UNTANGLING THE EFFECT OF MATERNAL SCHOOLING ON CHILD
MORBIDITY AND MALNUTRITION IN PERU

A Dissertation in
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by
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ABSTRACT

In the last decades, along with an increase in educational opportunities in developing nations, there has been a reduction of educational disparities in terms of gender. Rising levels of schooling for females has potentially important societal consequences for the next generation of children in terms of their health and wellbeing. For this reason, it is necessary to explore the pathways through which maternal education is working to help improve child opportunities.

The relationship between maternal education and child health has been studied by a variety of scholars, and two main trends of research can be identified on this issue. One trend points out that maternal education does not have an effect or its effect is attenuated once socioeconomic status, the husband’s education, or geographical residence are controlled (Desai and Alva, 1998; Kovstead et al., 2002). The other trend indicates that maternal education has a positive effect on reducing child mortality and malnutrition as well as increasing the likelihood that a child receives immunizations, which reduce the child’s chances of contracting future diseases (Caldwell, 1979; Cleland, 1989; Streatfield et al., 1990; Muhuri, 1995; Hug and Tasmin, 2007).

Most of the aforementioned studies used multivariate techniques that mainly estimated the direct effect of maternal education on child health outcomes; few studies explored the indirect effects of maternal education on child health (Glewwee, 1999; Frost et al., 2005). For this reason, this dissertation follows the second trend around this topic and estimates the structural relationships between maternal education and child health outcomes in order to talk specifically about causal relationships.
This dissertation explores whether mothers who are more educated have children with better nutritional and morbidity status. The logic is that schooling increases the mother’s cognitive abilities to process information, which is expressed in better health practices as well as health knowledge. Therefore, a mother with more education has better reasoning in terms of health. For example, a more educated mother will take better care of her child in terms of immunizations and nutrition. In addition, we include other pathways (a woman’s autonomy and index of economic resources) that could be having an influence according to the maternal education literature. In addition, we tested new pathways or mediator variables by including violence against the woman, since several studies have shown a significant effect of this variable on child health outcomes (Osofsky, 1999; Subramanian et al., 2007; Heaton and Fortse, 2008; Silverman et al., 2009). Lastly, this dissertation explores the existence of heterogeneous effects related to the mother’s ethnicity, since child health outcomes could be working in a different way giving the cultural differences.

This dissertation develops a secondary data analysis using data from the 2013 Peruvian Demographic Health Survey. The data was collected during the year of 2013, and it is publicly available at the website of the National Institute of Informatics and Statistics of Peru. The Demographic and Health Survey has nationwide coverage and regional statistical representativeness. The sample is comprised of 6,386 children and 5,337 households located throughout all the regions in Peru. The main purpose of the DHS is to provide information about the health and demographics of the household members. It has information about the nutritional and morbidity status of children under five years old as well as socio-demographic information about their mothers and families.
The dependent variables used in the dissertation are height-for-age (z-score) for nutritional status and acute respiratory infection as well as diarrheal episodes for the morbidity status of the children. As the main independent variable, we used the number of years of schooling of the mother. Then, as mediator variables or pathways, we used the index of economic resources, an indicator built by the National Institute of Informatics and Statistics of Peru based on several variables like ownership of durable assets (e.g., fridge), adequate housing quality (floor, ceiling and walls), and access to basic services (e.g., electricity). A second mediator variable is the mother’s health practices. This latent construct is based on three observed indicators: i) the mother gave birth at an adequate medical facility; ii) the mother had iron tablets during her pregnancy; and iii) the mother does something to make water safer to drink. A third mediator is the mother’s health knowledge. This latent construct is composed of three observed indicators that reflect different types of health knowledge. The observed variables included are: i) knowledge about tuberculosis, ii) knowledge about AIDS/HIV, and iii) knowledge about contraceptive methods. A fourth mediator is the woman’s autonomy. This latent construct is composed of five indicators that reflect the mother’s participation in different decision processes at home. Finally, the last mediator is violence against the woman. This latent construct is composed of four indicators that reflect different types of violence against the woman. The types of violence considered are: i) control of situations by the husband or partner, ii) physical violence, iii) psychological violence, and iv) sexual violence. Lastly, as statistical controls, we included variables such as sex, the child’s age in months, birth order, birth weight, the mother’s age, number of years of schooling achieved by the mother’s husband or partner, number of children, mother is indigenous, overcrowding, and place of residency.

To test the importance of maternal education and the different pathways that affect child nutrition and morbidity status, we use a Structural Equation Modeling (SEM) analysis (Kline,
2005). This technique will allow us to explore the relationship between latent (or unobserved) and observed variables through a measurement model. Then, the structural model is used to estimate the relationship between latent and/or observed variables through an equation system with more than one dependent variable. This method allows us to take into account the fact that the independent variables may not be completely exogenous, but could depend on other observed characteristics or be mediator variables in a recursive or non-recursive model. Also, this modeling technique enables us to correlate the error terms of different equations in the system, making it easier to control for possible correlation of unobserved variables between different equations.

The analysis performed shows that maternal education has a statistically significant effect on improving child nutritional status, reducing acute respiratory infections, and reducing diarrheal episodes in children under five years old in Peru. However, when we estimate the full model with all structural paths, the direct effect of maternal education on all child health outcomes vanishes, indicating that it is fully mediated by the variables used in our analysis. In terms of indirect effects, for nutritional status, our results show that maternal education uses three out of the five pathways tested: mother’s health knowledge, mother’s health practices, and index of economic resources—even after holding constant different individual and family variables that are associated with child nutritional status according to the literature. Among the pathways, the biggest indirect effect of maternal education was through the index of economic resources (0.10 SD), followed by the mother’s health knowledge (0.07 SD) and the mother’s health practices (0.06 SD); the total effect of maternal education was 0.23 SD. Meanwhile, no pathway was statistically significant for diarrheal episodes and acute respiratory infections.
In terms of heterogeneous effects, we found differences based on ethnicity in the structural paths for child nutritional status. Our results show that for the indigenous population, the only pathway through which maternal education improves child nutritional status is the index of socioeconomic resources; for non-indigenous populations, it is also through the mother’s health knowledge and the mother’s health behavior. This finding is not surprising since indigenous populations in Peru have higher poverty rates than non-indigenous populations as well as lower social indicators such as level of schooling and access to health facilities, among others (Benavides et al., 2010). Therefore, it makes sense that the main effect of maternal education for indigenous populations was improving the living standards of the family, expressed in the index of socioeconomic resources.

We tested violence against women as a new pathway through which maternal education can improve child health. However, our results do not support this hypothesis since this path was not significant for nutritional status or child morbidity indicators. However, we found a negative and significant association between violence against women and child morbidity. This result shows how complex the dynamic of domestic violence is since has consequences not only for the mother’s own health but also for her child’s health.

This dissertation provides insights into the causal relationship between maternal education and child health. Through the analysis developed by looking at five different pathways and three different health indicators, we find that it is clear that maternal education has an effect on child nutritional status, and there are different pathways through which it improves child health. While maternal education does not have a causal relationship with child morbidity, this could be due to a measurement error with the indicators used since they could not adequately capture these health issues for children under five years old.
Finally, different health and educational policies could be considered based on these results. In terms of health policies, it is necessary to develop campaigns to inform the population about the child health benefits of taking iron tablets during pregnancy, giving birth in adequate health facilities, or making water safer before drinking it. In terms of educational policies, it is necessary to rethink the adult education programs in Peru; we need to get away from the idea that adult education programs are oriented toward teaching to read and write. It is necessary to develop cognitive skills in the adult population since such skills could help them make better decisions for themselves and the next generations of citizens in Peru.
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Chapter 1. Introduction

Several aspects validate the development of studies focused on the issues surrounding children. In the first place, the concept of children refers to a population that, on the one hand, is protected by rights that are defined in a number of treaties and conventions and, on the other, is characterized by its need for special care and attention. Both of these aspects are the first line of importance for managers and policymakers around the world.

Second, in terms of a long-term overview, the first years of life are particularly important, as they comprise the cognitive and psychosocial development of children, and any disturbance during them may subsequently create negative long-term effects (in adolescence and/or adulthood). For example, relevant literature indicates that child malnutrition is associated with low cognitive levels, lower income, and morbidity (Martorell, 1999; Alderman, 2004; Grantham-McGregor et al., 2007; Guerrant et al., 2008). The importance of adequate development is based on the future impact that these children will have on society as adults. In consequence, there is no possibility of a well-learned, informed, healthy or socially cohesive society if its members have not undergone a positive and complete development process during the first years of their lives.

Studies on the factors that hinder child development have brought attention to the factors specifically related to diseases in children and malnutrition, probably due to the mortality rates associated with both (Bartlett, 2002). Similarly, over the last few years, strategies to combat the rise of these issues have become the most important interventions focused on children.
UNICEF (2014) reported that although infectious diseases have declined, acute respiratory infections such as pneumonia remain the main cause of death in young children (five years old or younger) around the world, followed by gastrointestinal diseases such as acute diarrhea. According to this source, as of 2013, pneumonia, diarrhea and malaria were the main causes of deaths under the age of five (one third of all deaths), and the concentration of cases was highest in Sub-Saharan Africa and Southern Asia (UNICEF, 2014). The situation reflected by such data is sufficient reason for the problems related to child diseases to become an issue of public interest and the target of new policies.

Therefore, it is important to identify the factors associated with the incidence of these diseases in the child population, as they could later be the subject of public policy and national interest. According to Bartlett (2002), there is an urgent need to develop research that may contribute to an effective analysis of the situation surrounding the different child-related issues, especially research based on studies of local contexts.

Several researchers have studied the factors associated with child health, especially child malnutrition and morbidity. Within this literature, maternal schooling is a variable that has a significant effect on improving child health outcomes, not only in developed countries but also in developing countries. In this sense, different studies have found that maternal schooling reduces child malnutrition (Boyle et al., 2006; Chen and Li, 2006; Frost et al., 2005; Heaton et al., 2004; Chopra, 2003; Glewee, 1999; Joshi, 1994; Bicego and Boerma, 1993; Victora et al., 1992; Thomas et al., 1991), increases child immunization (Huq and Tasmin, 2008; De and Bhathacharya, 2002; Govindasamy and Ramesh, 1997; Gage et al., 1997; Dargent-Molina et al., 1994; Streatfield et al., 1990; Cleland and van Ginneken, 1988), and reduces child
morbidity (Hatt and Waters, 2006; Shah et al., 2003; Molback et al., 1997; Dikassa et al., 1993; Selwyn, 1990).

Despite numerous research studies about the association between maternal schooling and child health, there is a scarcity of research that explores the different mechanisms or channels through which maternal schooling affects child health, with most of them focusing on analyzing the direct effects of maternal schooling. Therefore, the main objective of this study is to untangle the different pathways through which maternal schooling can improve child health in a specific context such as poor communities in Peru.

1.1 The magnitude of child morbidity and malnutrition

1.1.1 The international context

Three of the millennium development goals are related to diseases and malnutrition in children (UN, 2005). The first millennium goal focuses on the reduction of extreme poverty and hunger in the world, and intends to reduce by half the number of people that experience hunger. The fourth millennium goal focuses on reducing the child mortality rates of the nineties by two thirds. Finally, the seventh millennium goal is related to the reduction of the number of people without basic water and sanitation services by fifty percent.

The World Health Organization estimates that during 2015, 5.9 million children under 5 years of age died. In comparison with 1990, the mortality rate decreased from 91 to 43 deaths per 1000 live births in 2013. These results were considerable, yet insufficient for reaching the fourth Millennium Development Goal (MDG) target in 2015. Almost half of the under-five
deaths (in general) occurred mainly in five countries: India (21%), Nigeria (13%), Pakistan (6%), Democratic Republic of the Congo (5%), and China (4%). Children in Sub-Saharan Africa are more than 15 times more prone to die before the age of five than children in developed countries (UNICEF 2014). And, regardless of age groups, in terms of the main causes of death in low-income countries, respiratory infections were in first place and diarrheal diseases in third place in 2012 (WHO, 2014).

UNICEF (2014) shows that these two diseases account for 24% of deaths of children under five years old, with 15% of them caused by acute respiratory infections, and 9% by acute diarrheal diseases. Also, these two types of diseases are the main causes of death when it comes to infectious diseases, particularly in Sub-Saharan Africa and Southern Asia. In the former, the rate of death is almost twice the rate of death in the latter, and is higher than twice the rate of death in all other regions of the world. Therefore, on average, eight out of ten deaths of children under five years old occur in Sub-Saharan Africa and Southern Asia; meanwhile, in Africa alone, four out of ten deaths are caused by diarrheal diseases, and five out of ten deaths by respiratory diseases (UNICEF, 2014).

For Latin America, a comparative report prepared by USAID (2004) found that this region has the highest prevalence of Acute Respiratory Infections (ARI) in children under three years of age (25%), followed by Sub-Saharan Africa with 22%. Within Latin America and the Caribbean, the countries that report the highest ARI prevalence rates are Haiti (43%), Nicaragua (33%), and Bolivia (26%). At the same time, the prevalence rate increases when only the poorest families in each country are considered: Haiti (54%), Nicaragua (40%), and Bolivia (28%). In terms of gastrointestinal infections, Haiti (33%), Bolivia (25%), and Peru (20%) are the countries with the highest rate of diarrhea for children under three years old. This
prevalence rate increases when only the poorest families are considered in Peru (24%) and Bolivia (26%), while the opposite occurs for Haiti (32%) when this differentiation is made.

In terms of child malnutrition\textsuperscript{1}, the global prevalence of stunting among children under five years old dropped from 40% to 24% between 1990 and 2014. The Western Pacific was the region with the largest improvement for this indicator, with its prevalence of stunting reduced by 26 percentage points, followed by the South Asia region with 25 percentage points of reduction, and Africa with 13 percentage points (UNICEF, WHO, and the World Bank, 2014). A similar trend was found by Onis, Blossner, and Borghi (2011), who showed that child malnutrition dropped in developed and developing countries over the last two decades, with Asian countries the most successful in reducing their prevalence rates from 49% in 1990 to 28% in 2010.

For Latin America, the Pan-American Health Organization (2008) did a regional comparative study on child malnutrition. The main results show that countries such as Guatemala (55%) and Bolivia (33%) have the highest prevalence rates of stunted children under five years old, while countries like Argentina (8%) and Dominican Republic (12%) have the lowest prevalence rates within the region. Also, it shows that countries reduced their prevalence rates around 8 percentage points over time, and Brazil was the most successful at reducing child malnutrition, reducing the percentage of stunted children by 21 percentage points from 1986 to 1996.

\textsuperscript{1} Malnutrition is considered to be an underlying variable related to approximately 45% of the deaths in children under 5 years old (WHO, 2014).
In sum, despite the improvements made to reduce child morbidity and child malnutrition across regions, they are still a global problem that remains nowadays, mainly in developing regions.

1.1.2 The local context

In the year 2000, the Ministry of Health of Peru prepared a report on child and adult mortality in Peru. The report concluded that for children under one year of age, gastrointestinal diseases, respiratory diseases, and nutritional deficiencies were the eighth, ninth, and tenth causes of mortality in Peru. By 2010, the picture was not much different. A report about the health situation in Peru produced by the Ministry of Health indicates that the main cause of death among the Peruvian population is acute respiratory infections, and this remains the same leading cause if we divide the sample into gender or age groups.

Another source of information used to better define the scenario of child morbidity and nutrition in Peru is the Demographic and Family Health Survey (Encuesta Demográfica y de Salud Familiar – ENDES), currently developed by the National Institute of Statistics and Informatics (Instituto Nacional de Estadística e Informática). However, only since 1991 has it been possible to monitor child morbidity and nutrition at national and regional levels, and to collect data on a greater range of indicators related to diseases such as respiratory infections, diarrhea, fever, anemia, and child malnutrition. For example, in 1991, the percentage of children under five years old that had had episodes of diarrhea during the two weeks prior to the survey was 18%, while this proportion decreased to 12% in 2014. The same pattern can be identified in some Peruvian regions such as Arequipa and San Martín, where the prevalence

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2 http://www.minsa.gob.pe/estadisticas/estadisticas/SalaSituacional/04_Mortalidad.pdf
3 However, Arequipa increased from 8% to 11% between 2009 and 2014.
rate has declined over time. However, there are regions where the prevalence rate has increased. For example, in Lima it went from 11% in 1991 to 12% in 2014, and in Ucayali from 21% to 24% during the same time period.

As for chronic malnutrition, the percentage of children suffering from this deficiency at a national level went from 37% of children under five years old in 1991 to 15% in 2014. The same pattern can be observed in Peruvian regions: Lima went from 14% in 1991 to 5% in 2014, and Loreto showed the greatest reduction, decreasing from 45% to 25% during the same time period. Even though figures are better now, one fifth of the population under five years old is still affected by malnutrition or growth faltering.

1.2 Study objectives

Different studies have found a strong and positive effect of maternal schooling on child health outcomes such as malnutrition, health practices, and morbidity, among others; however, few of them explore the indirect effects of maternal schooling or identify possible pathways through which this variable can affect child health outcomes. Therefore, the main objective of this study is to untangle the different pathways through which maternal schooling can affect health in Peruvian children, as well as explore new pathways in order to enrich the existing literature.

The specific objectives for this study are:

- Objective 1: Estimate the total effect of maternal schooling on child malnutrition and morbidity.
Most of the literature regarding this causal relationship estimates only the reduced model where maternal schooling has a direct effect on child health, holding constant the effect of different confounding factors in this relationship. Unfortunately, the reduced form does not provide the indirect effects of maternal schooling on child health.

- **Objective 2: Identify the different pathways through which maternal schooling affects child malnutrition and morbidity.**

Literature on the different pathways through which maternal schooling affects child health outcomes is scarce and mainly focuses on child malnutrition. Therefore this study proposes a conceptual framework using the existing literature, by testing the pathways already identified and proposing and testing the relationship of new pathways on child morbidity outcomes.

- **Objective 3: Identify heterogeneous effects in the relationship between maternal schooling and child health according to ethnicity.**

Taking advantage of the datasets that have information for Spanish and indigenous populations, this study explores the existence of heterogeneous effects on the pathways according to ethnicity, given the possible cultural differences between these two populations.

Answering these objectives helps to increase understanding and enrich the debate about the effects of schooling and its intergenerational effects on the next generation of children, increasing their opportunities in life.
1.3 Setting the context: The Peruvian case

Peru is located in the west side of South America. It borders Chile and Bolivia to the south, Brazil to the east, and Colombia and Ecuador to the north (see Figure 1). The territory of Peru encompasses 1,285,215 square kilometers and has a population of 30.5 million inhabitants. The capital is Lima, and it has around 8.6 million inhabitants, who represent one third of the total population (INEI, 2014).

Figure 1. Map of Peru

The country can be divided geographically and administratively. In terms of geography, Peru has three natural regions: coast (12% of land), highlands (28% of land) and jungle (60% of
land). In administrative terms, it is divided into 24 regions, 196 provinces, and 1854 districts (INEI, 2014).

The official language in Peru is Spanish and 84% of the population has this language as a mother tongue. However, there are 47 indigenous languages spoken in the country; Quechua is the main indigenous language since 83% of the total indigenous population has it as their mother tongue$^4$.

### 1.3.1 Education in Peru

The educational system in Peru has four levels: pre-primary, primary, secondary, and tertiary. However, only the first three levels of education are compulsory according to the General Law of Education passed in 2003. The pre-primary level is oriented to children between 0 to 5 years old, and it is divided into two cycles. The first cycle of pre-primary is oriented toward children from 0 to 2 years old, and its focus is to offer early stimulation and child care; while the second cycle is oriented toward children from 3 to 5 years old, and it is oriented toward developing cognitive and socio-emotional skills in children. The primary level is oriented toward children from 6 to 11 years old; it is organized into three cycles, and each one has two grades. The secondary level is oriented toward adolescents from 12 to 16 years old; it is organized into two cycles, where the first one has two grades, and the second one three grades. The tertiary level can be divided into technical higher education with a duration of two to three years and university higher education with a duration of five years.

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$^4$ It was calculated using the system of data inquiries for the National Census of Population and Household 2007 available online at the following link: http://censos.inei.gob.pe/Censos2007/redatam/
Education in Peru has shown significant progress during recent decades, as access to schooling has increased at all levels. This can be observed in the changes over time in the net enrollment rates at the pre-primary, primary, and secondary levels. According to the Statistical Unit of the Ministry of Education, between 2001 and 2013, net enrollment rates went from 54% to 79% for pre-primary, remained at 93% for primary, and increased from 69% to 82% for secondary\(^5\). In terms of educational investment, due to the economic growth in Peru in the last decade, investment increased from 2.8 percent of the Gross Domestic Product (GDP) in 2003 to 3.3% of the GDP in 2013, showing an increment of 0.7%\(^6\); however, this is far from the target of 6% of the GDP proposed in the General Law of Education.

1.4 Organization of the study

This research study is organized as follows: Chapter 2 gives a review of the literature on associated factors of child health as well as on the effect of maternal schooling and its possible pathways for affecting child health; Chapter 3 presents details of the data used for this study and a detailed description of the research methods; Chapter 4 presents the results of the descriptive and multivariate analyses performed; and finally, Chapter 5 summarizes and discusses the findings of the study as well as discusses the limitations of the study and future directions for research.

\(^5\) Information available online at the following link: http://escale.minedu.gob.pe/tendencias
\(^6\) Information on GDP was retrieved from the following link: http://datos.bancomundial.org/indicador/SE.XPD.TOTL.GD.ZS
Chapter 2. Theoretical framework

2.1 Defining the child health outcomes of interest

As we saw in a previous section, this study has as its main aim untangling the effect of maternal schooling on the prevalence of children’s diarrhea episodes, acute respiratory infections, and stunting. Therefore, it is necessary to have clear definitions of these three child health outcomes.

- **Diarrhea**: according to the World Health Organization (WHO), an episode of diarrhea is a situation in which a child has three or more liquid stools during a time period of 24 hours. Even though it is normal for a child to have episodes of diarrhea, it is clear that inadequate treatment may cause the child to lose too many fluids and suffer from dehydration, which may in turn cause death or a weakening of the immune system, exposing the child to other diseases (UNICEF-WHO, 2009).

  A study by Gunther and Fink (2010) in which Demographic and Health Surveys for 70 developing countries were applied, showed that the incidence of diarrheal diseases worldwide has a statistic peak in the group between 11 to 15 months of age. In this group, between 26 and 33% of the children had an episode of diarrhea within the two weeks prior to the date of the interview.

- **Acute Respiratory Infections**: according to the International Classification of Diseases, acute/lower respiratory infections affect the airways behind the epiglottis and include acute manifestations of laryngitis, tracheitis, bronchitis, bronchiolitis, lung infections
(pneumonia), or any combination of two of them or one of them with an upper respiratory infection, including influenza (Lanata et al., 2004).

The respiratory rate criteria recommended by Lanata et al. (2004) for acute lower respiratory infections is approximately 0.3 episodes per child per year, while for acute respiratory infections the rate is 4 to 5 episodes per child per year. However, measuring this type of infection is problematic due to the difficulty of identifying its symptoms, or differentiating it from other similar types of infection. Nonetheless, several studies have provided an overview of the prevalence of this disease in the child population.

- Child malnutrition: a child is considered malnourished if he or she has a shortage of protein-energy and micronutrients in his or her system. It is considered a health issue since both aspects render a person unable to face other diseases fully, and affect his or her physical and mental development. Therefore, even though malnutrition may not be a direct cause of death, it is a condition that serves as an indirect cause of a great number of deaths.

The classic anthropometric indicators of protein-energy malnutrition in children are weight-for-height (wasting), height-for-age (stunting), and weight-for-age (undernutrition). Of these three indicators, stunting indicates long-term nutritional deficiency, and is caused by a continuous and permanent situation. By contrast, wasting and undernutrition reflect a short-term period that takes or took place at a specific moment in the life of the child or the family (Miller and Rodgers, 2009). Therefore, stunting is a relevant health indicator to address for securing child life opportunities.
A child is considered stunted if his or her height-for-age is two standard deviations below the median of the growth reference tables from the National Center for Health Statistics or the World Health Organization (WHO), according to his or her age and gender. For this study, we used the WHO growth reference tables since they use a reference population from 2006, in comparison with NCHS tables, which have a reference population from 1999.

2.2 A conceptual framework for child health

One of the first studies providing insight into the various determinants and factors of child health and malnutrition is the study conducted by Mosley and Chen (1984). This study identified various groups of variables and economic indicators that can influence the health of a child. The groups of variables established by the researchers were: a) maternal factors, such as the mother's age and interchild intervals; b) air, water, and soil pollution in the environment where the child lives; c) nutritional deficiency related to a lack of nutrients—such as calories, proteins, and micronutrients—in children; d) accidents affecting a child’s health both within and outside the household; and e) disease control, related to preventive health behaviors such as immunizations, medical controls, etc. In this way, the study proposed that the five groups of variables above act as mediators between socioeconomic factors and child health.

Another study that provided a conceptual framework for exploring the determinants of child health is reflected in the report prepared by UNICEF in 1990. In this document, UNICEF presented a strategy to improve the nutritional health of children in developing countries, while providing a conceptual framework to identify the various levels and causes of child malnutrition (UNICEF, 1990). The levels listed in this conceptual framework are: a) basic causes, b) underlying causes, and c) immediate causes. In terms of basic causes, the study
provided a list of factors related to the context in which families live, such as the area of residence and poverty levels in the community or country. The level of “underlying causes” included variables related to access to health and sanitation services in the household or community (hospitals in the community, drinking water, sanitation, household food safety, etc.). Finally, the level of immediate causes was related to the mother's health behavior (e.g., proper child nutrition) and the child's health (e.g., diarrhea). In this way, UNICEF presented an outline on how these connections work. These conceptual frameworks were later used by several researchers to explain the different factors affecting child health, namely child morbidity and malnutrition.

Frongillo et al. (1997) took this conceptual framework as the basis for defining the main determinants of chronic and acute malnutrition in three regions of the world: Africa, Asia, and Latin America. Researchers concluded that the main factors that explain the variability of child malnutrition are illiteracy rates in mothers and availability of energy. Subsequently, Wamani et al. (2005) and Hien and Hoa (2009) provided conceptual frameworks similar to UNICEF's to explain child malnutrition in Uganda and Vietnam, respectively, while Aerts (2004) and Genser (2006) dealt with the issue in Brazil by evaluating the presence of diarrheal diseases in children under 5 years old using the conceptual framework established by Mostley and Chen (1984).

In sum, we used Hien and Hoa’s (2009) and Wamani et al.’s (2005) works to divide the associated factors with child malnutrition and child morbidity into three groups: a) inherent factors, b) distant factors, and c) intermediate factors. In a way, this organization responds to a hierarchy or proximity of factors that have an impact on a child's health.
2.2.1 Inherent factors

Inherent factors refer to child characteristics such as gender, age, birth order, and birth weight. Studies on child health have found that males are more prone to acute respiratory diseases or malnutrition (Senauer and Garcia, 1991; Espo et al., 2002; Koch et al., 2003; Wamani et al., 2004; Jones et al., 2008; Semba et al., 2008; Taguri et al., 2008). In the case of diarrhea, the effect of gender is unclear: some studies show that male children (Mock et al., 1993) are most likely to suffer from this type of disease, while the opposite is true for other studies (Shah et al., 2003).

With regards to age, the literature shows that smaller and younger children are more exposed to respiratory infections (Graham, 1990; Berman, 1991). In the case of diarrheal diseases, the study conducted by Gunter and Finkel (2010) determined that the connection between diarrhea and age is not linear (i.e., the possibility of an episode increases during the first months of life, but decreases after the age of 11 or 15 months). Similar findings were provided by Genser et al (2006) and Fuchs and Victoria (2002) for Brazil, with the only difference being the inflection or turning point for the threshold. The relationship between age and nutrition shows a positive proportion. Taguri et al. (2008) in Libya, Senauer and Garcia (1991) in the Philippines, and Bomela (2009) in Central Asia conclude that older children have a greater possibility of suffering from chronic or global malnutrition.

Regarding birth order, studies carried out in developing countries such as the Philippines (Horton, 1988), India (Behrman, 1988), Sri Lanka (Atupurane et al., 2008), Vietnam (Haughton and Haughton, 1997), and Ethiopia (Kebede, 2005) have found a negative relationship between birth order and child health outcomes, with the explanation that families are not able to allocate
the same amount of household and parental resources (time and economic) over time to their children.

In terms of birth weight, this factor has been exhaustively studied by researchers. Low birth weight children are more prone to having lungs that are not completely developed as well as incompletely developed immune systems, all of which increase their chances of contracting infections and suffering from respiratory conditions. Different studies have found an association between low birth weight and child health. Lira et al. (1996) conducted research in Brazil on children from birth until six months of age. The study found that low birth weight children are more likely to experience episodes of diarrhea and vomiting. Berman (1991) and Graham (1990), when reviewing the literature on the factors that influence acute respiratory diseases, found that low birth weight has a positive impact on this type of disease due to the poorly developed respiratory system in children. Regarding child malnutrition, it has been found that the association is positive i.e., low birth weight children are more likely to suffer from malnutrition. Studies conducted in Brazil (Aeerts et al., 2004; Marins and Almeida, 2002) and in Central Asian countries (Bomelo, 2009) on children under 5 years old show this association, even after several children and family factors are controlled.

2.2.2 Distal factors

Distal factors are related to household characteristics such as parents’ education, household socioeconomic level, and area of residence. Literature on the subject demonstrates that parents’—especially the mother's—education plays an important role in child health. Maternal schooling has a positive effect on child health outcomes: different studies found that more educated mothers have better nourished children (Glewwe, 1999; Frost et al., 2005) as well as
less chance of morbidity (Hatt and Waters, 2006; Molback et al., 1997; Selwyn, 1990). Regarding all the other variables, it has been found that the socioeconomic level of families (for example, income level or level of wellbeing) has a positive effect on child health. In that sense, higher-income families have better access to health services, which decreases the chances of their children suffering from respiratory or diarrheal diseases (Huttly et al., 1987; Senauer and Garcia, 1991; Genser et al., 2006) or from chronic or global malnutrition (Martorell et al., 1984; Vella et al., 1994; Kikafunda et al., 1998; Aerts et al., 2004; Jones et al., 2008; Semba et al., 2008).

Another distant factor is household food security. According to the World Food Summit of 1996, food security is “when all people have access to sufficient, safe, nutritious food to maintain a healthy and active life”. Studies developed by Alderman and Garcia (1994) in Pakistan, Hacket, Quiñonez, and Alvarez (2009) in Colombia, and Rah et al. (2010) in Bangladesh found a significant positive relationship between food security and child nutritional status, showing the relevance of securing healthy food at home for the normal development of children.

Regarding the area of residence, there are no clear results about the direction of the connection. Studies such as those conducted by Semba et al. (2008) in Indonesia and Bangladesh show that children under 5 years old are more likely to be malnourished, while Hien and Hoa (2009), in a study conducted in Vietnam, conclude that it is children under 3 years old in rural areas who suffer more from malnutrition, compared to their peers in urban areas. In the case of diarrhea and respiratory infections, there are not many studies that include samples from both urban and rural populations. A study on diarrheal diseases conducted in the Congo concluded that children under 3 years old in urban areas are 3 times more likely to have an episode of diarrhea
compared to children in urban areas. The effects caused by the area of residence may be attributed to the fact that inhabitants in rural zones do not have access to all basic services, and thereby lack better disease prevention programs from an early age. For children in urban zones, due to their development level and locale, rather than a paucity of resources they are exposed to more powerful environmental contaminants, which generate a greater susceptibility to diseases.

Finally, in terms of family ethnicity, Larrea, Montalvo and Ricaurte (2005) carried out a study in three Andean countries (Bolivia, Ecuador, and Peru) using Demographic Health Surveys. The authors explored the factors associated with child malnutrition for children under five years old, and one of their findings is that indigenous children (from Quechua or Aymara families) have a lower nutritional status than their Spanish peers, even after individual, family, and community characteristics are held constant.

2.2.3 Intermediate factors

Intermediate factors are related to health and hygiene practices carried out by mothers at home, such as: maternal age at birth, immunizations administered to the child, overcrowding, breastfeeding, child feeding practices, food and water storage practices, and waste disposal practices. The relationship between child health and maternal age at birth is explained by the fact that younger mothers have more stress and anxiety and less knowledge about how to raise a child; moreover, it is more probable that children of very young mothers have a low birth weight. These aspects demonstrate the negative relationship between the mother's age and child health, a fact supported by the existing literature on the matter.
Mock et al. (1993) conducted a study in the Republic of the Congo on children under 3 years old, and concluded that the children of younger mothers are more prone to having episodes of diarrhea. When it comes to acute respiratory diseases, Selwyn (1990) conducted a study in four developing countries (Colombia, Guatemala, Papua New Guinea, and Uruguay), and found that maternal age is negatively associated with the existence of respiratory infections in children under 5 years old in three of the four studied countries. Similar results are observed for children’s nutritional conditions. Larrea and Kawachi (2005) and Aerts et al. (2004) found a negative association between maternal age and cases of malnutrition in children under 5 years old in Ecuador and Brazil, respectively. In the study by Larrea and Kawachi, this association remained statistically significant even after the factors related to a child's parents were controlled.

Receiving all required immunizations during the first years of life is another factor related to the spread of various types of diseases that may later affect the normal development of children. Studies such as those conducted by Frongillo and Hanson (1995) and Milman et al. (2005) found a negative association between immunization rates and the presence of retardation in children under 5 years old in developing countries, which reflects the importance of disease prevention in low-income countries.

Another variable considered among the intermediate factors is the level of home overcrowding. The level of overcrowding is measured by the number of individuals per room in a house. Therefore, households with higher overcrowding levels generate less space for each member of a family, largely inadequate hygienic conditions, and poor ventilation in the home environment. Such aspects increase the risk of disease transmission, especially for children. In the case of acute respiratory diseases, Berman (1991), Graham (1990), and De Francisco et al.
(1993) have found a positive association between overcrowding and respiratory diseases in children aged less than 5 years. However, Selwyn (1990) found an opposite association: households with a higher number of people per room are less likely to contract a respiratory infection. Unlike acute respiratory infections, the pattern is clearer when it comes to malnutrition: higher overcrowding levels are associated with the presence of global and chronic malnutrition in children under 5 years old (Senauer and Garcia, 1991; Baig-Ansari et al., 2006; Semba et al., 2008; Bomelo, 2009; Hien and Hoa, 2009).

Breastfeeding plays an essential role in the child's nutritional level and the prevention of episodes of diarrhea and respiratory diseases. Consequently, the World Health Organization (WHO) recommends breastfeeding as a means of providing nutrients to children during their first year of life. Additionally, the WHO recommends exclusive breastfeeding, at least during the first six months of life, since breast milk provides all the energy and nutrients that a child needs during this period, specifically for preventing exposure to possible contaminants that may come from complementary nutrition or from the liquids and/or water that children in poverty receive during their first months of life. Lopez-Alarcon et al. (1997) conducted research in Mexico on children from birth until six months of age. Researchers found that children who were exclusively breastfed until four months of age were less likely to suffer from respiratory infections, unlike those who received supplementary feeding during this period. Berman (1991) also identified different studies in India where exclusively breastfed children had fewer chances of suffering from these types of infections.

Popkin et al. (1990) and Vanderslice et al. (1994) conducted studies in the Philippines, monitoring children during their six first months of life. Both studies found that children on an

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7 World Health Organization (http://www.who.int/nutrition/topics/exclusive_breastfeeding/en/)
exclusive breastfeeding diet during the six first months of life experienced fewer episodes of diarrhea than those who received a dietary supplement; even Popkin et al. (1990) found that children who received an additional supplement could be two or three times more likely to suffer from episodes of diarrhea. Karim et al. (2001) and Shah et al. (2004) have found similar results in Bangladesh and Pakistan, respectively, but in a sample of children under 5 years old.

For malnutrition, it is a different story, and studies report multiple findings regarding the role of breastfeeding. Hien and Hoa (2009), when conducting a study of children under 3 years old in Vietnam, found that this group is 4 to 6 times more likely (odds ratio) to be malnourished compared to children who received exclusive breastfeeding for 6 or more months. A different situation is reported in the studies by Martorell et al. (1984), Kikafunda et al. (1998), and Reyes et al. (2004) who conducted studies in Nepal, Uganda, and Mexico, respectively. Researchers found that a longer breastfeeding period has a positive effect on child malnutrition. Kikafunda et al. (1998) reported that children under 3 years old who have been breastfed for 18 months or more have a higher chance of suffering from malnutrition; on the other hand, Reyes et al. concluded that children under 3 years old who have been breastfed for 6 months or more are more likely to be malnourished.

Another factor in this group is children’s nutrition from their mothers after the first year of life. This aspect takes into consideration a mother's practices related to ensuring food diversity in the diet of her children, in such a way that they are provided a diet rich in the calories, proteins, and micronutrients required for adequate development. Literature on the link between food diversity and child health (morbidity and malnutrition) is not yet very developed, and only a few studies have explored this subject. Oyango et al. (1998) conducted a study in Kenya on children between 1 and 3 years old in order to explore the effects of breastfeeding,
supplementary nutrition, or food diversity on the children's nutritional status. The research indicated that breastfeeding has no significant effect on nutritional indicators but that such indicators improve in households where children receive a balanced diet. Sawadogo et al. (2006) studied children between 6 to 35 months of age in Burkina Faso in order to observe the connection between home nutrition practices and the nutritional status of children. The results of this study show that such practices have a negative effect on the children's nutritional status (either in terms of chronic or global malnutrition).

Finally, good hygiene practices enable households to be free of viruses and bacteria that may cause either stomach or respiratory tract infections, which result in episodes of diarrhea, respiratory diseases, and malnutrition in children. Several studies have illustrated this relationship and have found a negative association between adequate hygiene practices and child health. Dikassa et al. (1993), on a sample of children under 3 years in Zaire, found that the cases of mothers who properly dispose of their children's stools and household waste and maintain a hygienic household environment have a reduced presence of episodes of diarrhea. Mirza et al. (1997), on a sample of children in Kenya, and Taguri et al. (2008), in Libya, concluded that the households where deposits of water for home consumption are covered have children who show fewer episodes of diarrhea or malnutrition, respectively.

2.2.4 Domestic violence as a new variable within intermediate factors

As seen in the sections above, there are a series of factors that influence child health. However, in recent years, the role of domestic violence on child development and on aspects related to child health in particular, has become more widely acknowledged.
Studies conducted by Osofsky (1999), Subramanian et al. (2007), Heaton and Fortse (2008), and Silverman et al. (2009) brought to light the consequences of violence against women on child health and malnutrition. The study reported by Osofsky consisted of a review of the available literature describing the different consequences of domestic violence on child development in the United States. The literature review found a number of consequences of violent behavior such as excessive irritability, immature behavior, sleep problems, and even learning issues in children. Additionally, Subramanian et al. (2007) reported empirical evidence of a significant association between violence against women and the presence of episodes of asthma in children under 5 years old in India.

Silverman et al. (2009) conducted a study in Bangladesh to explore the connection between violence against women and the prevalence of diarrheal diseases and respiratory infections. The main findings of this study showed that children under 5 years old from women who have suffered domestic violence have greater chances of having an episode of diarrhea or a respiratory infection.

In Latin American, Ribero and Sanchez (2004) carried out a study in Bogota, Barranquilla, and Barrancabermeja (Colombia) to explore the relationship between violence against women and child health outcomes. They found that children from families in which the mother suffers from domestic violence are more prone to suffer from health problems such as fever or acute diarrheal infections. Similar findings were found in a study by Gaxiola and Frias (2005) with children in Mexico. They found that violence against women has a positive and significant relationship with the probability that a child suffered from diarrhea, colds, or bronchitis, and they explained this relationship.
Heaton and Fortse (2008) analyzed the relationship between child health and the presence or absence of violence against women in five countries: Bolivia, Peru, Colombia, Haiti, and Nicaragua. The research measured the child health level based on child mortality and nutritional status. The results showed that the presence of violence was a factor that influenced child malnutrition, and that the absence of female autonomy was associated with child mortality.

In Peru, Benavides et al. (2015) explored the effects of domestic violence (against children and women) on child nutritional status (stunting) and child morbidity (diarrhea and acute respiratory infections) for children under five years old using the Demographic and Health Survey for Peru. The authors found that there is no relationship between domestic violence (against children and women) and child malnutrition (stunting), but a positive and significant relationship was found between domestic violence (against women) and morbidity (diarrhea and acute respiratory infections). Similar findings were found by Agüero (2013) using a pool of the Demographic and Health Surveys from 2000 to 2011.

In sum, due to the strong evidence of the effects of domestic violence on a child’s health, this pathway has been incorporated into this study as another pathway through which maternal schooling can affect child health. Using previous conceptual frameworks with this addition, this research study establishes the following conceptual framework in order to identify and understand which factors affect child health outcomes, as well as place maternal schooling within this framework.
2.3 The different pathways through which maternal schooling affects child health

The previous section offered a conceptual framework for identifying and understanding the role of individual, family, and contextual variables for child health outcomes. Among them, maternal schooling is a key variable; it could be a target for educational policies since it has important societal consequences for the next generation of children in terms of their health and wellbeing (Gunes 2013).

In recent decades, there has been an increase in educational opportunities in developing countries, reducing gender-related educational disparities. The percentage of women in Latin American and Caribbean countries enrolled in secondary education rose from 77% in 1991 to
95% in 2013; in other words, the enrollment rate increased by 18 percentage points in just 22 years. Similarly, in Peru, the percentage of women enrolled in secondary education grew from 65% in 1991 to 93% in 2013 within the same period of time, illustrating the overall increase in access to schooling for females over time.

Increased access to schooling in Peru was accompanied by an improvement in different health and wellbeing indicators for women in the same time period. Thus, in the period from 1991 to 2013, fertility rates went from 4 births per woman to 2 births per woman, female life expectancy at birth went from 68 to 78 years old, and the labor force participation for women went from 52% to 68%. By the same token, improvements in child health outcomes could be seen as well during the same time frame. Health indicators like child malnutrition (stunting and wasting, or low weight-for-height) and morbidity (acute respiratory infections) for children under five years old showed a vast improvement. At the national level in Peru, the percentage of stunted children dropped from 37% in 1991 to 15% in 2014, and wasted children dropped from 11% in 1991 to 3% in 2014; and the incidence of acute respiratory infections dropped from 23% to 17% within the same period of time (INEI, 2014; INEI, 1991).

The increase in female schooling and the improvement of child health outcomes show that female schooling not only has consequences for women’s own health, but also has societal consequences for the next generation of children, in terms of their health and wellbeing. Various studies have explored the relationship between maternal schooling and child health. One of the seminal works in the field was carried out by Caldwell (1979) in Nigerian slums. The main finding of this study illustrated a strong correlation between maternal schooling and

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8 World Development Indicators, available online at the World Bank web page (http://data.worldbank.org/).
9 Ibid op cit.
child mortality in children under five years old, even after taking into account confounding factors like paternal schooling, mother’s occupation, and father’s occupation. This study started a body of research about the intergenerational effects of maternal schooling.

 Mothers with a higher level of education not only have access to greater resources (Desai and Alva, 1998), but they also have greater cognitive abilities that may increase their understanding of their children's diseases (Glewwe, 1999; Frost et al., 2005) and change their attitudes towards modern medicine and alternative treatments (Castro, Martin, and Juárez, 1995). Regarding all of the other variables, it has been found that the socioeconomic level of families (for example, income level or level of wellbeing) has a positive effect on child health. This could be explained because higher-income families have better access to health services, which decreases the chances of their children’s suffering from respiratory or diarrheal diseases (Huttly et al., 1987; Senauer and Garcia, 1991; Genser et al., 2006), as well as from chronic or global malnutrition (Martorell et al., 1984; Vella et al., 1994; Kikafunda et al., 1998; Aerts et al., 2004; Jones et al., 2008; Semba et al., 2008).

 Following this stream of research, some studies have found that maternal schooling acts as a protective factor for child health. Furthermore, they report strong associations between maternal schooling and different child outcomes like malnutrition (Boyle et al., 2006; Chen and Li, 2006; Frost et al., 2005; Heaton et al., 2004; Chopra, 2003; Glewwe, 1999; Joshi, 1994; Bicego and Boerma, 1993; Victora et al., 1992; Thomas et al., 1991), immunization (Huq and Tasmin, 2008; De and Bhathacharya, 2002; Govindasamy and Ramesh, 1997; Gage et al., 1997; Dargent-Molina et al., 1994; Streatfield et al., 1990; Cleland and van Ginneken, 1988), and morbidity (Hatt and Waters, 2006; Shah et al., 2003; Molback et al., 1997; Dikassa et al., 1993; Selwyn, 1990).
Despite the numerous research studies about the association between maternal schooling and child health, there is a scarcity of work that investigates the different mechanisms or channels through which maternal schooling affects child health. Glewwe (1999), using a sample of Moroccan children under the age of five, explores the different pathways through which schooling affects child nutritional status, and he found that maternal schooling works through health knowledge, literacy, and mathematics skills. However, two main flaws can be seen in this study. First, the author uses socioeconomic status as a control variable rather than as a possible mechanism through which maternal schooling may work. Second, the structural relationships among the variables are determined using a set of multivariate linear regressions instead of a whole system of equations that would allow measurement of the magnitude of the indirect and direct effects of maternal schooling.

Frost et al. (2005) used the Demographic Health Survey for Bolivia to explore the different pathways between maternal schooling and child health. The authors extended the set of mechanisms this variable employs to affect child health and added other potential channels (socioeconomic status, healthcare utilization, autonomy, and reproductive variables). The main finding of this study was that the strongest channel for maternal schooling is socioeconomic status, and the weakest one is women’s autonomy. At the same time, maternal schooling did not have an effect on child health through reproductive variables. However, similar to Glewwe’s (1999) study, one main limitation was the method used to explore the maternal schooling pathways, since it only assessed the moderating effects of the different variables used as pathways for maternal schooling.
Then, Aslam and Kingdon (2010) developed a study to explore the different pathways through which parental schooling impacts the health of children under five years old in Pakistan. These authors found that maternal schooling has a direct and positive effect on child height-for-age, as well as an indirect effect through labor force participation, access to media information, and health knowledge.

Adding to these oft-discussed pathways, this study will explore a new pathway that has received little empirical evidence. Recent studies have found an association between violence against women and child health outcomes. Subramanian et al. (2007) found a significant relationship between violence against women and the presence of asthma in children under the age of five in India. They found that children from women who suffer or have suffered psychological and/or physical violence have higher chances of asthma. Heaton and Forts (2008) conducted a multi-country analysis for this relationship using Demographic Health Surveys from Bolivia, Peru, Colombia, Haiti, and Nicaragua. The authors found that for the five countries, violence against women was associated with child malnutrition, with stronger effects in Bolivia and Peru.

In sum, these findings evidence the need to further explore factors affecting the relationship between maternal schooling and child health, since maternal schooling helps to reduce domestic violence at home given that more educated women develop a more egalitarian relationship with their partner, reducing the chances of physical or psychological abuse (Youndt et al., 2011; Bates et al., 2004; Jewkes, 2002; Hoffman et al., 1994; McCall and Shields, 1986).
2.4 What has been done about child health in Peru?

The studies on child morbidity and malnutrition in Peru are few, and it is possible to find several studies exploring these subjects only starting in the early 1990s. The first studies were focused on the relationship between diarrheal diseases and malnutrition (López de Romaña et al., 1989). However, in 1991, a study conducted by Yeager et al. in Lima explored the determinants of the incidence of diarrheal diseases in children under three years old in urban areas in Lima. The main conclusions of this study were that socioeconomic level and adequate water storage practices have a negative effect on the occurrence of episodes of diarrhea in children, on the one hand. And, on the other hand, inadequate child hygiene practices, lack of safe water to drink, and latrines or bathrooms outside the house have a positive effect on the occurrence of episodes of diarrhea. In 1997, Marquis et al. reported a study about children between 12 and 15 months of age from urban areas in Lima. This study explored the effects of breastfeeding, diarrhea, and child nutrition or diet on chronic malnutrition. The main findings showed that the
aforementioned variables are associated with child malnutrition. It was also observed that the interaction between breastfeeding, low nutritional content of food, and presence of diarrhea episodes in children result in a one-centimeter growth retardation.

Checkley et al. (2003) did a longitudinal study following a sample of 224 Peruvian children from birth to 35 months old. They demonstrated that the prevalence of diarrhea during the first year of life has a long-term effect on child growth. The results showed a height deficiency of 1.5 cm in the children who experienced diarrhea 10% of the time during their first twenty-four months of life. This fact reveals a vicious circle between malnutrition and diarrheic infections, which is in turn related to access to sanitation infrastructure in Peru as well as other variables such as socioeconomic level or maternal schooling at an international level.

Another study by Checkley et al. (2004), on children under three years of age in Lima, Peru, evaluated the presence of diarrhea and malnutrition (measured by the height-for-age ratio) and analyzed the subject in relation to access to sanitation infrastructure and drinking water. The conclusions of this study showed that children with access to adequate sanitation infrastructure (sewage systems) were, on average, one centimeter taller than those with no access to any type of sanitation infrastructure. Furthermore, children with worse sanitation conditions had 54% more episodes of diarrhea than their counterparts. This study also reported the relative inefficiency of access to drinking water without access to sanitation infrastructure on the reduction of diarrheal diseases and child malnutrition.

A similar study in a different city in Peru was conducted in the district of Belen, province of Loreto, by Casapia et al. (2007). This study explored the different factors associated with the nutritional level of children under 5 years of age. Researchers found that a child's age and
previous stomach infections are variables that are positively associated with his or her nutritional level, while the mother's educational level and her height are negatively associated with the presence of malnutrition in the children of Belen. Also in 2007, Shin conducted a study of the determinants of child malnutrition in Peru; however, unlike previous studies, Shin made use of Demographic and Family Health Surveys, which have representative databases at national and regional levels. The study concluded that a mother's age, educational level, first language (Spanish), socioeconomic level, and postnatal care have positive effects on her child's nutritional status.

Then, Baldarrago (2009) carried out a study to explore the effect of maternal schooling on child malnutrition status for children under five years old using the 2008 Demographic and Health Surveys. Using Two Stages Least squares, the study showed that maternal schooling has a direct and positive effect on child height-for-age (z-scores), as well as identified the mother’s literacy and access to media information as pathways that affect child nutritional status.

In this way, it can be seen that most studies on child health conducted in Peru have been focused on identifying the variables that are related to or determine the nutritional status of Peruvian children, while only a few studies have explored the determinants of child morbidity, particularly aspects such as gastrointestinal diseases and respiratory infections.
Chapter 3. Methods

This chapter outlines the methods used to address each of the objectives stated in the first chapter. This dissertation performs a secondary data analysis using publicly available data from Peru\textsuperscript{10}.

3.1 Data

The data used comes from the 2013 Peruvian Demographic Health Survey (called Encuesta Demográfica y de Salud Familiar, ENDES). The ENDES uses multi-stratified random sampling to represent the entire Peruvian population. The level of inference of the ENDES is national, including geographic location (urban and rural), natural regions (Coast, Highlands, and Jungle), and administrative regions (Amazonas, Lima, others).

A total of 27,620 households were sampled, yielding a household response rate of 98%. Within each sampled household, the ENDES selected women of reproductive age (between 15 to 49 years) and gathered information on fertility, marriage, family planning, health practices, infant and child mortality, childhood immunization, child nutrition, AIDS/HIV knowledge and attitudes, and domestic violence.

To construct a relevant sample for this study, a selection process of relevant observations was carried out. Selected for the sample were women who: i) had at least one child under five years old, ii) were married or cohabiting, and ii) answered the domestic violence section. This left us

\textsuperscript{10} Information about data collection and participant recruitment is available at the following link http://iinei.inei.gob.pe/microdatos/
with a sample of 5,337 women and 6,386 children. The fact that we took into account only women who fulfilled the previous criteria may have caused a sample selection bias, which in turn would have biased the standard errors. To check if this was the case we ran mean t-tests on the mother’s characteristics from the original ENDES sample\textsuperscript{11} and the analysis sample.

The following table shows the number of children and mothers included in the sample, divided by place of residency.

<table>
<thead>
<tr>
<th>Place of Residency</th>
<th>Children</th>
<th>Mothers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>3,483</td>
<td>3,017</td>
</tr>
<tr>
<td></td>
<td>(55%)</td>
<td>(57%)</td>
</tr>
<tr>
<td>Rural</td>
<td>2,903</td>
<td>2,320</td>
</tr>
<tr>
<td></td>
<td>(45%)</td>
<td>(43%)</td>
</tr>
<tr>
<td>Total</td>
<td>6,386</td>
<td>5,337</td>
</tr>
<tr>
<td></td>
<td>(100%)</td>
<td>(100%)</td>
</tr>
</tbody>
</table>

Source: Peru DHS 2013
Author’s elaboration

3.2 Instruments

The data used in the study (available in the ENDES) came from the following two instruments:

- **Household survey:** an instrument that was administered as an interview with the head of household. This instrument gathered information on: i) sociodemographic characteristics of the family members, ii) household characteristics, iii) participation in social programs, iv) chronic disease, v) women’s height and weight, vi) hemoglobin test results, vii) high blood pressure test results, and viii) iodine and chlorine test results.

\textsuperscript{11} This refers to the sample of women with a child under five years old and no husband or partner. The t-test analysis indicated possible sources of bias between the original and the analysis sample in some women’s sociodemographic characteristics. Therefore, the Inverse Mills Ratio was estimated and included in the different multivariate regression analyses performed, in order to obtain unbiased estimators (Heckman, 1979).
Women's questionnaire: an instrument that was an interview with all women of reproductive age between 15 and 49 years old. This instrument gathered information on: i) the woman’s background; ii) reproduction and birth history; iii) contraception; iv) pregnancy, postnatal care, and breastfeeding; v) immunization, health, and nutrition; vi) marriage and sexual activity; vii) fertility preferences; viii) husband’s background and woman’s work; ix) HIV/AIDS and other sexually transmitted diseases; x) maternal mortality; and xi) domestic violence.

Finally, in case the head of household or the woman selected spoke an indigenous language (mainly Quechua), the fieldworkers were trained to give all instructions in the native language of the respondent, and all questionnaires were also translated into his or her native language.

3.3 Measurements

The definitions of the variables of study are aligned with the objectives defined previously as well as with the review of international and local literature pertaining to the factors associated with child malnutrition and child morbidity.

The dependent variables used in the present study are:

- Height-for-age (z-score): a standardized score using the 2006 growth charts from the WHO. This continuous variable represents the long-term health (nutritional) status of the child because his or her height cannot change in the short term. For example, an illness cannot
make a child lose centimeters. Height is related to long-term nutrition and overall health care a child receives.

- **Acute respiratory infections (ARI):** a qualitative variable that takes a value of 1 if child had experienced a cough or had difficulty breathing in the two weeks prior to survey administration (children who had only a stuffy nose were excluded) and 0 otherwise.

- **Diarrhea:** a qualitative variable that takes a value of 1 if the child had episodes of diarrhea (three runs per day) in the two weeks prior to the survey, and 0 otherwise.

The main independent variable is:

- **Maternal education:** a continuous variable that represents the number of years of schooling achieved by the child’s mother.

The mediator (intermediate) variables used in the present study are:

- **Index of economic resources:** a composite score that represents the level of family wellbeing. The index comprises items related to the household’s ownership of selected assets (e.g., television, bicycle), materials used for housing construction, and types of water access and sanitation facilities at home. The items are combined using a principal components analysis. Thus, the index placed each household on a continuous scale of relative level of wellbeing.
- **Health knowledge**: a composite score that combines knowledge about different health issues into one latent score. Three indicators compose this variable. i) Knowledge about different facts and myths related to the transmission of tuberculosis. It is the sum of six different items, each coded as 1 if the mother has the knowledge and 0 otherwise (e.g., it is transmitted by coughing or sniffing). ii) Knowledge about different facts and myths about AIDS/HIV, which is the sum of ten different items. Each one is coded as 1 if the mother has the knowledge and 0 otherwise (e.g., AIDS can be transmitted by mosquito bites). iii) Knowledge about male and female contraceptive methods, which is the sum of sixteen items. Each one is coded as 1 if the mother has the knowledge and 0 otherwise (e.g., use of contraceptive pills). Baker et al. (2010) analyzed the effect of schooling on health behavior decisions using a similar indicator.

- **Health practices**: a composite score that combines different health behaviors at home into one latent score. Three indicators compose this variable: i) gave birth at a medical facility, ii) had iron pills during pregnancy, and iii) mother does something to make the water safer to drink.

- **Empowerment or female autonomy**: a composite score that combines different items related to household decision-making. Each item was coded as 1 if the woman made the final decision or made it jointly with the husband or partner, and 0 otherwise. The five items related to household decisions are: i) own health care, ii) household purchases for daily needs, iii) daily needs for cooking, iv) household purchases, and v) visits to family and relatives. Frost et al. (2005) and Smith-Greenaway (2013) analyzed the effect of female autonomy on child health outcomes using a similar variable.
• **Violence against the woman**: a composite score that combines different indicators related to intimate partner violence into one latent construct. Four indicators compose this variable: i) controlling relationship, a qualitative variable that takes the value of 1 if the mother suffers from any controlling situation (e.g., he frequently accuses her of being unfaithful); ii) psychological violence against the woman, a qualitative variable that takes the value of 1 if the husband mentally or emotionally abused her (e.g., the husband did something to humiliate her in front of other people); iii) physical violence, a qualitative variable that takes the value of 1 if the husband intentionally used force against her (e.g., the husband slapped her); iv) sexual violence, a qualitative variable that takes the value of 1 if the husband sexually abused her (e.g., the husband physically forced her to perform any sexual acts she did not want). These indicators are similar to the ones used in local (INEI, 2015) and international studies (Hindin, Kishor, and Ansara, 2008).

The control variables used in the present study are:

• Birth order: an ordinal variable that indicates the order in which the child was born within the household.

• Birth weight: a continuous variable that indicates the child’s weight when she or he was born.

• Gender: a qualitative variable that takes a value of 1 if the child is female and 0 if the child is male.

• Child's age: the age of the child in months.
- Mother's age: the age of the mother in years on the date of the survey.

- Indigenous mother: a qualitative variable that takes a value of 1 if the first language of the mother is indigenous and 0 otherwise.

- Maternal employment: a qualitative variable that takes a value of 1 if the mother has a job (full or part time) and 0 otherwise.

- Husband or partner’s education: a continuous variable that that represents the number of years of schooling achieved by the woman’s husband or partner.

- Overcrowding: a continuous variable obtained by dividing the number of household members by the total number of rooms destined exclusively for sleeping.

- Geographical area: a qualitative variable that takes a value of 1 if the household is located in an urban community and 0 otherwise.

3.4 Statistical strategy

To test the importance of maternal education and the different pathways through which it affects child nutrition and morbidity status, we use a Structural Equation Modeling (SEM) analysis. This technique allows us to explore the relationship between latent (or unobserved) and observed variables through a measurement model. Then the structural model is used to estimate the relationship between latent and/or observed variables through an equation system.
with more than one dependent variable. This method allows us to take into account the fact the independent variables may not be completely exogenous, but rather may depend on other observed characteristics or be mediator variables in a recursive or non-recursive model. Also, this modeling technique enables us to correlate the error terms of different equations in the system, making it easier to control for the possible correlation of unobserved variables between different equations.

- **Objective 1:** *Estimate the total effect of maternal schooling on child malnutrition and morbidity.*

To address this objective, a series of multivariate analyses were performed in order to estimate the net effect of maternal schooling on child morbidity and child malnutrition. However, the dependent variables are categorical since they indicate the presence or absence of stunting, acute respiratory infections, or diarrhea. Thus, it is impossible to use a simple linear regression model to estimate these probabilities since the dependent variable can only be one of two values, and drawing a regression line between these two points (absence = 0 and presence = 1) would lead to predicted values above one or below zero (negative values). Instead, a logistic regression model enables us to narrow these ranges by estimating the occurrence ratio of an event, in this case the prevalence of the child’s stunting/acute respiratory infections/diarrhea.

The model specification for estimating the effect of maternal schooling is:

\[
\ln \left[ \frac{p}{1-p} \right] = \beta_0 + \beta_1 \text{Maternal Schooling}_j + \Gamma \mathbf{M} + \zeta_j
\]

Where:

- \( p \): probability of occurrence of the event \( Y \), \( p(Y=1) \)
- \( p/(1-p) \): event occurrence ratio
- \( \ln [p/(1-p)] \): ratio logarithm (logit)
- \( \beta_j \): regression coefficients for maternal schooling
- \( \Gamma \): vector with regression coefficients between the dependent variable and
control variables at the individual, family, and community levels
\( M \): matrix with control variables at the individual, family, and community levels
\( \zeta_j \): random error term

From this model, the coefficient of interest is \( \beta_{1i} \), which is associated with maternal schooling. It is expected to have a significant negative effect on stunting/acute respiratory infections/diarrhea.

- **Objective 2: Identify the different pathways through which maternal schooling affects child malnutrition and morbidity.**

To identify the different pathways through which maternal schooling affects child health, it is necessary to change the model specification described in the previous objective. Instead of using a single equation, it is necessary to estimate a recursive model that can draw the direct and indirect effects of maternal schooling on child health. The following is the recursive system that is estimated in order to identify the different pathways through which maternal schooling affects child health:

**Dependent variables**

- Eq1a - Stunting: \( Y_1 = \beta_{12}Y_2 + \beta_{13}Y_3 + \beta_{14}Y_4 + \beta_{15}Y_5 + \beta_{16}Y_6 + \gamma_{11}X_{1j} + \Gamma_1M + \zeta_{1j} \)
- Eq1b - ARI: \( Y_1 = \beta_{12}Y_2 + \beta_{13}Y_3 + \beta_{14}Y_4 + \beta_{15}Y_5 + \beta_{16}Y_6 + \gamma_{11}X_{1j} + \Gamma_1M + \zeta_{1j} \)
- Eq1c - Diarrhea: \( Y_1 = \beta_{12}Y_2 + \beta_{13}Y_3 + \beta_{14}Y_4 + \beta_{15}Y_5 + \beta_{16}Y_6 + \gamma_{11}X_{1j} + \Gamma_1M + \zeta_{1j} \)

**Mediator variables**

- Eq2 - Wealth index: \( Y_2 = \gamma_{21}X_{1j} + \Gamma_2M + \zeta_{2j} \)
- Eq3 - Health knowledge: \( Y_3 = \gamma_{31}X_{1j} + \Gamma_3M + \zeta_{3j} \)
- Eq4 - Health practices: \( Y_4 = \gamma_{41}X_{1j} + \Gamma_4M + \zeta_{4j} \)
- Eq5 - W. empowerment: \( Y_5 = \gamma_{51}X_{1j} + \Gamma_5M + \zeta_{5j} \)
- Eq6 - Violence against w.: \( Y_6 = \gamma_{61}X_{1j} + \Gamma_6M + \zeta_{6j} \)

Where:

\[ Y_1 = \ln \left( \frac{p}{1-p} \right),\text{ probability of occurrence of the event } Y_1,\text{ } p(Y_1=1) \]

...\[ Y_6 = \ln \left( \frac{p}{1-p} \right),\text{ probability of occurrence of the event } Y_6,\text{ } p(Y_6=1) \]

\( \beta_j \): regression coefficients between the dependent variable and mediator variables

\( \Gamma \): vector with regression coefficients between the dependent variable and control
variables at the individual, family, and community levels.

\[ \text{M} \quad \text{matrix with control variables at the individual, family, and community levels} \]

\[ \zeta_{ij} \quad \text{random error terms, and cov}(\zeta_{i}, \zeta_{j}) = 0 \]

Then maximum likelihood estimation is used to obtain all of the parameters in the recursive system. Finally, a chi-square test is used to check the model fit since it provides the likelihood ratio between the estimated model and the saturated one (unstructured). The null hypothesis is that there are no differences between the two of them, and the estimated model is adequate.

- **Objective 3: Identify heterogeneous effects in the relationship between maternal schooling and child health by ethnicity.**

To test for heterogeneous effects by ethnicity on the pathways between maternal schooling and child health, multiple-group models are used. This statistical strategy allows us to examine how the final model works across different groups, by testing if regression and covariance parameters vary across them.

In order to test parameter invariance across groups, a chi-square difference test is performed (Kline, 2005), where the chi statistic of the constrained and unconstrained model is compared. The former model is the one that assumes parameter invariance.

\[
\Delta \chi^2 = [\chi^2(\text{unconstrained}) - \chi^2(\text{constrained})] \quad \text{with,}
\]

\[
df(\Delta \chi^2) = df[\chi^2(\text{unconstrained})] - df[\chi^2(\text{constrained})]
\]

If the difference is statistically significant, the parameters across groups are different.
Chapter 4. Descriptive and multivariate analysis

The present chapter presents the analysis performed using the 2013 Peru DHS. This chapter has three sections. The first one gives an overview of the prevalence rates for each dependent variable. In addition, it shows the child and family characteristics according to the incidence of child health issues, showing if there are any statistically significant differences. The second section presents the main results of the measurement models estimated to obtain the latent constructs that reflect the different pathways that are tested. Finally, the last section shows the structural relationships between maternal education and the different child health outcomes in the study.

4.1 Descriptive results

In terms of chronic malnutrition, the following figure shows that around 16% of the surveyed children suffer from chronic malnutrition (below -2 SD). Those more likely to suffer from this health issue are boys (17%), children from indigenous mothers (34%), and rural children (25%). These results show that despite the significant improvement and reduction of chronic malnutrition in Peru, prevalence rates are still high in the population groups that need more attention, like rural areas and the indigenous population in Peru.
In terms of child and family characteristics and the prevalence of chronic malnutrition, the following table shows the mean averages for each independent variable considered in the analysis. Concerning child characteristics, there are statistically significant differences for all the variables considered, showing that malnourished children are mainly boys, older, with a low birth weight, and the last child in the family. In relation to family characteristics, most of the variables are significantly different between malnourished and non-malnourished children. Thus malnourished children live in families where the husband’s mother has low education, the mother is indigenous, the mother is more likely to work, there are more siblings, and there are few economic resources at home.
Table 2. Characteristics of the child and family by prevalence of malnutrition

<table>
<thead>
<tr>
<th></th>
<th>All sample</th>
<th>Chronic malnutrition (No)</th>
<th>Yes</th>
<th>Difference (No - Yes)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Child characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age in months</td>
<td>29.95</td>
<td>29.55</td>
<td>32.06</td>
<td>-2.51</td>
</tr>
<tr>
<td>Child is female</td>
<td>0.50</td>
<td>0.51</td>
<td>0.47</td>
<td>0.04</td>
</tr>
<tr>
<td>Birth weight</td>
<td>3231.52</td>
<td>3282.28</td>
<td>2925.39</td>
<td>356.89</td>
</tr>
<tr>
<td>Birth order</td>
<td>2.74</td>
<td>2.61</td>
<td>3.48</td>
<td>-0.87</td>
</tr>
<tr>
<td><strong>Family characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother’s age</td>
<td>29.90</td>
<td>29.89</td>
<td>29.95</td>
<td>-0.06</td>
</tr>
<tr>
<td>Husband/partner’s education</td>
<td>8.96</td>
<td>9.27</td>
<td>7.32</td>
<td>1.95</td>
</tr>
<tr>
<td>Indigenous mother</td>
<td>0.14</td>
<td>0.11</td>
<td>0.31</td>
<td>-0.19</td>
</tr>
<tr>
<td>Mother works</td>
<td>0.55</td>
<td>0.54</td>
<td>0.60</td>
<td>-0.06</td>
</tr>
<tr>
<td>Number of children</td>
<td>2.92</td>
<td>2.77</td>
<td>3.74</td>
<td>-0.97</td>
</tr>
<tr>
<td>Overcrowding</td>
<td>3.34</td>
<td>3.26</td>
<td>3.81</td>
<td>-0.55</td>
</tr>
<tr>
<td>Index of economic resources</td>
<td>-0.21</td>
<td>-0.09</td>
<td>-0.87</td>
<td>0.78</td>
</tr>
</tbody>
</table>

Note: Differences in bold indicate statistical significance at 5% according to the t-test for independent samples
Source: 2013 Peru DHS
Author’s elaboration

Concerning the prevalence of acute respiratory infections, the following figure shows an interesting picture. Children who suffer from this health problem are 31% of the surveyed children; in other words, 3 out of 10 children in Peru have an acute respiratory infection. The groups that are more likely to suffer from an ARI are male (33%), children from non-indigenous mothers (30%), and children who live in urban areas (34%). These results are interesting since children from non-indigenous mothers as well as urban children are more prone to suffer from ARI, showing that these health issues are not necessarily concentrated in underprivileged populations.
Figure 5. Prevalence of acute respiratory infections by child’s sex, ethnicity, and geographical location

The following table shows the differences in child and family characteristics divided by prevalence of ARI. In terms of child characteristics, children who suffer from ARI are more likely to be older, male, and the youngest child in the family, in comparison with those who do not suffer from ARI. In terms of family characteristics, as we saw previously, children from underprivileged groups are not necessarily those who suffer from ARI. In the following table, we could see that children who suffer from ARI tend to be from non-indigenous mothers, families with fewer children, homes where the mother’s husband is more educated, families with more economic resources.
Table 3. Characteristics of the child and family by prevalence of acute respiratory infections

<table>
<thead>
<tr>
<th></th>
<th>All sample</th>
<th>No</th>
<th>Yes</th>
<th>Difference (No - Yes)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Child characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age in months</td>
<td>29.83</td>
<td>30.15</td>
<td>29.12</td>
<td><strong>1.03</strong></td>
</tr>
<tr>
<td>Child is female</td>
<td>0.50</td>
<td>0.51</td>
<td>0.48</td>
<td><strong>0.04</strong></td>
</tr>
<tr>
<td>Birth weight</td>
<td>3228.41</td>
<td>3222.50</td>
<td>3241.16</td>
<td>-18.66</td>
</tr>
<tr>
<td>Birth order</td>
<td>2.75</td>
<td>2.79</td>
<td>2.65</td>
<td><strong>0.15</strong></td>
</tr>
<tr>
<td><strong>Family characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother’s age</td>
<td>29.92</td>
<td>30.06</td>
<td>29.62</td>
<td><strong>0.44</strong></td>
</tr>
<tr>
<td>Husband/partner’s education</td>
<td>8.97</td>
<td>8.86</td>
<td>9.21</td>
<td><strong>-0.35</strong></td>
</tr>
<tr>
<td>Indigenous mother</td>
<td>0.14</td>
<td>0.16</td>
<td>0.11</td>
<td><strong>0.05</strong></td>
</tr>
<tr>
<td>Mother works</td>
<td>0.55</td>
<td>0.55</td>
<td>0.54</td>
<td>0.01</td>
</tr>
<tr>
<td>Number of children</td>
<td>2.93</td>
<td>2.99</td>
<td>2.79</td>
<td><strong>0.20</strong></td>
</tr>
<tr>
<td>Overcrowding</td>
<td>3.34</td>
<td>3.32</td>
<td>3.38</td>
<td>-0.05</td>
</tr>
<tr>
<td>Index of economic resources</td>
<td>-0.21</td>
<td>-0.23</td>
<td>-0.16</td>
<td><strong>-0.07</strong></td>
</tr>
</tbody>
</table>

Note: Differences in bold indicate statistical significance at 5% according to the t-test for independent samples
Source: 2013 Peru DHS
Author’s elaboration

Finally, in terms of the prevalence of diarrheal episodes, the following figure shows that 12% of Peruvian children suffered from this health issue. In comparison with chronic malnutrition and ARI, there are not main differences between sex, ethnicity, or place of residence, showing that this health issue is more transversal and not concentrated in one specific group in the population.
In terms of child and family characteristics, the following table shows that there are not many differences between children who suffer from diarrheal episodes and those who do not. For child characteristics, males and older children are more likely to suffer from diarrheal episodes. In terms of family characteristics, only children with younger mothers are more likely to suffer from this health issue. This result could appear to be surprising, but it shows that this disease could be external to child and family characteristics, and possibly related more to environmental or community factors.
Table 4. Characteristics of the child and family by prevalence of diarrheal episodes

<table>
<thead>
<tr>
<th>Child characteristics</th>
<th>All sample</th>
<th>Diarrheal episodes</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Age in months</td>
<td>29.82</td>
<td>30.57</td>
<td>24.23</td>
</tr>
<tr>
<td>Child is female</td>
<td>0.50</td>
<td>0.51</td>
<td>0.46</td>
</tr>
<tr>
<td>Birth weight</td>
<td>3228.35</td>
<td>3224.66</td>
<td>3255.46</td>
</tr>
<tr>
<td>Birth order</td>
<td>2.75</td>
<td>2.75</td>
<td>2.71</td>
</tr>
<tr>
<td>Family characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother’s age</td>
<td>29.92</td>
<td>30.02</td>
<td>29.17</td>
</tr>
<tr>
<td>Husband/partner’s education</td>
<td>8.97</td>
<td>8.96</td>
<td>9.07</td>
</tr>
<tr>
<td>Indigenous mother</td>
<td>0.14</td>
<td>0.14</td>
<td>0.13</td>
</tr>
<tr>
<td>Mother works</td>
<td>0.55</td>
<td>0.54</td>
<td>0.57</td>
</tr>
<tr>
<td>Number of children</td>
<td>2.92</td>
<td>2.94</td>
<td>2.81</td>
</tr>
<tr>
<td>Overcrowding</td>
<td>3.34</td>
<td>3.33</td>
<td>3.39</td>
</tr>
<tr>
<td>Index of economic resources</td>
<td>-0.21</td>
<td>-0.20</td>
<td>-0.27</td>
</tr>
</tbody>
</table>

Note: Differences in bold indicates statistical significance at 5% according to the t-test for independent samples
Source: 2013 Peru DHS
Author's elaboration

Finally, our main independent variable is maternal education. The following figure shows the overall average number of years of schooling for the mothers in our sample according to their different demographic characteristics. The overall mean is 9 years of schooling; in other words, women in Peru have incomplete secondary education on average. In terms of child sex, we did not see differences—both groups had 9 years of schooling. The biggest gap is by place of residence, with urban woman having higher levels of education with 11 years of schooling or complete secondary, while rural women have on average 7 years of schooling—lower than the national average. Lastly, in terms of the mother’s ethnicity, we can observe that non-indigenous mothers have 9 years of schooling on average while indigenous ones have only 5 years on average. These results show the heterogeneity of educational levels in different groups in Peru.
Figure 7. Mean years of maternal education by child’s sex, ethnicity, and geographical location

Source: 2013 Peru DHS
Author’s elaboration

4.2 Measurement models

This section shows the results of the measurement model estimated using the Structural Equation Modeling (SEM) technique. The results for each of the measurement models estimated include the r-square for each of the equations as well as standardized factor loading for each of the observed variables.

The first measurement model is of the mother’s health knowledge. The main idea was to have different observed variables that refer to different types of health issues. Therefore, the indicators selected encompass issues related to TBC, AIDS/HIV, and contraception. The TBC items selected allow us to have an idea of the level of understanding of the disease by the respondent. The items comprised in this indicator are related to the ways in which TBC can be transmitted, and they are: i) by coughing or sniffing, ii) by sharing utensils, iii) through physical contact with an infected person, iv) through food, v) through sexual contact, and vi) by
mosquito bites. Each correct item was coded with 1 and 0 otherwise. Then, we added all the items into a single score.

The AIDS/HIV indicator has the same purpose and the idea is to have a measure of the respondent’s knowledge of facts and dispel myths about the disease. The items included are: i) the risk of getting AIDS is reduced by not having sex, ii) the risk of getting AIDS is reduced by using condoms, iii) the risk of getting AIDS is reduced by having only one sex partner, iv) AIDS can be transmitted by mosquito bites, v) AIDS can be transmitted by sharing food with a person who has AIDS, vi) people can get AIDS through hugs, vii) people can get AIDS by sharing utensils, viii) people can get AIDS in the shower or swimming pool, ix) people can get AIDS by supernatural witchcraft, and x) people can get AIDS by divine punishment. Each correct item was coded with 1 and 0 otherwise. Then, we added all the items into a single score.

Lastly, the contraception indicator refers to the mother’s knowledge about different family planning methods. The items included are: i) pills, ii) IUD, iii) shot, iv) diaphragm, v) condom, vi) female sterilization, vii) male sterilization, viii) abstinence, ix) coitus interruptus, x) norplant, xii) exclusive breastfeeding method, xiii) female condom, xiv) jelly or foam, and xv) the next day pill. Each method known was coded with 1 and 0 otherwise. Then, we added all the items into a single score.

Then, we combined each indicator using a confirmatory factor analysis within the SEM framework. As we can see in the following figures, the factor loadings have the expected sign (+), which indicates that the latent construct is positively associated with each of the observed indicators used. In addition, the model fit for each equation indicates that the latent factor explains 35% to 54% of the total variance for each observed indicator.
The second measurement model is of the mother’s health practices. This latent construct is composed of three observed indicators that indicate different healthy practices performed by the mother for herself and her children. The first observed indicator is the place where the mother gave birth. We considered an adequate health practice to be if the mother gave birth at a hospital, public health center, private clinic, or NGO clinic or with a private doctor, and non-adequate otherwise. The second indicator is related to healthy practices during the mother’s pregnancy. One healthy practice is to take iron pills since this helps not only the mother but also the baby; therefore, we coded this variable as a 1 if the mother indicated that she had taken iron pills during her last pregnancy. Lastly, we used a healthy practice at home—an indicator as simple as treating water before drinking it. We considered a healthy practice to be if the mother indicated that she boils the water, adds bleach/chlorine, strains it through a cloth, uses a water filter, uses solar disinfection, lets it settle, or uses packaged water.

Like the previous latent construct, we combined each indicator using a confirmatory factor analysis. As can be seen in the following figures, the factor loadings have the expected sign
(+), which indicates that the latent construct is positively associated with each of the observed indicators used. We observed that one of the indicators has a small correlation with the latent construct, which is also reflected in the percentage of variance explained (3%). However, we kept it in the CFA model since it still explained part of the variance. The model fit for the other two indicators is moderate, with an r-square of 34% for having given birth at an adequate facility and 27% for treating water before drinking it.

Figure 9. Measurement model for the mother’s health practices

The third measurement model is the woman’s autonomy variable. This indicator is comprised of five items that reflect the mother’s participation in different decision-making issues in the family. Other scholars (Frost, 2005; Greenaway et al., 2010) used a similar indicator for women’s empowerment, though not within a measurement framework. The items included are: i) own health care, ii) major household purchases, iii) purchases for daily needs, iv) visits to friends and relatives, and v) spending extra money in the family budget. Each item was coded as 1 if the mother made the decision about the issue by herself or with another family member, and 0 otherwise.
Then we used a confirmatory factor analysis in order to combine all the items. As we can see in the following figure, the factor loadings have the expected sign (+) for each item, which indicates that the latent construct is positively associated with each observed indicator. The model fit for each indicator is heterogeneous but adequate in all cases, and the latent construct could explain between one third to two thirds of the total variance across items.

**Figure 10. Measurement model for a woman’s autonomy**

Finally, the last measurement model estimated is of violence against the woman. We took advantage of the measurement framework and used different types of intimate partner violence to configure a construct that reflected the overall violence suffered by the child’s mother. The first indicator is controlling situations against the woman. The items included in the indicator reflect different situations in daily life in which the partner or husband attempts to control the mother. If the mother indicated that at least one of five listed situations happened to her, then the indicator took the value of 1, and 0 otherwise. The second indicator is physical violence against the woman. This variable indicates if the mother had suffered of any type of physical abuse from her husband or partner (e.g., slapping her). A mother is considered to have suffered from physical violence if she mentioned at least one situation where the husband or partner used this type of violence. The third indicator is psychological violence against the woman.
This variable indicates if the mother had suffered of any type of emotional or mental abuse from her husband or partner (e.g., he threatened her or a relative). A mother is considered to have suffered from psychological violence if she mentioned at least one situation where the husband or partner used this type of violence. Last is the sexual violence indicator. This variable indicates if the mother had been forced to have sex or do things related to sex against her will. A mother is considered to have suffered from this type of violence if she indicated that her husband or partner made her do sexual things against her will.

In the following figure we can observe that all factor loadings have the expected sign (+) for each item, like in the previous models. These results show that our latent construct is positively associated with each of the observed indicators. The model fit for most indicators is very good: the R-square indicator is above 60% for the physical, psychological, and sexual violence indicators, while the model fit for the control situation indicator is 34% of the variance.

![Figure 11. Measurement model for domestic violence](image)

In sum, all measurement models estimated show an adequate fit, and the factor loading for all of the observed variables shows the expected signs. A continuous parametrization was used only in the measurement model for the mother’s health knowledge. Since the observed
indicators are binary or qualitative in all of the other models, we used a categorical parametrization in order to more accurately evaluate the effect of the relationship between the latent construct and the observed indicator. In addition, the previous measurement models were estimated within the SEM framework, since this technique has the advantage of estimating the measurement and structural part simultaneously.

Before showing the structural relationship for each of the dependent variables considered in the study, it is necessary to explore the bivariate relationship between the key variables of study. First, we estimated the correlation between the main independent variable (maternal education) and the mediators used in the analysis. The following table shows the correlation coefficients for these relationships. A first finding is the significant positive correlation of maternal education with the mother’s health knowledge, the mother’s health practices, and the woman’s autonomy. Second, there is a significant positive correlation between the mother’s health knowledge, the mother’s health practices, and the woman’s autonomy. Finally, in terms of the mixed effects of the latent construct related to violence against the woman, it shows no correlation with maternal education, a positive correlation with both of the health constructs, and a negative correlation with the woman’s autonomy.

Table 5. Correlation matrix between the main independent variable and mediators

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mother’s health knowledge</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Mother’s health practices</td>
<td>0.41*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Woman’s autonomy</td>
<td>0.31*</td>
<td>0.28*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Violence against the woman</td>
<td>0.06*</td>
<td>0.05*</td>
<td>-0.06*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>5. Maternal schooling</td>
<td>0.62*</td>
<td>0.35*</td>
<td>0.28*</td>
<td>-0.01</td>
<td>1</td>
</tr>
</tbody>
</table>

* Indicates that the correlation coefficient is statistically significant at 5%

Finally, we correlated the estimated latent constructs with each dependent variable, and the following table shows the results. We can observe that almost all of the variables except for violence against the woman have a statistically significant positive correlation with height-for-
age. These results show that an increment in any of the variables is associated with an increment in the height-for-age indicator. For the ARI, only three variables were statistically significant and positively correlated. In the case of violence against the woman, we expected a positive correlation with ARI since the violence has negative consequences on child health. However, as we saw in the descriptive analysis, there is a positive correlation between ARI and maternal education as well as health practices. This issue could be associated with the fact that underprivileged groups are not necessarily those who suffer more from this health issue, and the bivariate analysis shows this. Lastly, in the case of diarrheal episodes, violence against the woman is the only variable that is positively associated, showing that children from battered women are more likely to suffer from this problem.

Table 6. Correlation matrix between the dependent variables and the main independent variable and mediators

<table>
<thead>
<tr>
<th></th>
<th>Height-for-age</th>
<th>ARI</th>
<th>Diarrhea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal schooling</td>
<td><strong>0.39</strong>*</td>
<td><strong>0.07</strong>*</td>
<td>0.02</td>
</tr>
<tr>
<td>Mother’s health knowledge</td>
<td><strong>0.37</strong>*</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Mother’s health practices</td>
<td><strong>0.26</strong>*</td>
<td><strong>0.03</strong>*</td>
<td>0.00</td>
</tr>
<tr>
<td>Woman’s autonomy</td>
<td><strong>0.18</strong>*</td>
<td>0.01</td>
<td>-0.01</td>
</tr>
<tr>
<td>Violence against the woman</td>
<td>-0.02</td>
<td><strong>0.06</strong>*</td>
<td><strong>0.03</strong>*</td>
</tr>
</tbody>
</table>

* Indicates that the correlation coefficient is statistically significant at 5%

4.3 Structural relationships

In the previous section, we mainly explored the bivariate relationship between maternal education and each mediator variable, as well as each dependent one considered for this study. This section reports the multivariate analysis performed using the SEM framework. In other words, we will report the total effect of maternal education on height-for-age, acute respiratory infections, and diarrhea episodes, as well as the different pathways through which maternal education affects child health outcomes.
The first analysis performed was for child nutritional status using height-for-age (z-score). We tested the conceptual model stated in a previous chapter, in order to check the path through which maternal education affects child nutritional status. In the following figure, we are able to observe six main aspects. First, there is no direct effect of maternal education on height-for-age; this indicates that the included intermediate variables fully mediate the existing direct effect of maternal education on nutritional status. Second, in terms of model fit, we can observe that the model as a whole has an adequate model fit, with adequate RMSEA, CFI, and TLI values of fit indexes as indicated by the literature (Kline, 2005). Third, the model fit for each pathway indicates that the variables used in the model explain a fair amount of variance for each dependent variable; the variance explained ranges from 27% to 64%. Fourth, three out of five pathways show an indirect effect of maternal education on child nutritional status. We can see that the mother’s health knowledge (0.08 SD), the mother’s health practices (0.05 SD), and the index of economic resources (0.10 SD) are the paths through which maternal education increases child nutritional status. Within these pathways, maternal education has the biggest effect by increasing the index of economic resources at home. Fifth, violence against the woman was tested, and it is not a pathway through which maternal education affects child nutritional status for Peruvian children. Maternal education does not appear to have an effect on violence against the woman, and violence against the woman does not show to have an effect on height-for-age. Finally, the total effect of maternal education on height-for-age is 0.23 SD; this indicates that the height for each indicator will increase by 0.23 SD for each increment of one standard deviation in maternal education.
Figure 12. Structural relationships for child nutritional status (Height-for-age – z score)

Note: Control variables used in the analysis are sex, child’s age in months, birth order, birth weight, mother’s age, number of years of schooling achieved by the mother’s husband or partner, number of children, indigenous mother, overcrowding, and place of residency

*** p<0.001, **p<0.01, *p<0.05, +p<0.10

The second analysis performed was for the prevalence of acute respiratory infections. In the following figure, we are able to observe six main aspects. First, there is no direct effect of maternal education on ARI; this indicates that the included intermediate variables fully mediate the existing direct effect between maternal education and ARI. Second, in terms of model fit, we observe that the model as a whole has an adequate model fit with adequate RMSEA, CFI, and TLI values of fit indexes according to the literature (Kline, 2005). Third, the model fit for each pathway indicates that the variables used in the model explain a fair amount of variance for each dependent variable; the variance explained ranges from 10% to 64%. Fourth, no pathway shows an indirect effect of maternal education on ARI. We observed that maternal education has an effect on the mother’s health knowledge (0.57 SD), the mother’s health practices (0.37 SD), the woman’s autonomy (0.20 SD), and the index of economic resources (0.37 SD), but none of these variables has an effect on ARI. Fifth, violence against the woman
was tested, and it is not shown to be a pathway through which maternal education affects child morbidity status for Peruvian children since maternal education does not appear to have an effect on violence against the woman. However, it is interesting that violence against the woman has an effect on ARI (0.12 SD), which shows another consequence of domestic violence. Finally, there is no total effect of maternal education on ARI since direct and indirect effects were not both found.

Figure 13. Structural relationships for acute respiratory infections

Note: Control variables used in the analysis were sex, child’s age in months, birth order, birth weight, mother’s age, number of years of schooling achieved by the mother’s husband or partner, number of children, indigenous mother, overcrowding, and place of residency

*** p<0.001, **p<0.01, *p<0.05, +p<0.10

The last analysis performed was for the prevalence of diarrheal episodes. In the following figure, we are able to observe six main aspects. First, there is no direct effect of maternal education on diarrhea; this indicates that the intermediate variables included fully mediate the existing direct effect between maternal education and diarrheal episodes. However, we need to take into consideration that the correlation between these two variables was already small and statistically significant at 10% (see Table 6). Second, in terms of model fit, we observe that the
model as a whole has an adequate model fit with adequate RMSEA, CFI and TLI values of fit indexes as indicated in the literature (Kline, 2005). Third, the model fit for each pathway indicates that the variables used in the model explain a fair amount of variance for each dependent variable; the variance explained ranges from 9% to 64%. Fourth, no pathway shows an indirect effect of maternal education on diarrheal episodes. We observed that maternal education has an effect on the mother’s health knowledge (0.57 SD), the mother’s health practices (0.35 SD), the woman’s autonomy (0.20 SD), and the index of economic resources (0.37 SD), but none of these variables has an effect on diarrheal episodes. Fifth, violence against the woman was tested, and it does not appear to be a pathway through which maternal education affects child morbidity for Peruvian children since maternal education does not appear to have an effect on violence against the woman. However, it is interesting that violence against the woman has an effect on diarrheal episodes like it does for ARI (0.14 SD), showing another consequence of domestic violence. Finally, there is not a total effect of maternal education on diarrheal episodes since direct and indirect effects were not both found.
Finally, since we were able to observe indirect effects of maternal education on child nutritional status only for the height-for-age model, we explore the existence of heterogeneous effects according to ethnicity. As proxy for ethnicity, we use whether the mother’s native language is an indigenous language in Peru. Using a multigroup analysis, we tested whether all three pathways remain significant independent of ethnicity, as well as which pathway shows a higher effect of maternal education on nutritional status. In terms of model fit, we have an adequate model fit for the full model (measurement and structural parts), as well as for equations estimated in the system (R-squares). The following figure shows that there are differences in the effect of maternal education on child nutritional status according to ethnicity. First, the number of pathways through which maternal education affects child nutritional status are not the same. For non-indigenous children, as for the full sample, the three pathways for maternal education are the mother’s health knowledge, the mother’s health practices, and the index of
socioeconomic resources; while the only pathway that remains statistically significant for indigenous children is the index of socioeconomic resources. Thus, the total effect of maternal education on child nutritional status for non-indigenous children is 0.26 SD while it is is 0.04 SD for indigenous ones.
Figure 15. Structural relationships for child nutritional status (height-for-age – z-score) according to ethnicity

Indigenous

Non-indigenous

Note: Control variables used in the analysis were sex, child’s age in months, birth order, birth weight, mother’s age, number of years of schooling achieved by the mother’s husband or partner, number of children, overcrowding, and place of residency

*** p<0.001, **p<0.01, *p<0.05, +p<0.10
Chapter 5. Summary and conclusions

With the increase in educational opportunities in developing nations, there has been a reduction of educational disparities in terms of gender. Rising levels of schooling for females has potentially important societal consequences for the next generation of children in terms of their health and wellbeing. Many studies have reported a strong association between maternal education and child health, even after income or social status are controlled. Concerning this relationship, most studies explore it in a reduced form, as few studies (Glewwe, 1999; Frost, 2005) explore the possible indirect effects of maternal education using different variables affected by maternal education (e.g., health knowledge), which could be a target for public policies.

Using secondary data analysis, this dissertation explored the mediating effect of maternal education using variables related to the mother’s health knowledge (e.g., knowledge about TBC), the mother’s health behaviors (e.g., she took iron pills during pregnancy), the woman’s autonomy, violence against the woman, and an index of socioeconomic resources. These pathways were selected since the literature that discusses the effects of maternal education on child health indicates that they are the main mechanisms through which maternal education influences child health (Glewwe, 1999; Ghuman, Lee, and Smith 2004; Frost et al., 2005). Lastly, given that Peru is a Latin American country with one of the largest indigenous populations, this dissertation explored possible heterogeneous effects of ethnicity on the pathways through which maternal education affects child health.
The analysis performed showed that maternal education has a statistically significant effect on increasing child nutritional status, reducing acute respiratory infections, and reducing diarrheal episodes in children under five years old in Peru. However, once we include the full model with the structural paths, the direct effect of maternal education on all child health outcomes vanishes, which indicates that it is fully mediated by the variables used in our analysis.

We tested the different pathways hypothesized in the conceptual framework of this dissertation using Structural Equation Models (Kline, 2005). The first outcome analyzed was child nutritional status (height-for-age z-score). Our results showed that maternal education affects child nutritional status through three out of the five pathways tested: the mother’s health knowledge, the mother’s health practices, and the index of economic resources, even after different individual and family variables that are associated with child nutritional status according to the literature are held constant (e.g., birth order). Among the pathways, the biggest indirect effect of maternal education was through the index of economic resources (0.10 SD), followed by the mother’s health knowledge (0.07 SD), and the mother’s health practices (0.06 SD), with the total effect of maternal education being 0.23 SD. Meanwhile, no pathway was statistically significant for diarrheal episodes and acute respiratory infections.

In terms of heterogeneous effects, we found differences in the structural paths for child nutritional status according to ethnicity. Our results showed that the index of socioeconomic resources is the only pathway through which maternal education improves child nutritional status for the indigenous population; while for non-indigenous populations, the mother’s health knowledge and mother’s health behavior also work. This
finding is not surprising since the indigenous populations in Peru have higher poverty rates than non-indigenous populations, as well as lower social indicators such as level of schooling, access to health facilities, among others (Benavides et al., 2010). Therefore, it makes sense that the main effect of maternal education for indigenous populations was improving the living standards of the family, as expressed in the index of socioeconomic resources.

These results pointed out different issues that the descriptive analysis was already showing us. First, the picture or the role of maternal education in improving child nutritional status is clear. Our results indicate that there is an intergenerational effect of maternal education; it not only improves the living standards of the family but also improves the health knowledge and health practices that mothers use with their children. Literature about the role that schooling plays in our society (Baker, 2014) indicates that it is more than a single social marker. Schooling gives people the chance to understand and reason about their daily life decisions, as well as the tools to reflect on facts or information about different social problems (e.g., diseases). Therefore, this dissertation showed evidence of the intergenerational benefits of schooling, including having better citizens and reducing possible burdens for child development.

Second, the child morbidity outcomes (ARI and diarrheal episodes) were not necessarily associated with underprivileged populations. In fact, it was the opposite, as higher prevalence rates of ARI were found in urban areas and in children with non-indigenous mothers. Also, the correlation between morbidity indicators and maternal education was very low for the entire sample. These results could demonstrate that the indicators used to measure ARI and diarrheal episodes have a high measurement error. It is necessary to
improve the questions used to measure acute respiratory infections and diarrheal episodes. In the case of acute respiratory infections, we could add questions about the presence of body aches, sore throat, and fatigue during the period that the children have congestion, a cough, and a runny nose. In the case of diarrheal episodes, we could add retrospective questions about the frequency of the runs, which could give us a better measure of the gastrointestinal problem. Lastly, since it is an unhealthy state for children, child morbidity could be highly associated with environmental conditions that the DHS survey could not capture since they do not have community questionnaires that could allow us to have measures of air, water, and land contamination that could lead to child morbidity.

Finally, we tested violence against women as new pathway through which maternal education can improve child health. However, our results did not support this hypothesis since this path was not significant for nutritional status or child morbidity indicators. In any case, we found a significant negative association of violence against the woman and child morbidity. These results show how complex domestic violence is since it does not have consequences only for the mother’s own health but also for her child’s health. In addition, it could be possible that the effect of education is not seen through violence against the woman, but rather it could be working by improving the woman’s autonomy, and this variable could thus be helping to reduce violence against women. Another possible explanation is the community social norms in communities where the use of violence is part of their daily life; it is very likely that individual education does not have an effect of reducing violence against woman in communities where it is a socially accepted behavior. Therefore, future research studies could explore the effect of maternal education through the woman’s autonomy in order to show that maternal education does have an indirect effect through violence against the woman. Additionally, the average
level of education of the community could be used as an explanatory variable, since communities with higher levels of education are more prone to having less positive attitudes towards violence against women.

5.2 Policy implications

One of our findings is the effect of the mother’s health practices on improving child nutritional status. We used simple indicators about mother’s health practices, and they could be the target of public policies. In terms of public health, development of campaigns is necessary to inform people about the importance of reducing chances of anemia during pregnancy, the importance of conditions for delivering a baby, and the necessity of treating water before drinking it. According to a meta-analysis carried out by Fewtrell and Colford (2004), health interventions as simple as washing hands have the biggest effect on improving child health.

Another interesting finding is the effect of violence against the woman on child morbidity (ARI and diarrheal episodes). These results pointed out the necessity to prevent violence against women since it has negative consequences for children. The development of campaigns oriented toward increasing awareness and reports of cases of domestic violence against women will help to improve the living conditions of children. In addition, it is necessary to scale successful public programs that could help to reduce violence against women since the benefits will be not only for the mother but also for their children.

Finally, maternal education has been found to affect child health through several pathways; therefore, to reduce child health inequalities, it is necessary to develop
interventions that enable mothers who did not receive formal education or dropped out of school to develop or activate their cognitive abilities. It is necessary to rethink adult education in Peru and discard the idea that an adult education program mainly involves teaching reading and writing. Adult education programs need to be oriented toward increasing the cognitive abilities of the participants, since enhancing these type of skills will enable people to make better decisions regarding not only their own health but also the health of the next generations of citizens in Peru.
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