status during pregnancy can be transferred intergenerational from mother to child, increasing the risk of children being born with iron deficiency anemia (WHO, 2017a, p. 14).

The Global Nutrition Targets incorporate anemia statuses of women of reproductive age. Target Two aims at reducing anemia in women by 50 percent from 2011 until 2025. (WHO, 2014a, p. 1) The relationship between the anemia prevalence in women of reproductive age and in children throughout continental South America can be witnessed in the result section.

2.4.1.1.1.2 Vitamin A Deficiency

Vitamin A has an impact on the immune function of affected individuals. It increases the likelihood of people developing anemia due to infections. Further, Vitamin A deficiencies have an impact on the iron metabolism, causing the mobilization of iron from stores in liver and spleen to decrease. The highest prevalence of Vitamin A deficiencies is found in low- and middle-income households, primarily affecting pre-school children and women of reproductive age. (WHO, 2017a, p. 15)

In 2017, Vitamin A deficiencies in the Andean region of Latin America accounted for nearly one-fifth of the anemia cases in children aged under five and 6.23 percent of the total YLDs (Institute for Health Metrics and Evaluation, 2019).

2.4.1.1.1.3 Vitamin B Deficiencies

Several vitamin B deficiencies also may play a determining role in the onset of anemia. Throughout the previous research riboflavin, folic acid and vitamin B_{12} have been identified to have some kind of impact on the development of the disease.

A lack of riboflavin has a negative effect on the iron metabolism and can cause a decrease in the iron mobilization from stores, a decrease in iron absorption, and an increase in iron loss. These effects coupled with an impaired hemoglobin production are generally found in pregnant and lactating women, infants, and children of pre-school age. In areas where milk and meat consumption is found to be low, this deficiency has an increased prevalence. (WHO, 2017a, p. 15)

Folic acid is crucial for the synthesis and maturation of erythrocytes. Low concentrations of folate in serum and erythrocytes can damage erythrocytes, reduce their lifespan or induce their death. A deficiency of folic acid leads to a megaloblastic anemia. (Balarajan, et al., 2011, p. 2128) Pregnant women and preterm infants are the highest risk groups of folate deficiency (WHO, 2017a, p. 16). In an example of the benefits of good public policy, since folic acid fortification has been introduced in Latin America and the Caribbean, folate deficiency is no longer a major public health concern (Brito, et al., 2015, p. 115).

Finally, vitamin B_{12} deficiency, especially severe cases, can lead to a megaloblastic macrocytic anemia. Individuals that lead a vegetarian lifestyle, particularly, live at the mercy of this deficiency. The prevalence in children and women in South America was estimated at 40 percent. (Balarajan, et al., 2011, p. 2128)

However, the actual contribution of vitamin B_{12} and folate to the global burden of anemia remains disputed (Metz, 2008, p. 74). Nonetheless, both vitamins are mentioned as influential factors on the prevalence of anemia by the World Health Organization (WHO, 2017a, p. 16).

2.4.1.1.1.4 Other Micronutrients

Further vitamins that might play a role in the development of anemia are vitamin C and E. In regard to the former, it is related to the iron metabolism, the enhancement of absorption of non-heme-iron, and the increase in the mobilization of iron from stores. Vitamin E deficiency is defined as a hemolytic anemia because the nutrient shows protective effects on polyunsaturated fatty acids in the membranes of red blood cells. Vitamin E deficiency generally occurs in infants of premature age and those with low birth weight. (WHO, 2017a, p. 16)

Generally, it can be said that there is a lack of information on the nutritional status of populations in Latin America in regard to further micronutrients. It should be noted, however, that Latin America has come a long way in implementing policies and programs that have aimed at eradicating micronutrient deficiencies. Consequently, there is evidence that deficiencies in such nutrients have been reduced over the past years. (López de Romaña & Cediel, 2017, p. 124)
The expansion of anemia interventions includes improvements in daily dietary intake, diversification of food, food fortification, supplementation of iron and other micronutrients, as well as appropriate disease control such as deworming and education. (Balarajan, et al., 2011, p. 2131) Such programs have been implemented all over Latin America, especially food fortification found practice in Peru as well as Bolivia (López de Romaña & Cediel, 2017, p. 130).[1]

As the World Bank does not provide any data on the prevalence of nutrient deficiencies, the individual effects of these nutrients on the development of anemia in children in continental South America cannot be observed. As nutritional anemias are predominantly caused by a poor diet and therefore an inadequate dietary intake of food, the status of undernourishment throughout continental South America is provided as a valuable indicator being represented in the result section.

[1] A whole list on nutritional policies that have been implemented in Peru and Bolivia can be found in the appendix. For this report interventions have not been reviewed in detail in order to focus primarily on determinants of anemia and self conducted research.

Furthermore, undernourishment is an important indicator of the SDG's agenda for 2030. Incorporated into Goal Two, it aims at ending hunger and ensuring access to safe, nutritious and sufficient food all year around for all people. It especially focuses on the poor and vulnerable groups, particularly infants. (United Nations, 2019a)

2.4.1.1.2 Underweight, Stunting and Wasting

Underweight is defined as a status of too low weight for an individual's age. It can reflect both, the status of a stunted child, where the height is too low for the age, and the nutritional status of a wasted child, where the weight is too low for the height. Children that are underweight have a low body mass. Underweight, stunting, and wasting are associated with anemia and share similar causal factors including, again, a poor maternal diet during pregnancy and inadequate feeding practices of the children. Other causes are poor home and community environments, contaminated water, and poor sanitation. (WHO, 2017a, p. 17)

Stunting is a form of undernutrition defined as the height for age ratio being two standard deviations below the standards for the affected age group. In Latin America stunting is the most prevalent nutritional deficiency in children aged under five. (Corvalán, et al., 2017, p. 8) Stunting is an irreversible consequence of inadequate nutrition and the repeated onset of infections during the first 1,000 days of children's lives. It shows, just like anemia, long-terms effects, like impaired cognitive and physical development and lower productive capacity. It further introduces individuals to a greater risk of non-communicable diseases such as diabetes.

The reduction of the prevalence of stunting is incorporated into Goal One of the Global Nutrition Targets for 2025. It aims to reduce childhood stunting by 40 percent from 2012 until 2025. (WHO, 2014b, p. 1) Moreover, it is also part of the SDG's agenda for 2030, being incorporated into Goal Two and aiming to achieve the eradication of all forms of malnutrition including, stunting and wasting (United Nations, 2019a).

Both, the prevalence of underweight and stunting have presented a lack of data throughout the time period from 1990 and 2016, specifically for Bolivia and Peru. Both indicators have therefore been excluded from the result section. Nevertheless, there could be seen an inverse relationship between both indicators and the anemia variable, taken the average numbers from all continental South American countries, which indicates an approval of previous research. It generally, can be said, that data available over time shows higher prevalence of morbidity throughout Bolivia more so than in Peru. (World Bank, 2017g; 2017h)

As the prevalence of wasting in children under the age of five has not shown a large enough correlation to the development of anemia in children aged under five in continental South America from 1990 to 2016, it will not be further discussed which does not mean that it is not a relevant factor of health disparity in general.

2.4.1.2 Infectious Diseases

In Latin America, infectious diseases are one of the top causes for anemia across the population. They contribute to anemia through impaired iron absorption and an impaired metabolism of iron and further micronutrients. They are also causing nutrient losses. (Balarajan, et al., 2011, p. 2129) In the following section, several infectious diseases that are said to have an impact on the onset of anemia will be further elucidated.

2.4.1.2.1 Soil transmitted Helminth Infections

Hookworm infection is the most prevalent form of soil transmitted helminth infections, globally. It occurs in tropical and subtropical areas due to good conditions for larval development. The infections are most common in areas of poverty where poor sanitation, poor water quality and inadequate infrastructure are predominantly common. (Balarajan, et al., 2011, p. 2129)

In the Andean regions of Latin America, including Peru and Bolivia, hookworm disease makes up one of the top causes for anemia (Kassebaum, et al., 2014, p. 620).

Outgrown parasites enter and, consequently, attach to the mucosa and submucosa of an individual's small intestine. Once in place, it causes serious damage to capillaries and arterioles. Through the secretion of anticlotting agents, the worm ingests the flow of blood, being able to cause chronic blood loss. The severity depends on the intensity of infection and the species of hookworm. Individuals in which the chronic blood loss exceeds their iron reserves, hookworm disease is often diagnosed and results in an iron-deficiency anemia. (Balarajan, et al., 2011, p. 2129)

Data on hookworm disease in children was not provided by the World Bank and is therefore excluded from the result section.

2.4.1.2.2 Malaria

This infectious disease causes an impairment of the iron metabolism in several ways. It contributes to anemia through hemolysis as well as a decrease in the production of red blood cells. Due to an increase of hepcidin, iron absorption can be impaired or reduced. (WHO, 2017a, p. 21)

Children from developing countries with tropical climate carry the highest burden of malaria. In Latin America, it especially affects the regions around the Amazon. In Bolivia, the incidence of malaria is estimated at 10.56 per 1,000 person-years and 9.24 in Peru. (Bardach, et al., 2015, pp. 69,75)

Though prevalent, Malaria was not listed as one of the primary causes for anemia in the Andean regions of Latin America (Kassebaum, et al., 2014, p. 620). It is therefore not considered to be an influential factor in the development of anemia from 1990 to 2016 in Bolivia and Peru. The relationship between the malaria incidence variable and anemia variable supports that claim by showing a low correlation and is therefore excluded from the result section.

HIV/ AIDS

Individuals living with human immunodeficiency virus (HIV) are very likely to develop some kind of anemia. Anemia in HIV affected persons results from opportunistic infections, for instance hookworm infections, as well as through nutritional deficiencies and types of HIV therapy that have a negative effect on erythropoiesis. Furthermore, HIV is associated with pro-inflammatory cytokines and altered iron metabolism. (WHO, 2017a, p. 22) Worldwide, anemia occurred in 73 to 100 percent of all HIV infected children (Calis, et al., 2008, pp. 1101-1109).

However, the relationship between the prevalence of anemia in children below the age of five in continental South America and the HIV variable used for this report did not meet the required correlation to be included in the result section.

2.4.1.2.3 Tuberculosis

Tuberculosis is another determinant for anemia given by the WHO. Anemia in tuberculosis patients is thought to result from increased blood loss and decreased production of red blood cells. Furthermore, tuberculosis contributes to a poor appetite and food intake. As a result, micronutrient deficiencies are expected which lead to anemia. (WHO, 2017a, p. 22)

As there is no data on tuberculosis incidence rates, specifically for children below the age of five, provided by the World Bank, this variable will be excluded from the result section.

2.4.1.3 Hemoglobin Disorders

Genetic hemoglobin disorders, especially sickle-cell disease and thalassemia, belong to the most prevalent causes of anemia in Latin America (Kassebaum, et al., 2014, p. 620). Globally, 330,000 infants are born annually with genetic hemoglobin disorders. This predisposes them to a high risk for developing anemia. Causes for these disorders can be structural variations or an impaired production of globin chains of haemoglobin. (Balarajan, et al., 2011, p. 2130)

Due to data constraints for the aforementioned determinant, it will not be included in the result section.

2.4.2 Economic and Social Determinants

A wide range of determinants of social, behavioral and environmental nature are owing to the exposure of some individuals and population groups to a greater risk of anaemia. (WHO, 2017a, p. 23) In the following these factors contributing to anemia will be further explained.

2.4.2.1 Socio Economic Status – Poverty

The most prominent determinants of anemia, globally, is the state of poverty and, therefore, the socio-economic status (SES) of an individual or their family. Poverty is a major determinant of health in general and is more than just a lack of income and resources to ensure a sustainable livelihood. It also manifests itself in poor living and working conditions, poor sanitation and hygiene, as well as a meager access to health care services. Furthermore, it is indicated by an inadequate infrastructure and limited access to electricity. (WHO, 2017a, p. 23)

Children living in the lowest quantiles of poverty are considered to be up to 21 percent more likely to be anemic than those living in the highest quantiles (Balarajan, et al., 2011, p. 2124). In Latin American countries, the prevalence of anemia was shown to be higher in low or very low SES areas than in middle or high SES areas (Iglesias Vázquez, et al., 2019, p. 9).

In this report, poverty is measured by the percentage of people living below the international poverty line. The international poverty line is set at 1.90 US Dollars per day. People living below this value are considered extremely poor. This indicator is also incorporated into Goal One of the SDG's agenda. The goal is to end extreme poverty, in all its forms, everywhere. More specifically, it aims to erase the prevalence of people living at the international poverty line by 2030. (United Nations, 2019a)

To achieve the aforementioned goal, economic growth plays a huge role. It can provide sustainable jobs and further promote equality, another factor mentioned in the prevalence of anemia in children and females. (United Nations, 2019b)
The annual growth rate of the gross domestic product represents an indicator to measure the economic growth (United Nations, 2019a). The GDP per capita describes the value of the entire number of goods and services that have been produced within a country in a particular year, divided by the number of people living in this country (World Bank, 2017a). In the SDG's agenda, a positive percentage change of the annual GDP per capita is said to indicate an increase in the average standard of living for the residents of a country. One of the targets of Goal Eight of the SDGs is to achieve a minimum of seven percent yearly increase of the gross domestic product by 2030. (United Nations, 2019a)

In the following, further indicators used in this report that stand in correlation with the socio-economic status and poverty will be described.

2.4.2.1.1 Access to electricity

Inadequate infrastructure leads to an increased prevalence of diseases (WHO, 2017a, p. 23). Globally, access to electricity plays a huge role in regard to economic development. Currently, 2.6 billion people still do not have constant electricity access. Electricity access is invaluable for creating good conditions for economic growth and improving people's standard of living. Limited or no access to electricity effects everything from trade to manufacturing to farming. As such, the expansion of electricity access is the seventh goal on the SDG's agenda for 2030. (United Nations, 2019a)

2.4.2.1.2 Poor sanitary living conditions

Sanitation is crucial for human development. Many international organizations use hygienic sanitation facilities as a measurement of positive development in the fight against poverty, disease, and death. Generally, sanitation refers to the establishment of facilities and services for the safe discarding of human feces and urine. Improper sanitation is a main cause for the onset of diseases world-wide. Improving the sanitation situation shows a significant positive impact on people's health status. (World Bank, 2015b)

Basic and safely managed sanitation services can therefore lessen diarrheal diseases and worm infections that make children more vulnerable to malnutrition and severe infections. Furthermore, it significantly lessens the adverse health impacts of disorders responsible of death and disease among millions of children. (World Bank, 2015b)

Goal Six of the SDG's agenda targeted for 2030 is defined by achieving access to adequate and equitable sanitation and hygiene for all in order to end open defecation, particularly paying attention to those in the most vulnerable situations. It also includes the universal and equitable access to safe and affordable running water for all. (United Nations, 2019a) As safely managed sanitation services have shown to result in improved health outcomes in children in the past, it is very likely that by ensuring the access to such services by 2030 child health will significantly be improved (Larsen, et al., 2017, p. 6).

2.4.2.2 Health Care System

Health systems, defined as combined arrangements of institutions and actions, serve to promote, restore and maintain the health status of a population. They are key to fighting diseases and improving health throughout populations and therefore reduce morbidity and mortality. Good and effective health care systems are characterized by effective finance structures, good service delivery, adequate workforce and governance as well as sufficient and eloquent knowledge. (World Bank, 2016d)

Universal Health Coverage (UHC) represents the idea of an effective health system. It means that all people are able to obtain health services they need without suffering financial hardship. The third SDG, better health for all people, incorporates the idea of UHC. It is especially important when numbers for out of pocket health expenditures are concerned. Health care is a key reason why people globally get pushed into poverty and remain in that state. (WHO and World Bank, 2017, pp. 1-42; United Nations, 2019a)

The actions that need to be taken to achieve the third SDG Goal by 2030 is to strengthen health systems and implicate UHC in all countries, especially in those with the weakest health systems and poorest communities. (WHO and World Bank, 2017, pp. 1-42; United Nations, 2019a)

The World Bank dataset contributes to the evaluation of health systems throughout the world. By providing data on health worker density including the number of physicians, nurses and midwives, and community health workers it represents the availability of medical persons for the population. The WHO estimated that at least 2.5 medical staff needs to be provided per 1,000 people to provide an adequate coverage of primary health interventions. (World Bank, 2016d) Furthermore, the World Bank provides data on the coverage of social insurance programs. The data represents the percentage of the population that is participating in programs providing old age contributory pensions and social security and health insurance benefits. (World Bank, 2016e)
For both variables, unfortunately, there is insufficient data over the time period from 1990 to 2016 in continental South America. As such, they have been excluded from the result section.

2.4.2.3 Education

Education is another important determinant of health. A lack of formal education or a low education level is linked to the onset of anemia. In a survey conducted by the WHO, mothers with no education were eight percent more likely to develop anemia than women with secondary or higher education and their children were nine percent more likely to have anemia.
Low maternal education might affect mothers' ability to access and understand health and nutrition information, and can result in negative effects on the quality of their children's diet. (WHO, 2017a, p. 23)

Further, higher levels of parental education can also provide better work opportunities and, consequently, better income. This often leads to expanded access to high quality foods, diversity in the children's diet, in addition to an improvement of the environment where the children live. (Cotta & Fabiana de Cássia Carvalho Oliveira, 2011, p. 316)

Females in Latin America and the Caribbean had primary school completion rates estimated at 82 percent in 1973, increasing to 98 percent in 2017 (World Bank, 2017e). As the numbers have been relatively high throughout the given time period, this report will focus on females' completion rates of lower secondary school. This is reaffirmed by substantial amounts of literature referencing lower secondary school as the relevant factor in regard to proper education and the onset of anemia. The starting age for lower secondary in continental South America has been estimated at twelve years of age (World Bank, 2018a).

Lower secondary in continental South America usually takes four to five years, five years in Peru specifically (World Education News & Reviews, 2015). Females that have completed lower secondary school are estimated to be at an age between 16 and 17 years. The mean age women at giving birth to their first child was estimated at 22 years, an approximation calculated from the data available for Peru, Bolivia, Colombia, Paraguay and Guyana (Central Intelligence Agency, 2018). The importance of these calculations will be further explained in the methodology section.

Education is not only a factor for the prevalence of anemia. It is also incorporated in Goal Four of the SDG's agenda. By 2030, it aims to provide inclusive and equitable education and promote of lifelong learning opportunities for all. By providing complete, free, equitable, and quality primary and secondary education, relevant and effective learning outcomes should result. (United Nations, 2018)

2.4.2.4 Rural Residence

Finally, rural residency has been associated with higher prevalence of anemia. This is, in part, due to limited access of services, increased exposure to some infectious agents, and a less varied diet than their counterparts living in urban areas. Populations belonging to specific ethnic, cultural, or religious groups are at greater risk to being exposed to discrimination in the workforce, resulting in suppressed opportunities for generating income, adequate education, as well as accessing health and social services. (WHO, 2017a, pp. 23-24)

Indigenous people in Latin America are especially vulnerable to this, as they account for nearly 13 percent of the total population but about 40 percent of the rural population. The quality of published data on anemia in indigenous populations remains poor, making it hard to track the extent of the problem. (Corvalán, et al., 2017, p. 8; Khambalia, et al., 2011, p. 715)

3. Development of anemia in continental South America from 1990 to 2016 in children under the age of five

This report explores the prevalence of anemia in children under five, highlighting the majority of continental South America. Further, a comparative analysis between Peru and Bolivia will be conducted. Similarities in topography, as well as a shared culture and history, make them an ideal case study in which to explore the effects of good governance and economic policy on the prevalence of anemia.

In 1990, the year in which data collection of anemia in continental South America starts, anemia afflicted 40.58 percent of children under five years of age. The countries with the highest prevalence of anemia were Bolivia and Peru. In 1990, 59 percent of all Bolivian children under five were effected by anemia. A shocking number, when put into context. Not far behind was Peru, having 55 percent of children under five having anemia. Since 2003, Peru has been engaged in a rapid decrease in anemia rates for children aged under five, a rate far outpacing all other South American countries during this time period. During the first 13 years of available data, Peru experienced a six percentage-point decrease in the prevalence of anemia. During the next 13 years, Peru was able to reduce their numbers to 32 percent, when compared to the first time period, this is nearly three times the decrease. In regard to the prevalence of anemia in children under the age of five, Peru has, over time, been able to surpass both Guyana and Suriname. Further, they are now just 4.5 percentage points above the median anemia prevalence rate of 27.50. (World Bank, 2016a)

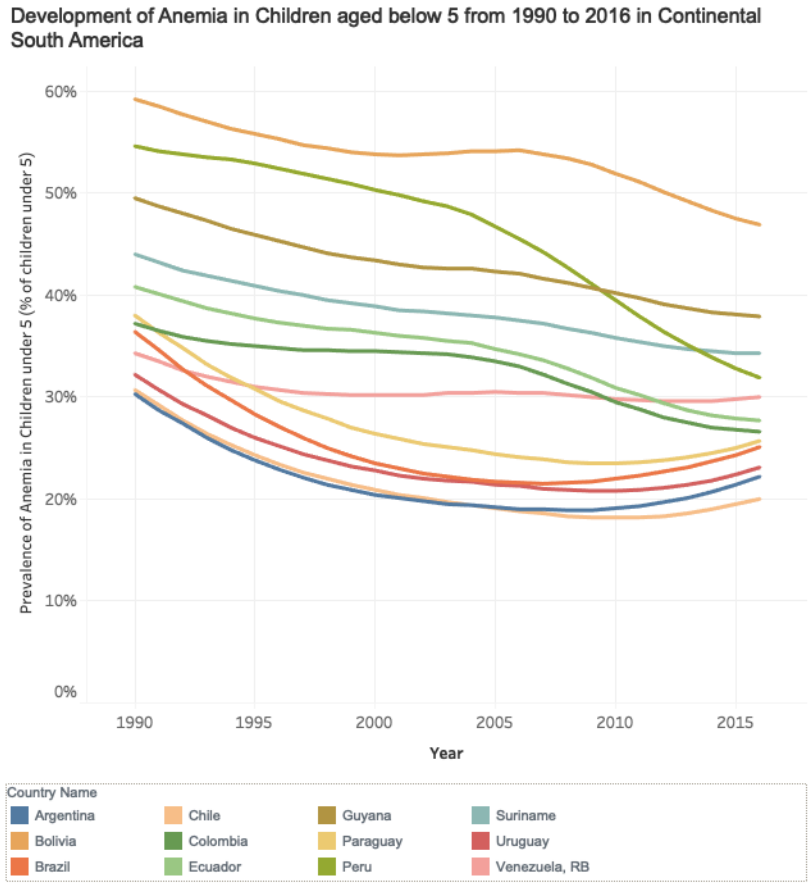

Figure 2: Development of anemia in children below the age of five from 1990 to 2016 in continental South America

Source: Wor d Bank, A), 2016; se f-generated

Bolivia's decrease in the prevalence of anemia in children below the age five has been more modest. Over the 26 years of available data, they were only able to decrease the prevalence of anemia by 12 percentage-points, or 20 percent of the original rate. When compared to Peru, with a decrease of 42 percent, it is clear that Bolivia has underperformed. (World Bank, 2016a)

4. Methodology

In this section, the methodology used to achieve the aforementioned objectives will be outlined. It is divided into the methodological process for conducting the previous literature research, data set up, as well as the methodology for conducting the descriptive analysis, setting the foundation for the result section and further discussion.

4.1 Previous Literature

Through a thorough review of previous literature from sources including the WHO, the United Nations (UN), and several partner organizations, determinants for the onset of anemia were defined. The aim of this literature review was to delve deeper into information and details about the determinants and influential factors of anemia in vulnerable groups, particularly children. To accomplish this, the scientific platform "PubMed" was utilized.

Overall, there has been three PubMed searches, each with different keywords and filters that have been completed to cover three main topics, complementing research conducted by the WHO and the UN.

The first search was to ascertain all research papers on anemia in children in general. Keyword included in this search were "anemia" AND "children" in multiple variations. Active filters used for this search were "systematic reviews" and "meta-analysis". By performing the search with the aforementioned keywords and filters, 490 papers showed up as results. Excluding criteria, to further narrow down the amount of papers, are as followed: older than 2010; research being conducted in one specific country or area outside of Latin America and not referring to global importance or importance for Latin America; research paper in which anemia is not being the main focus. After the exclusion of research papers falling into the aforementioned criteria, there were 14 papers left that were considered as relevant for the purpose of this paper. Another nine have been excluded after thorough consideration, leaving five research papers that have been included in this report.

The second search was to identify the global burden of anemia and, therefore, consequences and outcomes of morbidity for all age groups. Articles preferred included particular information about the burden of anemia in children and Latin America. Keywords used for this search were “anemia” AND “burden” in multiple variations. Filters that were activated included “systematic reviews” and “meta-analysis”. By performing the search with the listed filters and keywords, there were 20 research papers coming up as a result. Excluding criteria, similar to that in search one, included: older than 2010; research being conducted in one specific country or area outside of Latin America and not referring to global importance or importance for Latin America; research included too specific information about the burden of a disease being correlated with anemia but not anemia itself. After applying excluding criteria, two out of 20 articles were left, one which was already included from the previous search.

The third search was to locate information about the general nutritional status in children in Latin America, as nutritional anemias play a large role in the onset of anemia. Keywords used throughout the third search were “children” AND “nutrition” AND “Latin America” in multiple variations. Due to a poor amount of research papers having come up when only using filters “systematic reviews” and “meta-analysis” it was decided to add a more general filter, namely “review”. After doing so, there were 100 research papers, of which seven have been considered relevant for the purpose of this report. By applying the outsourcing criteria, four studies have been considered as valuable to the contribution to the purpose of this report. After thorough consideration, another three have been excluded, one due to being identical to a paper used for search two, which leaves one research paper.

Apart from the aforementioned PubMed searches to specific topics, there was further research needed, for specific determinants. These studies have been handpicked through a thorough search on the PubMed platform including either globally valid or specifically Latin American based information of diseases being correlated to anemia as well as the inclusion of information specifically referring to health outcomes in all age groups, including or specifically children.

4.2 Data Setup

Based on the literature research, indicators selected for inclusion represent a number of biological as well as socioeconomic determinants of anemia.

The dataset used for this report was gathered from the World Bank. This source had the most thorough and complete data, going back several decades. An added benefit of using a single source for the data is all datasets were structured the same way, providing a great opportunity to compare outcomes throughout different countries and age groups. In its original form, every variable is presented in its own excel sheet, displaying values for all countries across the globe that have been analyzed by the World Bank. Though all datasets start in 1960, reporting did not start in most countries until 1990. The start year of the final analytic file reflects this.[2]

Once collecting all relevant data, information for continental South American countries, defined in this report as Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, Uruguay and Venezuela, was included. It then became necessary to aggregate the data into a single analytic file.

To identify indicators that are most relevant to this analysis and therefore being included in the result section, correlations have been computed. These correlations compare the dependent variable of the prevalence of anemia in children aged under five to all indicators identified in previous research. Correlations have been computed via excel code "=CORREL(Section Variable 1; Section Variable 2)". Only those with high correlation and, therefore, the R-value being above or below + 0.5 or – 0.5 as well as sufficient data over several years for both, Peru and Bolivia, are included in this report. Descriptions and correlations of those variables are presented in the following section and tables.

[2] The final analytic file is provided on the accompanying cd.

4.3 Variable descriptions and correlations

There are two types of variables used in this report, a dependent variable and various independent variables. The dependent variable is the variable used in every single correlation and is deemed to be a result of some combination of independent variables. The independent variables represent the variables that are only used once as they will be individually crossed with the dependent variable. Correlations between the dependent variable and each independent variable will be included.

4.3.1 Dependent variable

The dependent variable is, as given by the World Bank, described as the **prevalence of anemia among children (% of children under five)** and indicates the percentage of children under the age of five whose hemoglobin levels are less than 110 grams per liter at sea level. (World Bank, 2016a)

4.3.2 Independent variables

The following table includes all independent variables, relevant for this report, with descriptions and correlations to the dependent variable.

Table 1: Independent Variables: Names, Descriptions and Correlations

Variable Name	Description	Correlation
Prevalence of anemia in women of reproductive age (% of women ages 15-49)	The percentage of women of reproductive age (ages 15-49), whose hemoglobin levels are less than required. The data included both, non-pregnant women with hemoglobin levels below 12 g/dL and pregnant women with hemoglobin levels below 11 g/dL. (World Bank, 2016b)	0.74

Prevalence of undernourishment (% of population)	The percentage of people whose food intake is not sufficient to meet their dietary energy requirements continuously. (World Bank, 2015a)	0.83
GDP per capita (current US Dollars)	The gross domestic product divided by midyear population. The GDP is the sum of gross value added by all the resident producers in the economy plus any product taxes and minus subsidies not included in the value of the products. (World Bank, 2017a)	-0.63
Poverty Headcount Ratio at 1.90 US Dollars a day (2011 PPP) (% of population)	The percentage of people living on less than 1.90 US Dollars a day at 2011 international prices. (World Bank, 2017b)	0.62
Access to electricity (% of population)	The percentage of the population provided with access to electricity. (World Bank, 2016c)	-0.82
People using safely managed sanitation services (% of population)	The percentage of people using improved sanitation facilities, including flush/ pour flush to piped sewer systems, septic tanks or pit latrines. Sanitation facilities must not be shared with other households and excreta has to be deposited safely of in situ or be transported and treated offsite. (World Bank, 2015b)	-0.57

Lower secondary completion rate, female (% of relevant age group)[3]	The completion rate is quantified as the gross intake ratio to the last grade of lower secondary education. It is defined by the number of new participants in the last grade of lower secondary education, irespective of age, divided by the population at the entrance age for the last grade of lower secondary education. (World Bank, 2017f)	-0.19
Rural population (% of total population)	The percentage of people living in rural areas defined by national statistical officers. The rural population is calculated as the difference between the total population and the urban population. (World Bank, 2017c)	0.58

Source: se f-generated

[3] In order to conduct the correlation between the influence of mother's education levels on children's prevalence of anemia, in this report, it will be assumed that all females included in the data set would have given birth at their expected age. Based on the information given in the previous literature research section, females are supposed to be around the age of 16 when finishing lower secondary education. The expected age of giving birth the first time in continental South America is set at around 22. That means that there are six years in between the completion of lower secondary school and the expectance of the first child. In this report, the author looked at the outcomes of anemia in children six years after the possible mothers should have finished lower secondary school within a range of plus five years, due to the fact that data is given for children from zero to five years of age. The average value was conducted for all females and crossed with the anemia variable of anemia prevalence in children from 1990 to 2016.

5. Results [4]

In the following section, results of the crossed-variable analysis will be presented, including correlations and trends in development of formerly discussed determinants and their effect on the onset of anemia in children below the age of five throughout continental South America. It will highlight similarities and differences between Peru and Bolivia, with attention paid to the determinants of anemia and efforts to combat the disease.

5.1 Prevalence of anemia in women of reproductive age

As identified in previous literature, mothers' iron states have impactful, negative consequences on the iron levels in their children. Poor iron states during pregnancy can be transferred intergenerational and introduce infants to a higher risk for the onset of iron deficiency. (WHO, 2017a, p. 14) Maternal anemia states are therefore described as one of the strongest predicators for anemia in children (Balarajan, et al., 2011, p. 2124).

This relationship holds true in South America. As seen in figure 3, there is a strong, positive correlation between the prevalence of anemia in women of reproductive age and in children under five years of age. That is to say, the higher the proportion of women of reproductive age who have anemia, the higher the prevalence of anemia in children under five years of age.

Looking at Peru and Bolivia, both countries' prevalence of anemia in children differs from the value set at the trend line. More specifically, over the course of the dataset, a higher proportion of children in these two countries have anemia in relation to women of reproductive age. This deviation from the mean trend line suggest children in these countries are at higher risk than of their counterparts across the continent.

[4] The country name "South America" refers to all data from South American countries, Peru and Bolivia excluded.

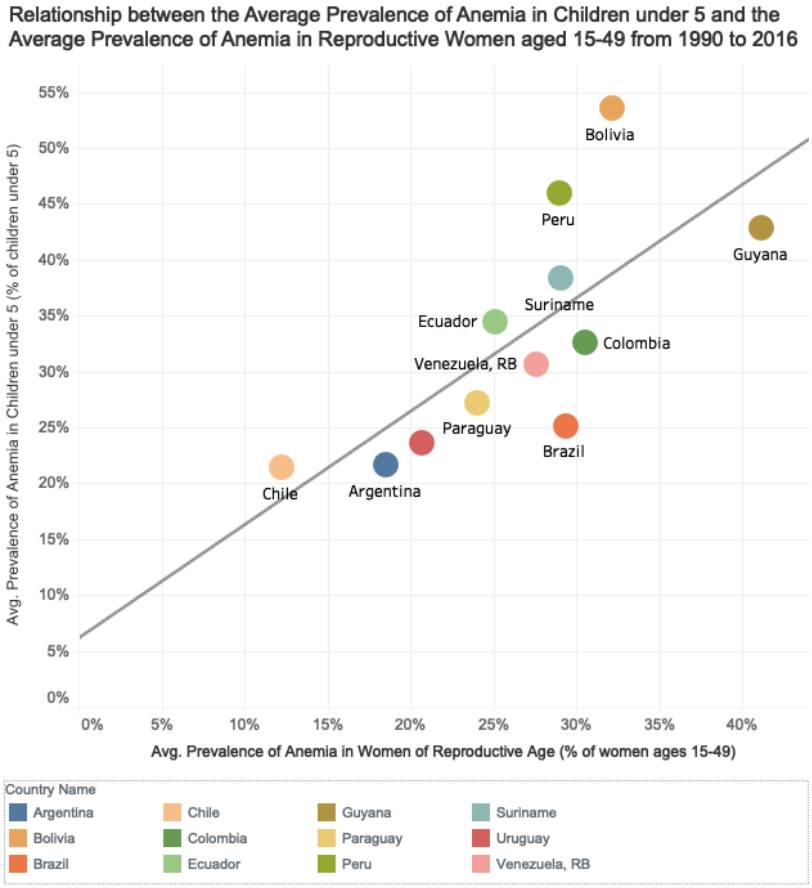

Figure 3: The relationship between the average prevalence of anemia in children aged below five and the average prevalence of anemia in women of reproductive age in continental South America covering data from 1990 to 2016

Source: Wor d Bank, 2016a; 2016b. Se f-generated

The percentage changes of both variables throughout time largely mirror each other. Peru, after the year 2000, shows consistent and strong reduction in the percentage of children with anemia as well as with mothers of reproductive age. Conversely, Bolivia remains the country with the least reduction in the prevalence of anemia for both cases, growing between 2000 and 2006.

Since 2013, the average prevalence of anemia in women of reproductive age in continental South America has begun to increase again. Unsurprisingly, Bolivia has also begun to experience a growth in the prevalence of anemia in women of repro-ductive age. In comparison, Peru continues to reduce the prevalence of anemia in this group, though at a smaller rate than previously experienced.

Between 1990 and 2016, Peru was able to reduce the prevalence of anemia from 2 in every 5 women of reproductive age to 1 in 5. Over the same time, Bolivia was able to decrease the prevalence of anemia from 36 percent of women of reproductive age to 30 percent. Across continental South America, the average prevalence of anemia went from 35 percent of women of reproductive age to 22 percent.

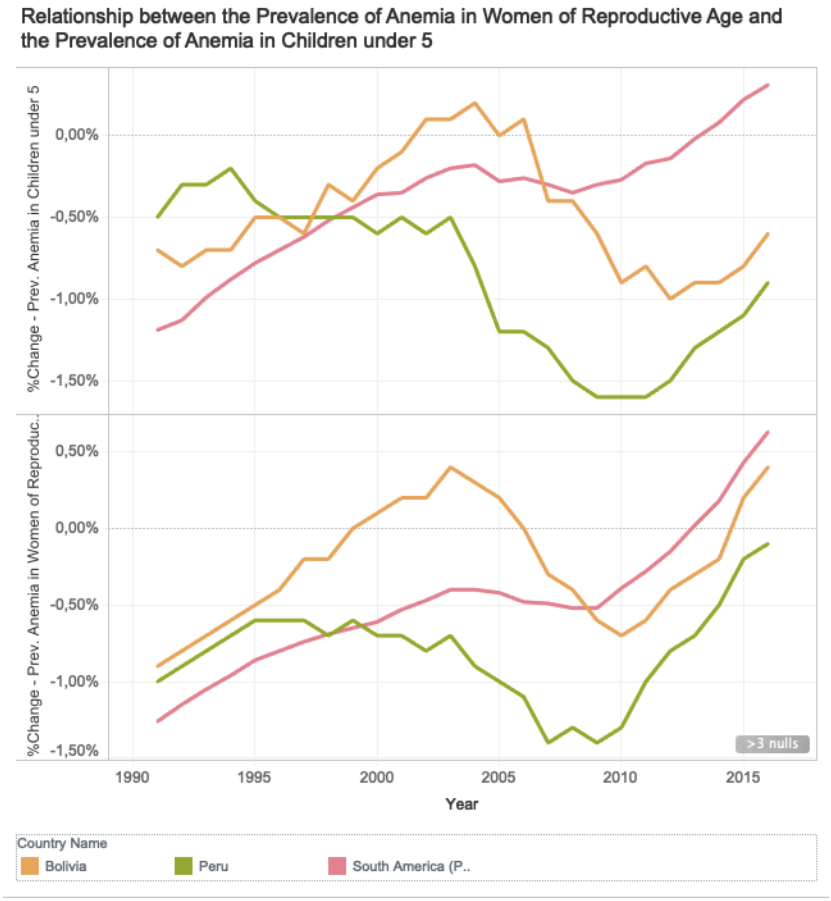

Figure 4: Development of the percentage change of the prevalence of anemia in children aged below five and the percentage change of the prevalence of anemia in women of reproductive age in continental South America from 1990 to 2016

Source: Wor d Bank, 2016a; 2016b. Se f-generated

A reduction of 50 percent of anemia in women of reproductive age from 2011 to 2025 is incorporated into the Global Nutrition Targets (WHO, 2014a). Currently, Peru has less than one-fifth of women of reproductive age having anemia. To meet this target, Peru will need to, on average, decrease the prevalence level of women of reproductive age by 0.66 percentage-points annually. Between 2011 and 2016, they have only been able to average a 0.46 percentage-points annual reduction. Though good, if it does not expedite future reduction, it will not meet this target.

Bolivia in the year of the baseline in 2011 showed a prevalence of 30.5 percent for women of reproductive age. Their annual average until 2016 can be calculated to minus 0.06 percentage points. Continuing at the same rate, Bolivia in 2025 will end up with a prevalence of 29.96 percent and therefore only show a reduction of the prevalence of anemia of 1.8 percent. A fraction of what may be expected from their neighbor.

If the relationship between the prevalence of anemia in women of reproductive age and the prevalence of anemia in children under five is causal, in regard to Peru, a continued reduction in the prevalence of anemia in children under five could be experienced. In the case of Bolivia, unfortunately, stagnation in the reduction of the prevalence of anemia in children under five may be expected. By trying to realize the GNTs for 2025, specifically the reduction of the prevalence of anemia in women of reproductive age, both countries may benefit in regard to the prevalence of anemia in children below the age of five.

5.2 Prevalence of Undernourishment (% of population)

Well-nourished children show better mental and motor development and consequently show better performance in school. Provided a good nutrition, health knowledge, and education, they can grow into healthy adults and provide a better start to life for their own children. The state of undernourishment has therefore longtime effects on peoples' and communities' development. (World Bank, 2015a)

The importance of the prevalence of undernourishment for the onset of anemia in children aged below five can be witnessed in the following graph. Numbers of prevalence of undernourishment are represented as percentages of the whole population. It is assumed that the percentage of undernourished children is proportionate.

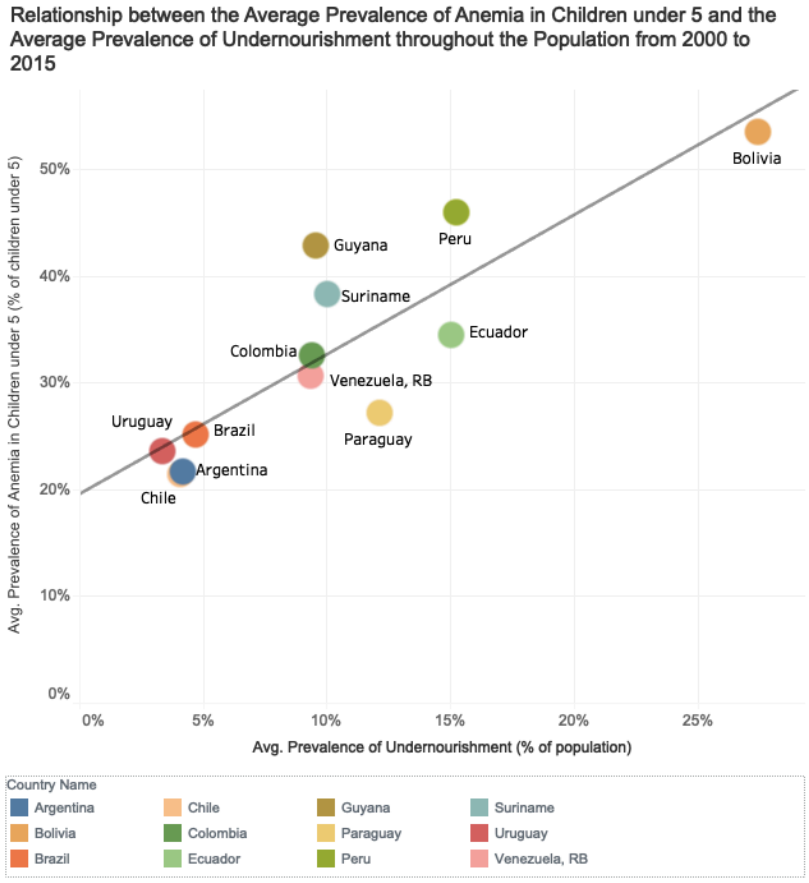

Figure 5: The relationship between the prevalence of anemia in children aged below five and the prevalence of undernourishment throughout the population in continental South America covering data from 2000 to 2015

Source: Wor d Bank, 2015a; 2016a. Se f-generated

There is a strong correlation of 0.86 between the prevalence of anemia in children under five and the percentage of undernourished people in the country. The development of both variables throughout the given time period is realized in figure 6.

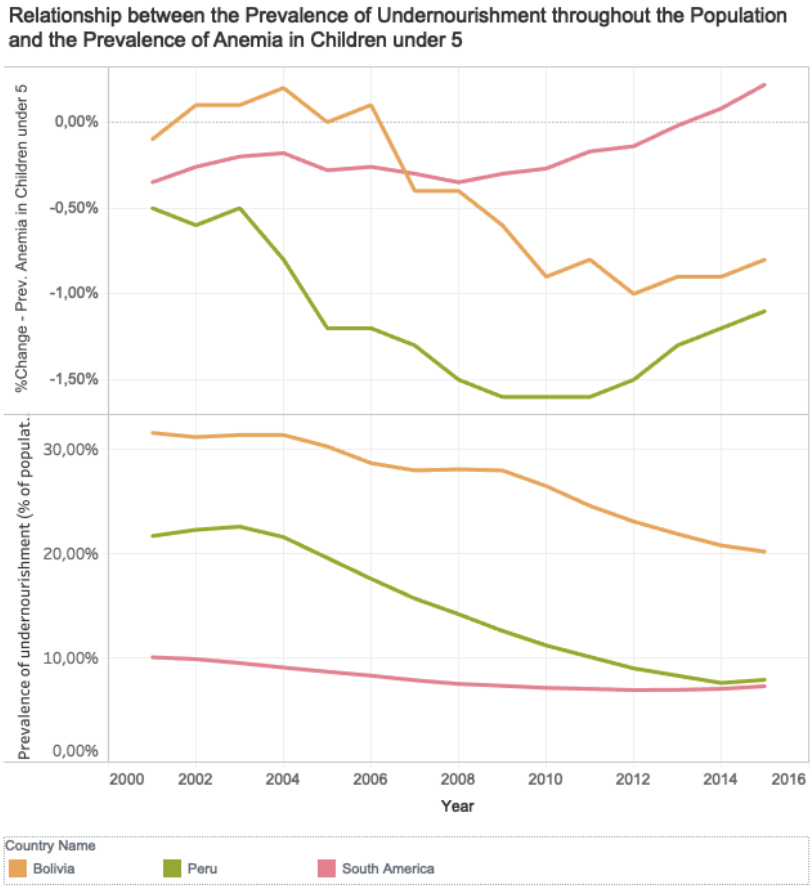

Figure 6: Development of the percentage change of the prevalence of anemia in children below age five and the prevalence of undernourishment throughout the population in continental South America from 2000 to 2015

Source: Wor d Bank, 2015a; 2016a. Se f-generated

When averaging across the dataset, Bolivia represents the worst performer in continental South America. In regard to Peru, the country has approached the average throughout the rest of the continent.

The prevalence of undernourishment in children aged below five in continental South America went through a similar development as the prevalence for anemia. Peru was able to undergo the most successful development when compared to Bolivia and continental South America as a whole. Starting with a prevalence of undernourishment of 22 percent in 2000, Peru was able to reduce their numbers by 63.8 percent to 8 percent of the population being considered undernourished. Bolivia was only able to reduce their numbers from 33 percent to 20 percent.

Peru has made the largest reduction in this variable. To reaffirm this trend, the amount of kilocalories people were lacking in 1990 was 222 per person, reduced to 50 kilocalories in 2016. In Bolivia, there was 261 kilocalories deficit in the county in 1990, which was reduced to 104 kilocalories per person in 2016. Continental South America went from lacking 96 kilocalories per person to lacking 40 kilocalories in 2016. (World Bank, 2016g)

The Sustainable Development Goal Two is to bring the number of people suffering from undernourishment down to zero by 2030 (United Nations, 2019a).
The annual percentage change in Peru from 2000 to 2015 is set at minus 0.93 percentage points. Continuing with that trend, all other factors being equal, in 2030 they are likely to achieve the aforementioned goal. Bolivia's annual percentage change from 2000 to 2015 is set at minus 0.88 which, all other things being equal, will get them to 7 percent of prevalence of undernourishment in children below the age of five. An indicator that they may not reach the goal by 2030. Based on the historical average decrease, continental South America as a whole will end up at 4 percent of the population undernourished.

5.3 GDP per Capita (current US Dollar)

The GDP per capita describes the value of the entire number of goods and services that have been produced within a country in a particular year, divided by the number of people living in this country (World Bank, 2017a). The prevalence of anemia among children under five within continental South America is given in percentages as well as in percentage change. There is a correlation of -0.63 between GDP per Capita and the prevalence of anemia in children under five.

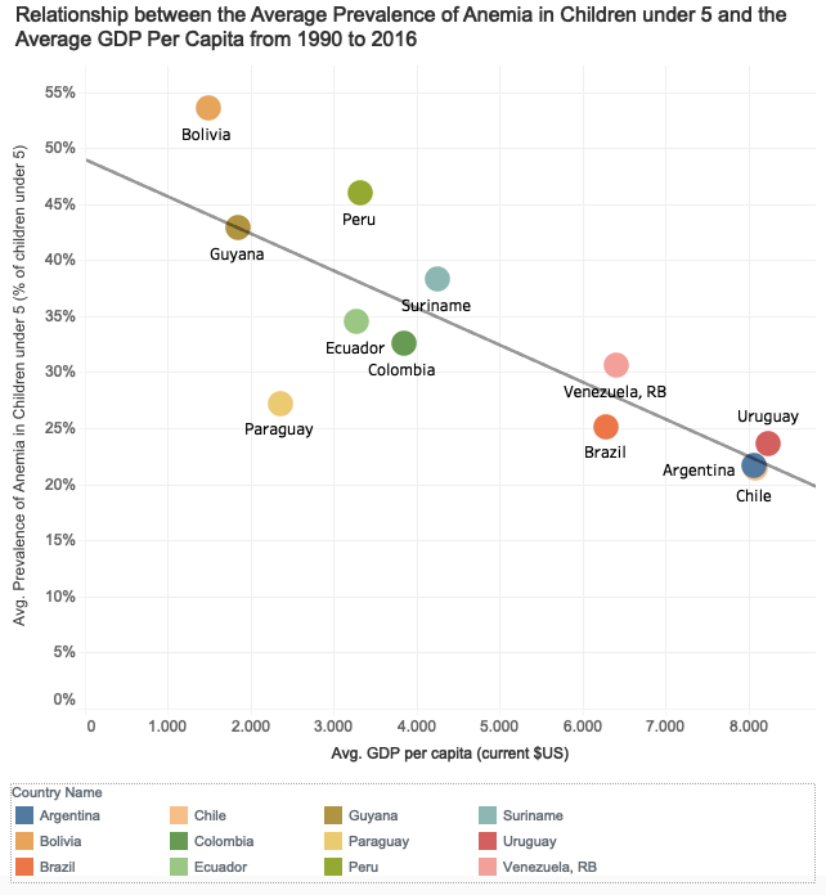

Figure 7: The relationship between the prevalence of anemia in children aged below five and the GDP per capita in continental South America covering data from 1990 to 2016

Source: Wor d Bank, 2016a; 2017a. Se f-generated

The graph above is displaying the correlation between the aforementioned variables and indicates an inverse relationship. The higher the GDP per capita in a certain country, the lower the prevalence of anemia in children below the age of five. As Bolivia is considered to be the poorest country in continental South America, this seems to explain their relatively high prevalence of anemia, the most in continental

South America. This is in contrast to a country like Chile, who experiences the lowest frequency of anemia in children under five while having the highest GDP per capita.

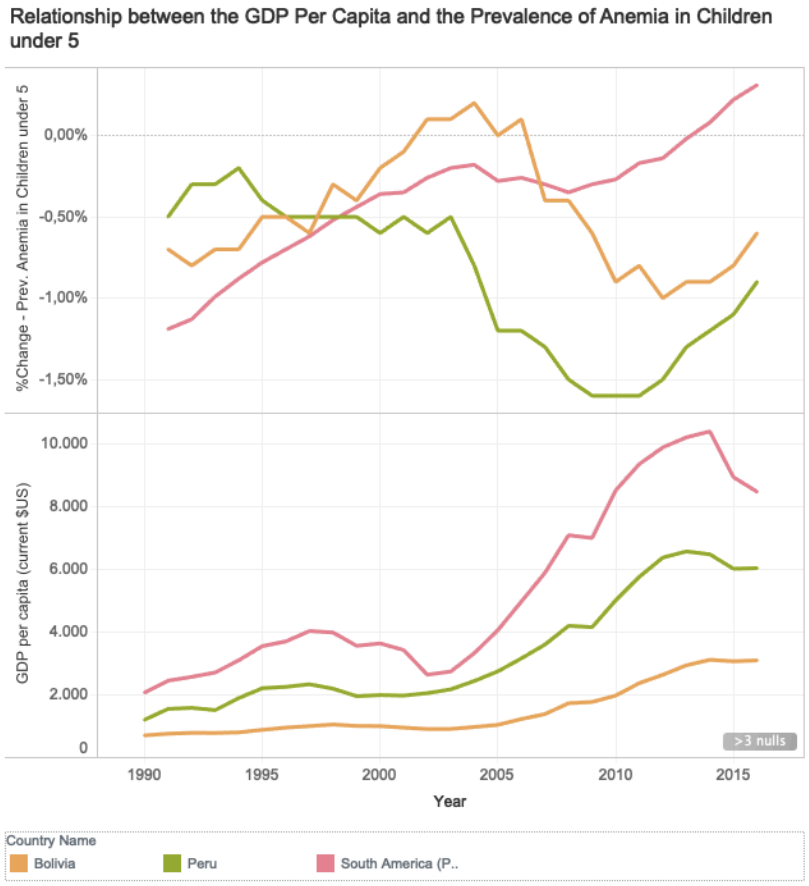

Figure 8: Development of the percentage change of the prevalence of anemia in children below age five and the GDP per capita in continental South America from 1990 to 2016

Source: Wor d Bank, 2016a; 2017a. Se f-generated

In 1990 Peru has had a GDP per capita at 1,210 US Dollars. They increased that amount by 340 percent to 6,049 US Dollars in 2016. It can be seen that since 2003, the GDP has been rising more steeply, just as the prevalence of anemia has been falling with the highest rates. The inverse relationship is more obvious when examining percentage change in regard to the prevalence of anemia.

Bolivia has under-gone a similar positive economic development throughout the given time period, increasing their GDP per capita by 337.3 percent from 710 US Dollars in 1990 to 3,105 US Dollars in 2016. Nevertheless, the discrepancy stays significant between GDP per capita rates in Peru and Bolivia. The difference of GDP per capita in Peru is nearly twice that of its neighbor. Similarly, continental South America has in-creased from 2,077 US Dollars in 1990 to 8,490 US Dollars in 2016.

Being an important part of the SDG agenda, a positive percentage change of the annual GDP per capita is considered to be correlated with an increase in the average standard of living for a country's population. Goal Eight is to promote economic growth and seeks for a minimum of seven percent yearly increase of the GDP per capita by 2030. (United Nations, 2019a)

Thus far, Peru and Bolivia have been successful in achieving this goal. If the current trend continues and if the relationship between GDP per capita and the prevalence of anemia in children under five is causal, we can expect to see further improvements in the latter.

5.4 Poverty Headcount Ratio at $1.90 a day

The most influential determinant of anemia, globally, is the state of poverty an individual or their family lives in (WHO, 2017a, p. 23). In this report, extreme poverty is measured by the amount of people living under the international poverty line of 1.90 US Dollars per day. Globally as well as in continental South America, there is an obvious correlation between the aforementioned variable and the prevalence of anemia in children below the age of five.

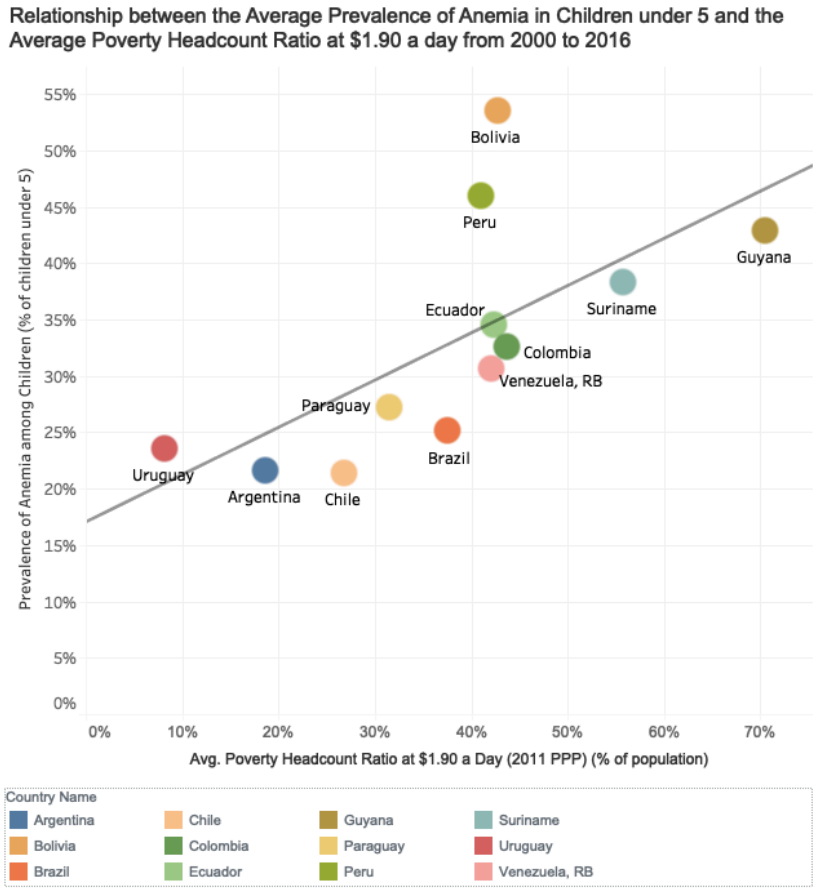

Figure 9: The relationship between the prevalence of anemia in children aged below five and the poverty headcount ratio at $1.90 in continental South America covering data from 2000 to 2016

Source: Wor d Bank, 2016a; 2017b. Se f-generated

The aforementioned variables share a positive correlation of 0.62, indicating that, the more people there are in a country living below the international poverty line, the higher seems to be the prevalence for anemia in children below the age of five.

Surprisingly, Bolivia and Peru, experienced similar rates as those experienced in Ecuador, Colombia, and Venezuela, in regard to the amount of people living below the international poverty line. Guyana and Suriname, while displaying higher numbers of those living under the poverty line, have lower prevalence of anemia for children in their countries, when compared to Bolivia and Peru.

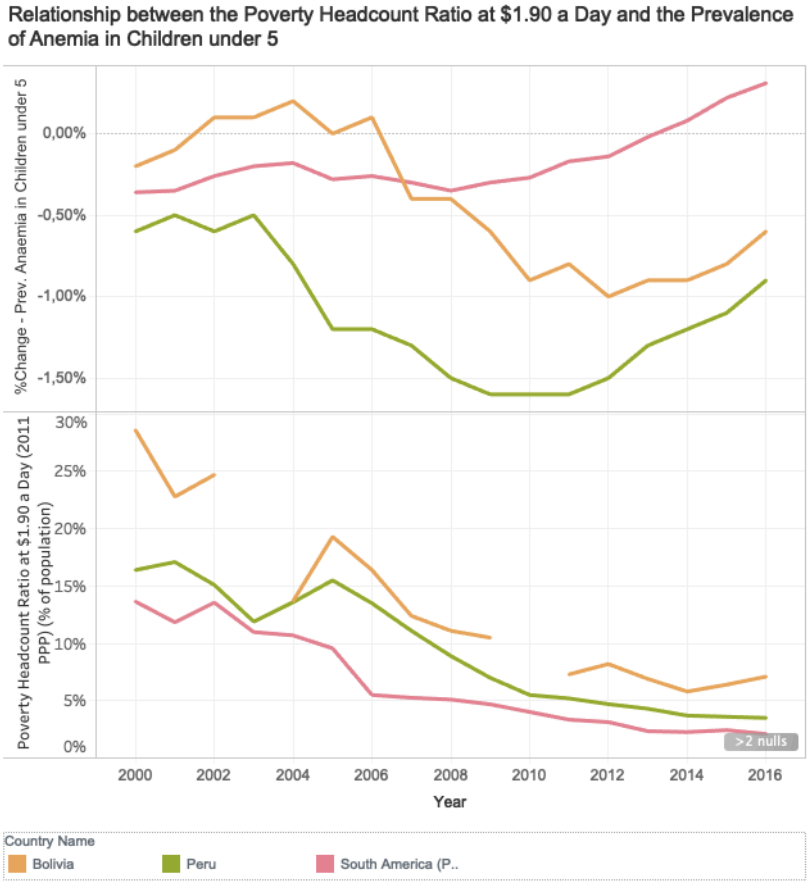

Figure 10: Development of the percentage change of the prevalence of anemia in children below age five and the poverty headcount ratio at $1.90 a day in continental South America from 2000 to 2016

Source: Wor d Bank, 2016a; 2017b. Se f-generated

Target One of Goal One on the SDG's agenda seeks to eradicate extreme poverty completely in all its forms by 2030 (United Nations, 2019a). When sticking to the trend Peru has undergone from 2000 to 2016, all other factor being equal, they will hit the target by 2022. If Bolivia's trend is to continue, they will hit this goal by 2025. Similar to GDP per Capita, the eradication of extreme poverty will most likely play a large role in the reduction of the prevalence of anemia in children under five.

5.5 Access to electricity (% of population)

Electricity and therefore energy, as described in previous literature, represents a valuable good for creating decent conditions for economic growth. Moreover, electricity is crucial for human development in regard to both, the individual's and the family's health condition. (World Bank, 2016c)

The connection between the access to electricity and health can be witnessed in the example with anemia in children in figure 11.

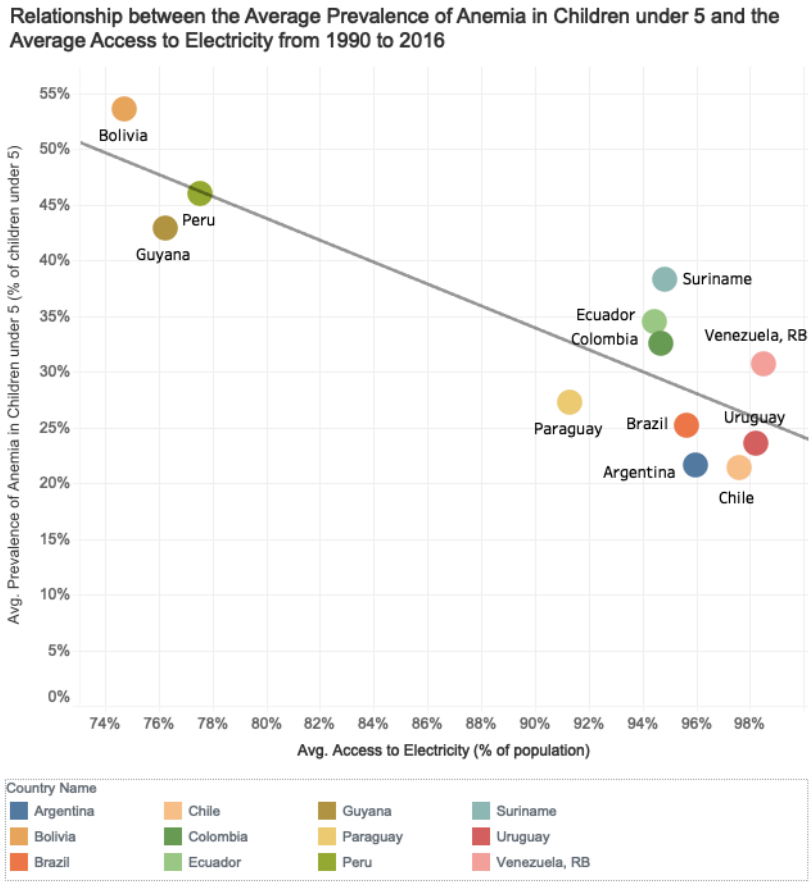

Figure 11: The relationship between the prevalence of anemia in children aged below five and the percentage of people having access to electricity in continental South America covering data from 1990 to 2016

Source: Wor d Bank, 2016a; 2016c. Se f-generated

In continental South America, including all twelve countries, the percent of the population with access to electricity has an inverse correlation of -0.81. This relationship indicates that the higher the proportion of the population with access to

electricity, the lower the prevalence of anemia in children below the age of five. When viewing this from the alternative perspective, the lower the penetration of electricity into society, the higher the prevalence of anemia in that country's youth can be expected. That is especially true for Bolivia, Peru and Guyana.
Taken the average data from 1990 to 2016, these three countries represent the highest anemia prevalence as well as the lowest proportion of people having access to electricity.

The development of Peru, Bolivia, and continental South America in terms of access to electricity can be witnessed in figure 12. In regard to the development of the percentage of people having access to electricity in continental South America, Bolivia and Peru have experienced similar success, as both countries have approached continental averages.

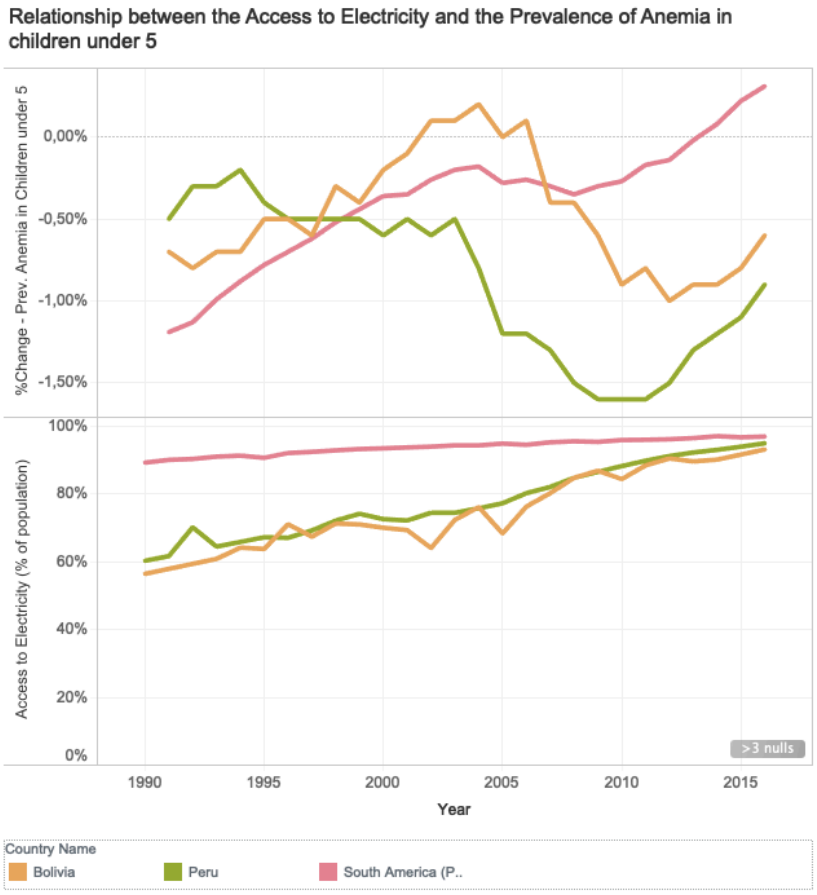

Figure 12: Development of the percentage change of the prevalence of anemia in children below age five and the percentage of people having access to electricity in continental South America from 1990 to 2016

Source: Wor d Bank, 2016a; 2016c. Se f-generated

There seems to be some diminishing returns to the effectiveness of electricity access in combatting the prevalence of anemia. In the context of Bolivia and Peru, it seems that once they hit the 84 percent of the population having access to electricity, further penetration has smaller effects. It could be the case, however, that some other external variable is slowing the reduction of the prevalence of anemia, regardless of gains made in electricity access.

Nonetheless, reliable and affordable access to electricity saves and improves lives. It is, therefore, incorporated into Goal Seven of the SDG agenda (United Nations, 2019a). By hitting percentages over the 90 percent mark in 2016 it seems to be likely, given the same conditions and no stagnating factors, that all countries throughout continental South America will achieve the goal of being able to provide affordable and sufficient access to electricity for everyone.

People using safely managed sanitation services (% of population)

Sanitation is crucial for human development. By improving the sanitation situation that people live in a significant positive effect on people's health can be shown. (World Bank, 2015b) The following graphs depict the relationship between the percentage of people using safely managed sanitation services in continental South America and the prevalence of anemia in children.

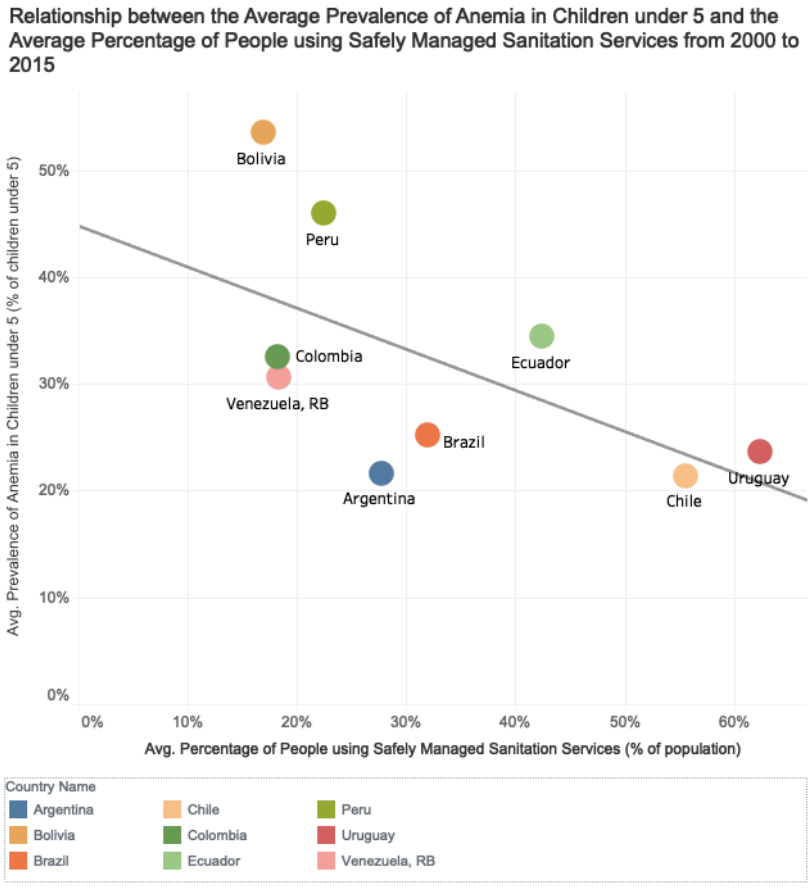

Figure 13: The relationship between the prevalence of anemia in children aged below five and the percentage of people using safely managed sanitation services in continental South America covering data from 2000 to 2015

Source: Wor d Bank, 2015b; 2016a. Se f-generated

The variables have an inverse correlation of 0.57. Said differently, as the amount of people using safely managed sanitation services rises a decrease in the prevalence of anemia is generally experienced.

As with other metrics, Bolivia represents the country with the least favorable results. It is the country with the least amount of people using safely managed sanitation services while also representing the highest prevalence of anemia in children below the age of five. Peru ranks fourth after Bolivia, Colombia, and Venezuela, in regard to the lowest performers in the sanitation metric.

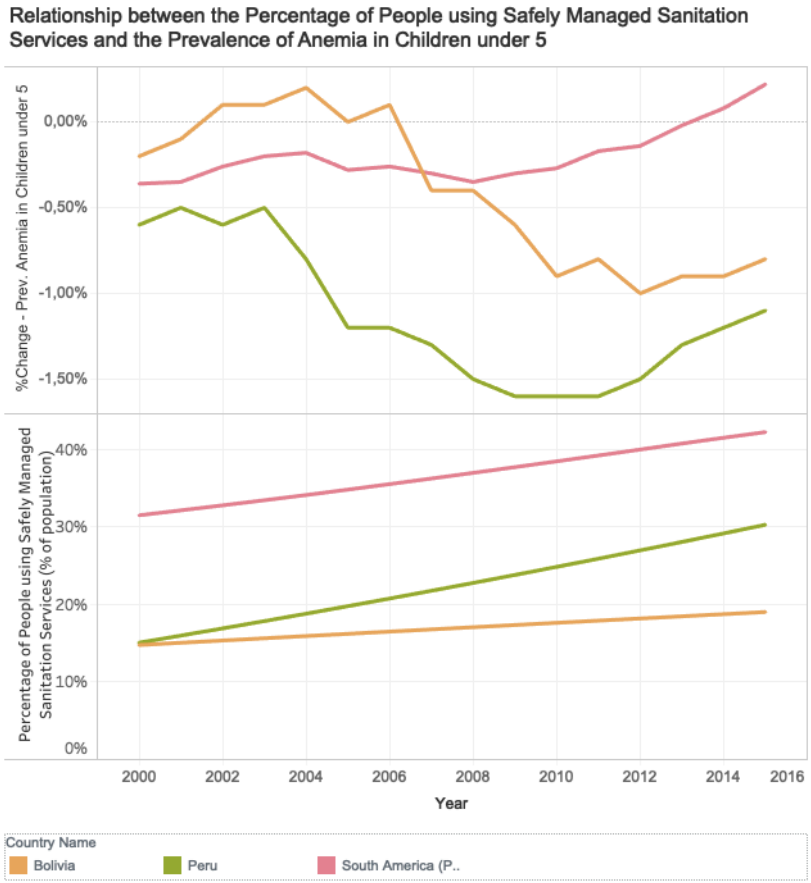

Figure 14: Development of the percentage change of the prevalence of anemia in children below age five and the percentage of people using safely managed sanitation services in continental South America from 2000 to 2015

Source: Wor d Bank, 2015b; 2016a. Se f-generated

Figure 14 displays the year-on-year change of the variables for Peru, Bolivia, and continental South America. Both Peru and Bolivia started with 15 percent of the population having access to proper sanitation.

Whereas Peru has doubled the pro-portion of people with access to sanitation, Bolivia has only increased by four percentage-points. However, nothing like Bolivia, Peru has developed with a very positive trend until 2015.

Goal Six on the SDG's agenda targeted for 2030 aims to provide access to adequate and equitable sanitation and hygiene for all and end open defecation, particularly paying attention to those in the most vulnerable situations. One indicator therefore is the access of the population to safely managed sanitation services. (United Nations, 2019a)

For Peru, Bolivia, and continental South America as a whole, the aforementioned target seems not to be achievable by 2030, when accounting for the trends from 2000 to 2015. More specifically, at the current rate Peru will end up at roughly 45 percent of the population having access to proper sanitation by 2030. The country that will end up the furthest away from providing adequate sanitation services will most likely be Bolivia. If their current trend persists into the future, they will end up with just 23 percent of the population in 2030 having access to adequate sanitation.

Completion rate of lower secondary education (% of females)

Globally, the completion of lower secondary education of females and, more specifically, mothers is an important factor in regard to the prevalence of anemia in children. The access to an adequate level of education and health information in women and mothers can be passed down to their children. (WHO, 2017a, p. 23) Furthermore, better jobs can be obtained, resulting in higher incomes and greater contribution to a country's economic development. Mothers will then be able to better provide for their children and give them a good nutrition. Education is therefore crucial to the prevention of anemia in childhood years. (Cotta & Fabiana de Cássia Carvalho Oliveira, 2011, p. 316)

For this report, the expected correlation between females' completion rates and the prevalence of anemia in children below the age of five in continental South America was not witnessed. That is to say, though education had been frequently highlighted in previous research, there was not a strong relationship between these two variables. Nonetheless, because of its prominence in previous research, it has been included here.

Despite the low correlation shown between both metrics, there are some conclusions that can be made from figure 15, which shows the development of lower secondary education completion of possible mothers. Surprisingly, Bolivia has been undergone the most successful development during the time period, with a 36 percentage-point increase in the number of possible mothers having completed lower secondary education, from 54 percent in 2001 to 90 percent in 2016. Peru, starting from a higher base, improved by 33 percentage points to 89 percent of possible mothers having secondary education.

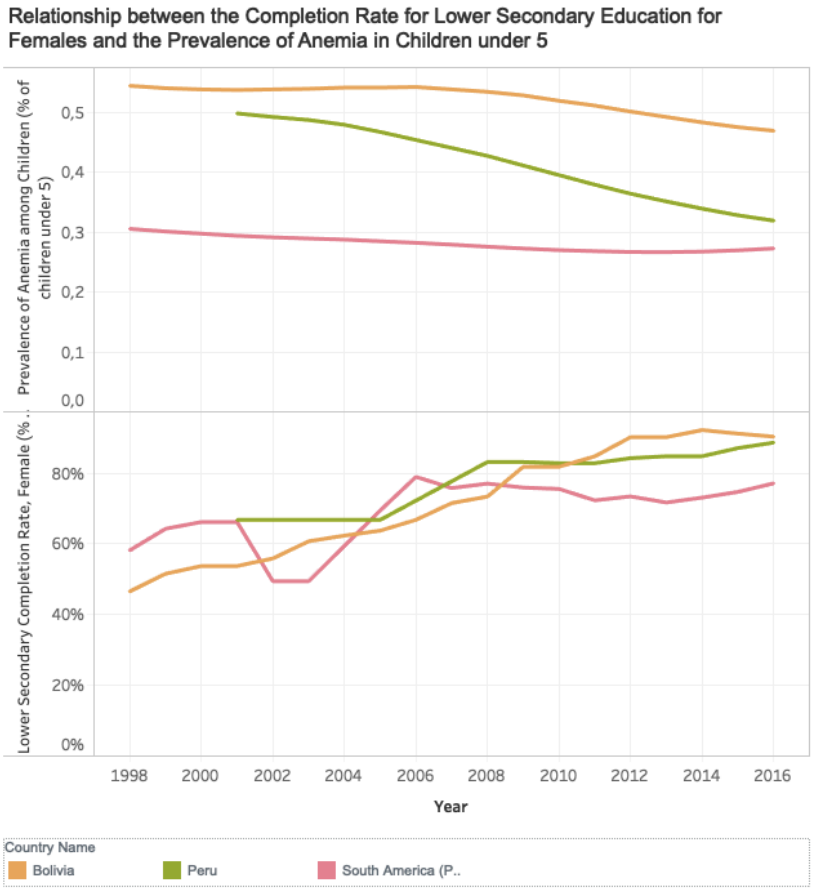

Figure 15: Development of the percentage change of the prevalence of anemia in children below age five and the percentage of possible mothers having completed lower secondary education in continental South America from 1998 to 2016

Source: Wor d Bank, 2016a; 2017f. Se f-generated

Due to the decrease in anemia prevalence in children under the age of five while secondary completion rates in females were increasing and the affirmation of previous research, it can be assumed that there is an inverse relationship between both variables. The steeper decrease of Peru's child anemia prevalence since 2003 in comparison to Bolivia and continental South America as a whole, however, cannot be explained by this relationship alone.

5.6 Rural Residence (% of population)

Life in rural areas is correlated to a lower standard of living, including impaired health status. Due to limited access to services and increased exposure to infection through poor living situations and a diet less diverse than in urban areas, people in rural residence face higher challenges in regard to the onset of anemia. (WHO, 2017a, p. 23)

Measured differently in every country, the count of percentage of rural population must be used with caution when making cross-country comparison. These are estimates by the World Bank and, as such, considered the most consistent data available for all countries. (World Bank, 2017c)

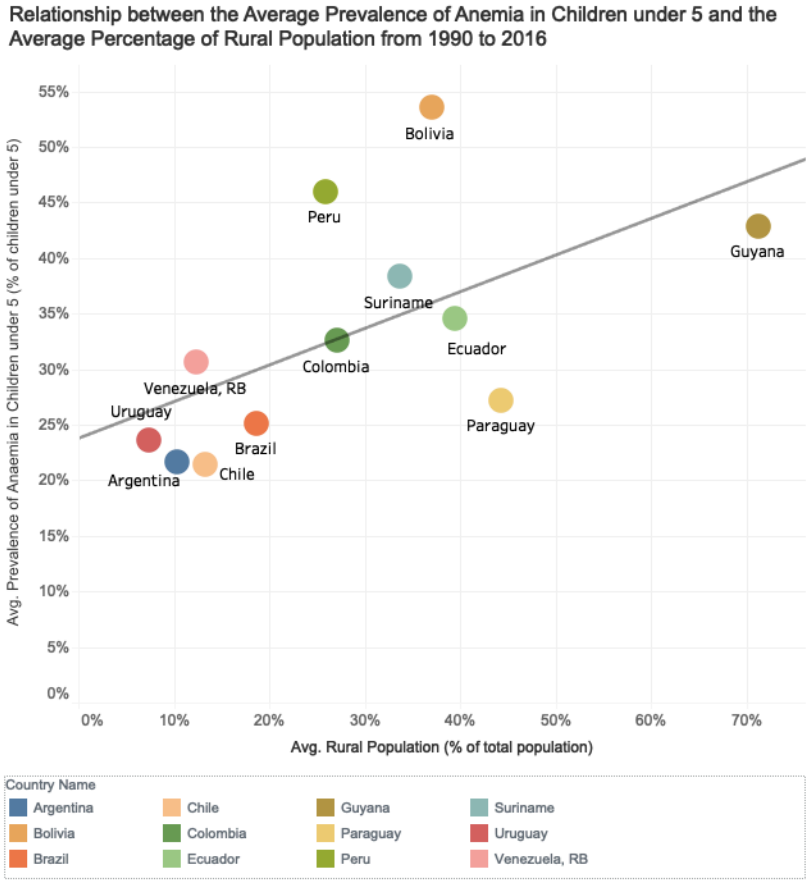

Figure 16: The relationship between the prevalence of anemia in children aged below five and the percentage of rural population in continental South America covering data from 2000 to 2015

Source: Wor d Bank, 2016a; 2017c. Se f-generated

The aforementioned variables share a positive correlation of 0.58. Decreasing numbers in the prevalence of anemia in children below the age of five accompany the reduction in the percentage of rural population.

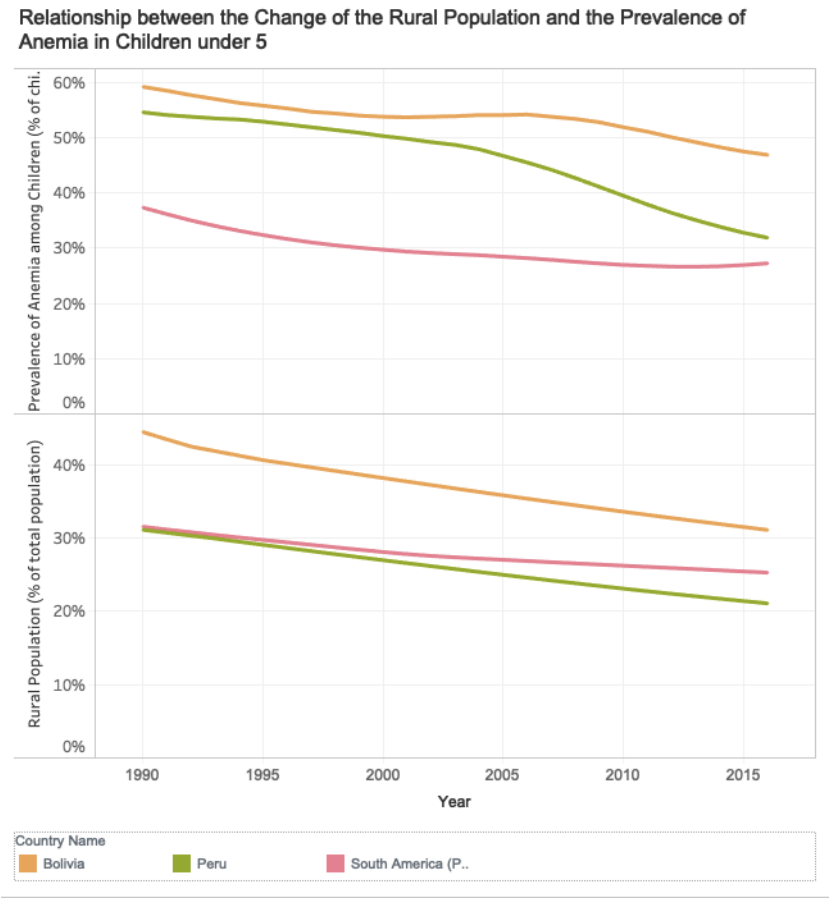

Figure 17: Development of the percentage change of the prevalence of anemia in children below age five and the percentage of rural population in continental South America from 1998 to 2016

Source: Wor d Bank, 2016a; 2017c. Se f-generated

Throughout the time period ranging from 1990 to 2016, Peru has experienced the most success in regard to reducing their percentage of rural population. They achieved an overall decrease of 10 percentage points, from 31 percent in 1990 to 21 percent in 2016. Though Peru ends with a smaller proportion of the population living in rural regions of the country, Bolivia experienced a larger percentage-point reduction during this time, going from 44 percent in 1990 to 30 percent in 2016.

GDP in rural areas represents lower numbers than then in urban areas. Because rural living and GDP per capita is closely linked, it is unsurprising that countries with higher proportions of rural residence also experience higher prevalence of anemia in children under five years of age.

6. Further Research

In this report, the prevalence of anemia in children under five has been examined under the lens of eight indicators. These indicators were identified from previous academic research as being correlated with the presence of this disease. This report used simple correlations to see how these indicators interacted with the main variable of interest in the context of continental South America. The dataset used in this report stretches from 1990 to 2016, though many countries and variables had large amounts of missing data throughout. Though this report reaffirmed many of the relationships identified in previous research, there remain many assumptions that must be recognized.

Firstly, this report has applied retrospective techniques, which can only provide information on correlations between variables. Moreover, this report utilizes bi-variate relationships. As such, it did not simultaneously account for information from other variables. The likelihood of one or more of these indicators, for example GDP per Capita and Percentage of the Population in Extreme Poverty, being strongly correlated is high. Exploring these relationships independently of one another leaves a cause for concern.

To address this issue, there are several solutions. In a world unbound by political and financial restrictions, the best solution would be to conduct a Randomized Controlled Trial (RCT) modeled to explore the various indicators previously high-lighted. More realistic would be to conduct a longitudinal study. Using a multivariable linear regression methodological approach, is suggested.

Further, program evaluations of already implemented nutritional policies as well as more robust data collection is greatly needed. Lastly, it would also be beneficial to conduct studies that emphasized biological factors not mentioned in the results section of this report. Were these to be included, they will help guide the pathway to effectively reduce the prevalence of anemia in children throughout continental South America.

7. Conclusion

This report has aimed to examine the underlying factors of Peru's success in regard to reducing their anemia prevalence in children below the age of five. The report has done so by comparing it to Bolivia, its Andean neighbor, and continental South America. Further, it shows the importance of achieving the Sustainable Development Goals in regard to the reduction of the prevalence of anemia, as these goals are related to indicators correlating with the onset of anemia. Differences in socio-economic factors across the continent have proven to be influential in the continued prevalence of this disease. Overcoming these barriers, Peru has accordingly had the largest and most positive development in the reduction of their anemia prevalence in children below the age of five. This is no more obvious than when compared to Bolivia. The stark differences between anemia reduction in Peru and Bolivia are, therefore, seemed to be related to changes in the determinants which have shown correlation with the prevalence of anemia in children.

Moreover, countries who successful achieve the SDGs will, most likely, greatly reduce the prevalence of anemia across all age groups. Since Peru has shown the greatest improvement in a great number of SDGs and, therefore, anemia indicators, all else being equal, they are more likely to continue to outperform Bolivia into the future.

Bibliography

Amerson, R., Miller, L., Glatt, M. & Ramsey, K., 2017. Assessment of Anemia Levels in Infants and Children in High Altitude Peru. *Global Journal of Health Science,* 9(7), pp. 87-95.

Balarajan, Y. et al., 2011. Anaemia in low-income and middle-income countries. *Lancet*, 2 August, Volume 378, pp. 2123-35.

Bardach, A. et al., 2015. Epidemiology of Malaria in Latin America and the Caribbean from 1990 to 2009: Systematic Review and Meta-Analysis. *Value in Health Regional Issues,* December, Volume 8, pp. 69-79.

Breymann, C., 2000. Assessment and Differential Diagnosis of Iron-Deficiency Anaemia during Pregnancy. *Clin. Drug Investig.,* May, Volume 19, pp. 21-27.

Brito, A. et al., 2015. Folate and Vitamin B12 Status in Latin America and the Caribbean: An Update. *Food and Nutrition Bulletin,* Volume 36, pp. 109-118.

Calis, J. et al., 2008. HIV-associated anemia in children: a systematic review from a global perspective. *AIDS,* 22(10), pp. 1099-1112.

Central Intelligence Agency, 2018. *The World Factbook - Mother's mean age at first birth.* [Online]
Available at: https://www.cia.gov/library/publications/resources/the-world-factbook/fields/352.html [Accessed 2 February 2019].

Corvalán, C., Garmendia, M. L., Jones-Smith, J. & Lutter, C. K., 2017. Nutrition status of children in Latin America. *Obesity Reviews,* 18(2), pp. 7-18.

Cotta, R. M. M. & Fabiana de Cássia Carvalho Oliveira, M., 2011. *Cadernos de Saúde Pública,* 27(2), pp. 309-320.

Ghosh-Jerath, S. et al., 2017. *Undernutrition and severe acute malnutrition in children,* London: THE BMJ.

Iglesias Vázquez, L. et al., 2019. Prevalence of Anemia in Children from Latin America and the Caribbean and Effectiveness of Nutritional Interventions: Systematic Review and Meta–Analysis. *Nutrients,* 11(183), pp. 1-20.

Institute for Health Metrics and Evaluation, 2019. *GBD Compare.* [Online] Available at: https://vizhub.healthdata.org/gbd-compare/ [Accessed 10 February 2019].

Kassebaum, N. J., Jasrasaria, R. & Naghavi, M., 2014. A systematic analysis of global anemia burden from 1990 to 2010. *Blood,* 123(5), pp. 615-624.

Khambalia, A. Z., Aimone, A. M. & Zlotkin, S. H., 2011. Burden of anemia among indigenous populations. *Nutrition Reviews,* 69(12), pp. 693-719.

Larsen, D. A., Grisham, T., Slawsky, E. & Narine, L., 2017. An individual-level meta-analysis assessing the impact of community-level sanitation access on child stunting, anemia, and diarrhea: Evidence from DHS and MICS surveys. *PLoS Neglected Tropical Diseases,* 8 June, 11(6), pp. 1-13.

López de Romaña, D. & Cediel, G., 2017. *Current Situation of Micronutrients in Latin America and the Caribbean: Prevalence of Defciencies and National Micronutrient Delivery Programs,* Lima: World Food Programme.

Metz, J., 2008. A High Prevalence of Biochemical Evidence of Vitamin B12 or Folate Deficiency does not Translate into a Comparable Prevalence of Anemia.. *Food and Nutrition Bulletin,* Volume 29, pp. 74-85.

Mujica-Coopman, M. F., Brito, A. & Lopez de Romana, D., 2015. Prevalence of Anemia in Latin America and the Caribbean. *Food and Nutrition Bulletin: Sage Journals,* Volume 36, pp. 119-128.

United Nations, 2018. *The Sustainable Development Goals Report 2018,* New York City: United Nations.

United Nations, 2019a. *E-Handbook on the Sustainable Development Goals Indicators,* New York City: United Nations.

United Nations, 2019b. *About the Sustainable Development Goals,* New York City: United Nations.

WHO and World Bank, 2017. *Tracking universal health coverage: 2017 global monitoring report.,* Geneva: Wolrd Health Organization.

WHO, 2014a. *Global Nutrition Targets 2025 - Anaemia Policy Brief,* Geneva: World Health Organization.

WHO, 2014b. *Global Nutrition Targets 2025 - Stunting Policy Brief,* Geneva: World Health Organization.

WHO, 2015. *The global prevalence of anaemia in 2011,* Geneva: World Health Organization.

WHO, 2016. *Malnutrition,* Geneva: World Health Organization.

WHO, 2017a. *Nutritional anaemias: tools for effective prevention and control,* Geneva: World Health Organization.

WHO, 2017b. *Global database on the Implementation of Nutrition Action (GINA).* [Online] Available at: https://extranet.who.int/nutrition/gina/en/programmes/1520 [Accessed 20 March 2019].

WHO, 2017c. *Global database on the Implementation of Nutrition Action (GINA).* [Online] Available at: https://extranet.who.int/nutrition/gina/en/programmes/1389 [Accessed 20 March 2019].

World Bank, 2015a. *Prevalence of undernourishment (% of population).* [Online]
Available at: https://data.worldbank.org/indicator/SN.ITK.DEFC.ZS
[Accessed 8 February 2019].

World Bank, 2015b. *People using safely managed sanitation services (% of population).* [Online]
Available at: https://data.worldbank.org/indicator/SH.STA.SMSS.ZS
[Accessed 2 February 2019].

World Bank, 2015c. *People using safely managed drinking water services (% of population).* [Online]
Available at: https://data.worldbank.org/indicator/SH.H2O.SMDW.ZS
[Accessed 5 February 2019].

World Bank, 2016a. *Prevalence of anemia among children (% of children under 5).* [Online] Available at: https://data.worldbank.org/indicator/SH.ANM.CHLD.ZS
[Accessed 4 February 2019].

World Bank, 2016b. *Prevalence of anemia among women of reproductive age (% of women ages 15-49).* [Online]
Available at: https://data.worldbank.org/indicator/SH.ANM.ALLW.ZS
[Accessed 4 February 2019].

World Bank, 2016c. *Access to electricity (% of population).* [Online]
Available at: https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS
[Accessed 14 February 2019].

World Bank, 2016d. *Physicians (per 1,000 people).* [Online]
Available at: https://data.worldbank.org/indicator/SH.MED.PHYS.ZS
[Accessed 17 February 2019].

World Bank, 2016e. *Coverage of social insurance programs (% of population).* [Online] Available at: https://data.worldbank.org/indicator/per_si_allsi.cov_pop_tot [Accessed 17 February 2019].

World Bank, 2016f. *Coverage of social insurance programs in poorest quintile (% of population).* [Online]
Available at: https://data.worldbank.org/indicator/per_si_allsi.cov_q1_tot
[Accessed 17 February 2019].

World Bank, 2016g. *Depth of the food deficit (kilocalories per person per day).* [Online] Available at: https://data.worldbank.org/indicator/sn.itk.dfct
[Accessed 20 January 2019].

World Bank, 2017a. *GDP per capita (current US$).* [Online]
Available at: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD
[Accessed 10 January 2019].

World Bank, 2017b. *Poverty headcount ratio at $1.90 a day (2011 PPP) (% of population).* [Online]
Available at: https://data.worldbank.org/indicator/SI.POV.DDAY
[Accessed 12 February 2019].

World Bank, 2017c. *Rural population (% of total population).* [Online]
Available at: https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS
[Accessed 2 February 2019].

World Bank, 2017d. *Children (0-14) living with HIV.* [Online]
Available at: https://data.worldbank.org/indicator/SH.HIV.0014
[Accessed 15 February 2019].

World Bank, 2017e. *Primary completion rate, female (% of relevant age group).* [Online] Available at: https://data.worldbank.org/indicator/SE.PRM.CMPT.FE.ZS
[Accessed 2 February 2019].

World Bank, 2017f. *Lower secondary completion rate, female (% of relevant age group).* [Online]
Available at: https://data.worldbank.org/indicator/SE.SEC.CMPT.LO.FE.ZS
[Accessed 15 January 2019].

World Bank, 2017g. *Prevalence of stunting, height for age (% of children under 5).* [Online] Available at: https://data.worldbank.org/indicator/sh.sta.stnt.zs
[Accessed 25 January 2019].

World Bank, 2017h. *Prevalence of underweight, weight for age (% of children under 5).* [Online]
Available at: https://data.worldbank.org/indicator/SH.STA.MALN.ZS
[Accessed 4 February 2019].

World Bank, 2018a. *Lower secondary school starting age (years).* [Online]
Available at: https://data.worldbank.org/indicator/SE.SEC.AGES
[Accessed 10 February 2019].

World Bank, 2018. *Fighting Malnutrition in Peru: Enhancing the Demand for and Supply and Governance of Health and Nutrition Services in Three Regions.* [Online] Available at: http://www.worldbank.org/en/results/2018/04/18/fighting-malnutrition-in-peru [Accessed 4 February 2019].

World Education News & Reviews, 2015. *Education in Peru.* [Online]
Available at: https://wenr.wes.org/2015/04/education-in-peru
[Accessed 3 February 2019].

Appendix

Appendix Table 1: Implementation of Nutrition Actions in Peru

Policy Name
GNPR 2009-2010: **1 Maternal, infant and young child nutrition** - Breastfeeding promotion and/or counseling – Infants (up to 1 year of age) - Complementary feeding promotion and/or counselling – Infants and young children - Counselling on nutritional support and care for people living with HIV – Pregnant/ lactating women with HIV/AIDS - Deworming – Infants and young children - Distribution of insecticide-treated bed nets – Family (living in same household) - Food distribution/ supplementation for prevention of acute malnutrition – Infants and young children and lactating/ pregnant women - Preventive malaria treatment – Women of reproductive age - Promotion and implementation of properly timed cord clamping – Newborns (to 28 days of age) - Promotion of improved hygiene practices including handwashing – All population groups **2 Obesity and diet-related NCDs** - Food-based dietary guidelines – All population groups - Implementation of legislation on marketing of unhealthy foods and beverages to children – All population groups - Labelling of food products – All population groups - Nutrient-based dietary guidelines – All population groups - Nutrition counselling – All population groups - Promotion of fruit and vegetable intake – All population groups - Removal/ reduction of trans fatty acids

- Salt reduction

3 School-based nutrition

- Growth monitoring and promotion – School age children
- Implementation of legislation on marketing of unhealthy foods and beverages to children – Preschool-age children
- Provision of safe water – Preschool-age children and school age children
- School feeding programs – Preschool-age children and school age children
- School milk scheme – Preschool-age children and school age children

4 Vitamin and mineral nutrition

- Complementary food fortification – Infants and young children
- Iron and folic acid supplementation – Pregnant women
- Iron supplementation – Pregnant women and preschool-age children
- Salt iodization – All population groups
- Vitamin A supplementation – Lactating women and preschool-age children
- Wheat flour fortification – All population groups

GNPR 2016-2017:

1 Infant and young children child nutrition

- Complementary feeding promotion and/ or counselling – Infants and young children
- Growth monitoring and promotion – Infants and young children/ preschool-age children
- Breastfeeding promotion and/ or counselling – Lactating women and pregnant women/ infants and young children

2 Nutrition and infectious disease

- Counselling on nutritional support and care for people living with tuberculosis – tuberculosis cases malnutrition

- Counselling on nutritional support and care for people living with HIV – HIV cases

3 Prevention and management of acute malnutrition

- Food distribution/ supplementation for prevention of acute malnutrition

4 Promotion of healthy diet and prevention of obesity and diet-related NCDs

- Food-based dietary guidelines
- Nutrition and health claims
- Ban or virtual elimination of industrial trans fatty acids – All population groups
- Media promotion of healthy nutrition

5 School health and nutrition

- Monitoring children's growth in schools – School age children
- School feeding programs – School age children

6 Vitamin and mineral nutrition

- Wheat flour fortification – All population groups

Micronutrient supplementation strategy for children aged 6-36 months:

- Multiple micronutrient powder (point-of-use-fortification) – Infants and young children

Source: (WHO, 2017b). Se f-generated

Appendix Table 2: Implementation of Nutrition Actions in Bolivia

Policy Name
Chispitas program 2006: - Iron supplementation – Infants and young children
Desnutrición Cero 2007: - Baby-friendly Hospital Initiative – Adult men and women - Complementary feeding promotion and/ or counselling – Infants and young children - Food distribution/ supplementation - Nutritional surveillance system – All population groups
GNPR 2009-2010: **1 Maternal, infant and young child nutrition** - Breastfeeding promotion and/ or counselling – Infants (up to 1 year of age) - Complementary feeding promotion and/ or counselling – Infants and young age children - Food distribution/ supplementation for prevention of acute malnutrition – Infants and young children - Management of moderate malnutrition – Preschool-age children - Management of severe acute malnutrition – Preschool-age children - Preventive malaria treatment – Women of reproductive age - Promotion and implementation of properly timed cord clamping – Newborns (up to 28 days of age) - Promotion and improved hygiene practices including handwashing – All population groups

2 Obesity and diet-related NCDs

- Food-based dietary guidelines – All population groups
- Implementation of legislation on marketing of unhealthy foods and beverages to children
- Labelling of food products
- Media promotion of healthy nutrition – All population groups
- Nutrition-based dietary guidelines – All population groups
- Nutrition counselling – Preschool-age children

3 School based nutrition

- Iron and folic acid supplementation – Preschool-age children
- Provision of safe water – Preschool-age children and school age children
- School fruit and vegetable scheme – Preschool-age children and school age children
- School milk scheme – Preschool-age children and school age children
- Vitamin A supplementation – Preschool-age children

4 Vitamin and mineral nutrition

- Complementary food fortification – Infants and young children
- Iron and folic acid supplementation – Pregnant women
- Margarine/ butte fortification – All population groups
- Multiple micronutrient powder (point-of-use fortification) – Infants and young children
- Multiple micronutrients supplementation – Pregnant women and preschool-age children
- Sugar fortification – All population groups
- Vitamin A supplementation – Lactating women and preschool-age children
- Wheat flour fortification – All population groups
- Zinc supplementation – Diarrhoea cases

GNPR 2016-2017:

1 Promotion of healthy diet and prevention of obesity and diet-related NCDs

- Front-of-pack labelling system – All population groups
- Guías alimentarias para la población Boliviana – Food-based dietary guidelines
- Nutrient-based dietary guidelines
- Nutrient declaration
- Ban or virtual elimination of industrial trans fatty acids
- Taxation and price policies
- Implementation of legislation on marketing unhealthy foods and beverages to children
- Nutrition education and counselling

2 Nutrition and infectious diseases

- Counselling on nutritional support and care for people living with HIV – HIV cases

3 School health and nutrition

- Programa Nacional de Alimentación Complementaria Escolar – School feeding programs – School age children
- Programa Nacional de Alimentación Complementaria Escolar – Nutrition education included in school curriculum – School age children
- Programa Nacional de Alimentación Complementaria Escolar – Monitoring children's growth in schools – School age children

4 Infant and young child nutrition

- Complementary feeding promotion and/ or counselling – Infants and young children
- Growth monitoring and promotion – Infants and young children and preschool-age children

- Breastfeeding promotion and/ or counselling – Lactating women and pregnant women and infants and young children
- Baby-friendly Hospital Initiative – Newborns (up to 28 days of age) and lactating women
- Feeding of LBW infants – Newborns (up to 28 days of age), lactating women and infants (up to 1 year of age)
- Infant feeding in the context of emergencies – Infants and young children, lactating and pregnant women

5 Prevention and management of acute malnutrition

- Food distribution/ supplementation for prevention of acute malnutrition – Infants and young children
- Management of moderate malnutrition – Infants, young children and preschool-age children
- Management of severe malnutrition – Infants, young children and preschool-age children

6 Vitamin and mineral nutrition

- Multiple micronutrient supplementation, including folic acid and iron supplementation – Pregnant women
- Multiple micronutrients supplementation, including vitamin A and zinc supplementation – Preschool-age children and school age children
- Wheat flour fortification – All population groups
- Oil fortification – All population groups
- Salt iodization – All population groups

Source: (WHO, 2017c). Se f-generated

Statutory Declaration

I declare that I have authored this thesis independently, that I have not used other than the declared sources and resources, and that I have explicitly marked all material which has been quoted either literally or by content from the used sources.

Hamburg, 03/20/2019