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# Asset Holdings and Undernutrition of Young Children: Evidence from China Health and Nutrition Survey

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# Asset Holdings and Undernutrition of Young Children: Evidence from China Health and Nutrition Survey

by

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ABSTRACT OF THE DISSERTATION

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Undernutrition is an underlying determinant of 45% of all childhood deaths annually, resulting in 3.1 million deaths to children less than five years globally (Black *et al.*, 2013). The adverse effects of undernutrition, especially chronic undernutrition, could cause impaired physical growth, mental development retardation, low productivity and poverty during adulthood, and undernutrition of next generation. Worldwide, over 200 million children are undernourished (Black *et al.*, 2013). Thus, there is an imperative to identify effective preventive actions or interventions for child undernutrition. Studies have documented links between undernutrition and low income, but few has tackling the causation from assets to child nutrition. The study proposed an asset-based framework for alleviating undernutrition. It is hypothesized that assets could increase child nutrition via improving house food security, child care, household environment, and access to health services. The study pools Wave 2004 and 2009 of China Health and Nutrition Survey and testifies the hypotheses by linear regression, logistic regression, and SEM modeling. Nutritional status is indicated using international growth standards for anthropometry, measured by height-for-age z score (HAZ), weight-for-age z score (WAZ), and weight-for-height (WHZ) z score, while the wealth index is obtained by principal component analysis as the proxy of assets. Findings from both the regressions and SEM models suggest that assets have a positive impact on HAZ or chronic malnutrition, mainly via household food security, child dietary intake, and infections. The same effects on WAZ and WHZ were not found. The employment status and education level of parents are also reported significantly associated with the key constructs on the pathways to child nutrition. Sensitivity tests show that missing values do not bias the findings. The study suggests the importance of combining asset-based interventions with other poverty and nutrition strategies to prevent and alleviate undernutrition in China and other developing countries with the similar culture and development level.

## Chapter I: Introductions

### 1.1 Background

Undernutrition is a violation of *the Convention on the Rights of the Child*, as it eliminates a child's right to the highest attainable standard of health. Undernourished children are at increased risk for serious infections and death due to common childhood illness, such as diarrhea, measles, and pneumonia. 45% of child deaths, about 3.1 million annually, is caused by undernutrition (Black *et al.*, 2013). In 2011, at least 165 million young children were stunted [height-for-age (HAZ) $<-2$], while 52 million were underweight [weight-for-age (WAZ) $<-2$] (Black *et al.*, 2013).

According to the life-cycle perspective on human nutrition, undernutrition can start in utero and extend to adulthood and even the next generation (United Nations Administrative Committee on Coordination Sub-Committee on Nutrition (ACC/SCN), 2000). Growth failure during infancy might lead to short statue and impaired mental development (Victoria *et al.*, 2008). Childhood stunting is also associated with low educational achievement (Alderman, Hoddinott, & Kinsey, 2006; Daniels & Adair, 2004). Women who experienced undernutrition during childhood are likely to deliver a baby with intrauterine growth retardation (Victoria *et al.*, 2008). Undernutrition in adulthood might also reduce the capacity to care for children and further lead to or exacerbate undernutrition for their offspring (ACC/SCN, 2000). Figure 1.1 presents the details of undernutrition throughout the life cycle. In sum, good nutrition is the cornerstone for children to succeed from the beginning of life. When children are deprived of a nutritious diet, they tend to have learning difficulties and bad health conditions during both childhood and adulthood, which diminishes their economic prospects and makes them more likely to fall into poverty.

Although undernutrition has declined since 1980, there are still a considerable proportion of children under the age of five undernourished (de Onis, Frongillo, & Blossner, 2000). According to UNICEF's most updated statistics (2012a), globally 16%, 27%, and 10% of the children under the age of five are considered low weight−for−age, height−for−age, and weight−for−height, respectively.

As a main cause of undernutrition, micronutrient deficiency occurs when the body does not have enough vitamins or minerals (iron, vitamin A, vitamin D, folic acid, zinc, etc.). Millions of children are affected by micronutrient deficiency. UNICEF (2009a) reports that 33% of the preschool children, about 190 million, don't receive enough Vitamin A. Based on nationally representative surveys from 1993 to 2005, WHO reports 47% of preschool children worldwide have anemia (Black *et al.*, 2008). It is thought that an important proportion of anemia is related to iron deficiency (Rastogi & Mathers, 2002).

Geographically, undernutrition is not equally distributed. Developing countries are where undernutrition is concentrated. The prevalence of underweight and stunting of least developed area are 21% and 31% higher than the average of industrialized countries (UNICEF, 2012a). One third of children younger than five in the developing world, about 195 million, are stunted, while another 129 million are underweight (UNICEF, 2009b). Asia and Africa are the two continents having the highest percentages of undernutrition, where over 90% of chronically undernourished children live (UNICEF, 2009b). Timor-Leste has the highest rate of underweight, 45% (UNICEF, 2012a). In Afghanistan, the prevalence of stunting is noticeably 59%, while one fifth of the children younger than five in India suffer from wasting (UNICEF, 2012a).

## 1.2 The Study

The immediate causes of undernutrition are complex, including exposure to diseases, unclean water, insufficient breastfeeding, hunger, unhealthy household environment, and lack of healthcare (UNICEF, 2012b). Beyond these, poverty might be the ultimate underlying cause of undernutrition, according to UNICEF's conceptual framework (UNICEF, 2012b). The linkage between poverty and undernutrition has also been reported often in the literature (Nandy *et al.*, 2005; Svedberg, 2000). Additionally, undernutrition could result in adulthood poverty. Undernutrition and poverty therefore can together form an intergenerational vicious cycle. The two could reinforce and exaggerate each other, which adds difficulty to undernutrition elimination.

Traditionally, people design and apply interventions directly targeting the more proximal determinants of undernutrition. However, regardless of the potential problems in the fidelity in implementation, they may still fail due to the internal invalidity. As the causes of undernutrition are various and interrelated, with the limited goals one program can target on, other existing causes may be ignored, which sometimes influence the targeted goals tremendously and weaken the effectiveness of the program.

Reducing undernutrition via addressing the ultimate underlying cause of poverty could be a promising way. Ideally, when targeted population moves out of poverty, they could spontaneously improve the nutritional status for themselves and their offspring with or without assistance. Based on the above hypothesis, the ultimate task is finding a solution to poverty. Among the numerous interventions to poverty, asset building could be a best approach. Assets do not only provide economic backup for consumptions, but also could shape owners' behaviors and promote aspirations. People with few assets are in chronic poverty and are more vulnerable than just low–income population, as they do not have necessary economic resources to get out of poverty (Carter & Barrett, 2006; Hulme & Shepherd, 2003).

This study tries to answer whether increased asset holdings lead to better nutritional outcomes for children under the age of five years. An asset–based conceptual framework is proposed based on UNICEF's conceptual framework of undernutrition and three related key hypotheses will be examined: first, asset holdings protect household food security and further adequate dietary intake for preschoolers; second, asset holdings increase child care in the pathway to young child nutrition; third, asset holdings create a healthy household environment and improve access to health services, and then reduce infections for young children. By studying this, the research provides evidence whether asset building could a valid and effective tool to fight against undernutrition.

**1.3 Significance of the Study**

The severe adverse effects and high prevalence of undernutrition ought to be enough to posit reducing undernutrition as one of the highest priorities on the agenda of policy makers, researchers, and practitioners. "Eradicating extreme poverty and hunger" is the first goal of United Nations' Millennium Development Goals (United Nations, 2012). The third target of the goal, aiming at halving, between 1990 and 2015, the proportion of people who suffer from hunger (United Nations, 2012), is closely related to undernutrition. Three risky factors related to undernutrition, i.e. hunger and malnutrition, infection diseases, and water and sanitation, are also proposed among the most important challenges the world confronts by *Copenhagen Consensus 2012*. Intervening chronic undernutrition in preschoolers are given the highest rankings among the solutions to the challenge of hunger and malnutrition due to its high cost–benefit ratio. The proposed study aims at making contribution to these issues.

In addition, the study directly addresses the undernutrition in China. The prevalence of stunting in China was about 33% in 1990 and decreased to 11% by 2005, while the percentage of underweight children was also reduced from 19% in 1990 to 7% in 2005 (Figure 1.2, UNICEF, 2009b). Despite the remarkable progress, the prevalence of underweight is still the 24$^{th}$ highest among the countries with data available, while the prevalence of stunting ranks 13$^{th}$ (UNICEF, 2012a). Given the large population, that is more than 12 million stunted preschool children in China, ranking second after India in terms of number, and about five million children underweight (UNICEF, 2009b). Additionally, undernutrition is distributed disproportionally in rural and inland areas which are poorer. While the prevalence of stunting in coastal area is 4.9%, the prevalence in the inland area is noticeably twice higher (Liu *et al.*, 2008). 11.7% of the rural children are stunted, but only 2.2% of their urban counterparts are stunted (Liu *et al.*, 2008). Details are provided in Figure 1.3 (Liu *et al.*, 2008).

Micronutrient deficiencies are even more serious in China. Ma and his colleagues (2007) estimate that 10.8 million children under the age of two, around 24% of the total children population, have iron-deficiency anemia. About seven percent of the urban children between the age of two and three years do not have adequate zinc intake, as well as 24% of their rural counterparts (Ma *et al.*, 2007). For the children between the age of four and six, the prevalence of zinc intake inadequacy in urban and rural areas are 12% and 16%, respectively (Ma *et al.*, 2007). By examining the biomarker of 1,375 preschool children aged between three and five from Jiangsu province, another study finds that the prevalence of zinc deficiency is about 38%, while that of iron deficiency is about 24% (Liu *et al.*, 2011). The prevalence of vitamin A deficiency for the children under the age of six is 11.7%, and that in the poverty−stricken counties is 23.3% (Lin *et al.*, 2002). For the infants younger than six months, vitamin A deficiency prevalence is 21.2% and 39.4% in urban and rural areas, respectively (Lin *et al.*, 2002).

Undernutrition draws great attention from both the public and private sectors. Since 2011, Chinese government has launched a program to improve the nutrition of rural elementary and junior middle school students in poor regions. About 2.5 billion U.S. dollars will be allocated annually to provide daily lunch worth about half a U.S. dollar per child for 260 million students in 680 cities and counties (People's Daily, 2012). *Free Lunch for Children*, a non−profit organization founded in 2011, has raised over five million U.S. dollars to offer meals to students in over 160 schools from mountainous areas (Free Lunch for Children, 2013). However, there are not any government projects targeting the undernutrition for the preschoolers who are more vulnerable to undernutrition. The empirical evidence generated from the study could contribute later to establish a new comprehensive asset−based intervention to the undernutrition of children under the age of five, which might be particularly significant for practitioners and policymakers in China and other developing countries.

# Chapter II: Theoretical Framework

## 2.1 Defining Undernutrition

UNICEF (2006) proposes undernutrition as the outcome of insufficient food intake and repeated infectious diseases. It is further indicated that undernutrition includes being underweight for one's age, too short for one's age (stunting), dangerously thin (wasting), and micronutrient (vitamins and minerals) deficiency.

FAO defines undernutrition as the result of prolonged low levels of food intake and/or low absorption of food consumed, which is generally applied to energy (or protein and energy) deficiency, but it may also relate to vitamin and mineral deficiency (FAO, 2012). Compared to UNICEF, FAO's definition only emphasizes that undernutrition is caused by insufficient energy intake. Additionally, FAO introduces two other related concepts: food insecurity and micronutrient deficiency. The former is "low level of food intake, which can be transitory (when it occurs in times of crisis), seasonal, or chronic (when it occurs on a continuing basis)", while the latter is "lack of essential vitamins and minerals resulting from unbalanced food intake and specific problems of absorption of food consumed" (FAO, 1999). Apparently, all the three definitions attribute problems to low food intake, while UNICEF's definition implies that undernutrition has multiple causes.

To better refine the definition of undernutrition, three similar concepts are compared. Hunger has been found frequently in several articles related to undernutrition and health (McMahon *et al.*, 2011; Olson, 1999). As a bodily signal of a desire for food, hunger refers more to a short-term feeling, while undernutrition could be either acute or chronic. Hunger also appears related to general food intake, and undernutrition could be the result of the deficiency of certain micronutrients. Although persistent hunger can lead to undernutrition, the physical sensation of hunger does not necessarily reflect undernutrition. A study finds that individuals with a very low daily calorie intake (400 calorie (cal)) experience less hunger than others having 1200 cal (Wadden *et al.*, 1987).

Malnutrition is another term adopted in the literatures indicating nutritional problems. Compared to undernutrition, malnutrition could refer to both undernutrition and overnutrition which is obesity or over−consumption of specific nutrients (Black *et al.*, 2008).

Undernourishment is similar to but distinguishable from undernutrition. Undernourishment is defined as the status of food intake continuously insufficient to meet the dietary energy intake, and undernutrition could be the result of undernourishment (Shetty, 2002).

In sum, these concepts are apparently related to but different from undernutrition. Hunger, food insecurity, undernourishment, or micronutrient deficiency could trigger undernutrition but definitely not overnutrition. Undernutrition is also a comparatively long−term status, compared to hunger. To avoid the confusion, *malnutrition*, *hunger*, or *undernourishment* are not used other than in this section. Additionally, regarding the disagreement between UNICEF's and FAO's definitions of undernutrition, the statement chooses UNICEF's definition which is more comprehensive and implies the complexity of causes of undernutrition.

**2.2 Causes of Undernutrition**

According to UNICEF's conceptual framework (Figure 2.1), the causes of undernutrition are hierarchical. The first level from the top is the immediate causes, which are *inadequate dietary intake* and *diseases*. *Household food insecurity, inadequate care,* and *unhealthy household environment and lack of health services*, are in the second level, which are the underlying causes. While *household food insecurity*, *unhealthy household environment*, and *lack of health service* lead to undernutrition via immediate causes, inadequate care can result in undernutrition directly and indirectly. *Income poverty*, the further underlying cause in the third level, has an overall influence on undernutrition through other causes in the upper levels. *Lack of capital* and *social, economic, and political context* are listed as basic causes.

### *2.2.1 Inadequate Dietary Intake*

Inadequate or poor quality diet is one of the most important causes of undernutrition. Given that it is relatively easy to find carbohydrate in normal diet, micronutrients highly concentrate only in special food which might be difficult to access for certain population due to the rarity and expense. However, because of the need for the rapid growth, pregnant women, lactating women, infants, and toddlers need more micronutrients than older children and adults. Thus, the former group is even more vulnerable to micronutrient deficiency.

One of the most important micronutrients is zinc which aids various biochemical processes in human body. The Recommended Dietary Allowance (RDA) is around 3mg/day for children and about 12mg/day for women during pregnancy or lactating (National Institutes of Health (NIH), 2012). Zinc−rich sources include seafood (such as oyster, crab, and lobster), red meat, poultry, beans, nuts, and whole grains (NIH, 2012). Zinc deficiency results in the vulnerability to diarrhea, pneumonia, and malaria. The relative risk of the child mortality related to zinc deficiency is estimated 1.27 for diarrhea, 1.18 for pneumonia, and 1.11 for malaria (Black *et al*., 2008).

As important as zinc, iron is a component making up cells. Iron is found in many enzymes helping digest food (Center for Disease Control and Prevention (CDC), 2011). Iron is also a key element in the protein hemoglobin, which carries oxygen from lung throughout our bodies (CDC, 2011). Iron deficiency could cause anemia. The RDA for the infants between seven to 12 months is 11mg/day, while RDA for pregnant women is 27mg/day (CDC, 2011).

Iron deficiency leads to delay in motor and mental development for infants (CDC, 2011). A combined analysis based on five trials finds that there is a 1.73 point decrease in IQ score per 10 g/L decrease in hemoglobin (Stoltzfus, Mullany, & Black, 2004).

Vitamin A is vital to eye health and immune system, the deficiency of which could cause preventable blindness. Milk, liver, and eggs are rich in bioavailable vitamin A, while red, orange, and yellow fruits and vegetables are concentrated in carotenoids, a less bioavailable form of vitamin A (UNICEF, 2009a). To prevent and control vitamin A deficiency, UNICEF (2009a) recommends high-dose vitamin A supplementation every four to six months be targeted to all children between the ages from six to 59 months living in affected areas.

Consuming enough energy from staple food is essential for health. Carbohydrates is the main sources of energy, while fats and protein may also be the others when energy from other chemicals is limited. The energy could come from ethanol as well, especially for the alcoholic (FAO, 2001). Minimum energy is the amount needed to meet the energy expenditure for maintaining "body size, body composition and a level of necessary and desirable physical activity consistent with long-term good health", which includes "the energy needed for the optimal growth and development of children, for the deposition of tissues during pregnancy, and for the secretion of milk during lactation consistent with the good health of mother and child" (FAO, 2001, page 11). FAO (2001, page 11) sets the recommended level of energy intake as "the mean energy requirement of the healthy, well-nourished individuals who constitute that group." For children, minimum energy is required for both basic biological function (energy expenditure) and growth (both energy expenditure and deposit). FAO (2001) gives both the reference weight and the minimum energy intake by weight for infants from one to 12 months, which varied by month from 329 to 473 KJ/Kg/day (Table 2.2). Extra energy supplementation is also suggested for catch−up growth and recovering from infections (FAO, 2001).

### *2.2.2 Household Food Insecurity*

Household food insecurity could directly cause insufficient nutrient intake, the immediate cause to undernutrition. U.S. Agency for International Development (USAID) specifies three dimensions of food security: availability, access and utilization. Food availability means the sufficient quantities of appropriate, necessary types of food available to individuals (USAID, 1992). Food access is defined as the condition that individuals have income or other sources to obtain foods (USAID, 1992). Food utilization is achieved when "food is properly used; proper food processing and storage techniques are employed; adequate knowledge of nutrition and child care techniques exists and is applied; and adequate health and sanitation services exist" (USAID, 1992). Natural environment and food stock could ensure food availability, while food price and variety are closely related to both food access and utilization.

People usually obtain food from markets, where price may determine quantity and variety of food purchase. The study in south rural India suggests that nutrient intake is correlated with food price, especially the price of sorghum, the most important staple food for the sample households (Behrman & Deolalikar, 1990). By following the price of staple food (rice, wheat flour, coarse grains, pork, eggs, & oils) and surveyingover than 5,000 adults in China about their consumption, Guo *et al.* (1999) concludes that people, especially those with low income, respond to food price increase by reducing food consumption. On the other side, people are also more sensitive to price change on expensive food, such as pork (Guo *et al.*, 1999). Although the study reports that people might keep the nutrition level by switching to cheap food, it should be paid attention that only macronutrients, i.e. energy, protein, and fat, are included in the analysis as the outcome variable.

Increasing the variety of foods across and within food groups is key to high quality diets. Dietary diversity is especially important to poor populations, as they may reply heavily on staple food, but not animal-source food, fresh fruits, or vegetables (Ruel, 2003). The loss of micronutrients due to price increase might not be compensated by this strategy, as they are usually rich in specific food but may not their substitutes. Based on a nationally representative survey, Iannotti *et al.* (2012) report that the intake of micronutrients, such as zinc and folate, is inversely associated with food price. Christian (2010) further gives the pathways how economic crisis or high food price would bring low nutrient intake especially micronutrients, which could finally cause undernutrition (Figure 2.3). The sufficiency of micronutrients may be achieved only if food variety is guaranteed.

United States Department of Agriculture (USDA) (Bickel *et al.*, 2000) has developed a tool to measuring household food insecurity and hunger in a continuum for both national surveys and local community assessment. The 18-item core module set of indicators “capture the various combinations of food conditions, experiences, and behaviors” (Bickel *et al.*, 2000, page 2). The scale can be also simplified into four categories: food secure, food insecure without hunger (concerns about food adequacy and/or reduced food quality), food insecure with moderate hunger (adults reduce intake and feel hunger), and food insecure with severe hunger (children reduced intake and experience hunger) (Bickel *et al.*, 2000). Similar tools asking about food anxiety, behaviors, and shortage, have been developed in other industrialized countries, such as New Zealand, Australia, and Canada (Radimer & Radimer, 2002). The module has also been revised and validated in developing countries (Gulliford, Nunes, & Rocke, 2006; Melgar-

Quinonez *et al.*, 2006; Pérez-Escamilla *et al.*, 2004). However, the module does not distinguish staple food and "high quality food", such as animal-source food, which is rich in micronutrients. Therefore, the module can only test household general or staple food security.

Dietary diversity could be a good supplement to the module. Dietary diversity can be measured by dietary diverse score, which is the sum of the number of foods or food groups consumed over a reference period (Krebs-Smith *et al.*, 1987; Löwik *et al.*, 1999). Brinkman *et al.* (2010) applies food consumption score developed by World Food Program which is similar to dietary diverse score and presents that the increase of food price brought by world economic crisis resulted in a low food consumption score for developing countries (Brinkman *et al.*, 2010). Although there are other ways of measuring dietary diversity, simple food group counts is commonly adopted in developing countries (Ruel, 2003). Dietary diversity score have shown positive association with nutrient adequacy and child growth (Ruel, 2003).

### *2.2.3 Infections*

Infections and undernutrition can form a vicious cycle (Figure 2.4). Infections could result in 'loss of appetite, increased nutrient requirements and/or decreased absorption of nutrients consumed', which 'triggers further weight loss and reduced resistance to further infections' (UNICEF, 2012b, Page 6). Undernutrition would then 'reduce immunity to infections' to increase 'the likelihood of an individual getting an infection or increase its duration and/or severity' (UNICEF, 2012b, Page 6).

Among all the infections to children, diarrhea, pneumonia, malaria, and measles are dangerous and most often happen. Diarrhea is defined as the passage of loose or liquid stools (more than two per day or more frequent than normal) (WHO, 2009). The illness could be caused by bacterial infections, viral infections, and parasites which are usually transmitted by human or animal feces and the contaminated water (National Digestive Diseases Information Clearinghouse (NDDIC), 2011). Diarrhea may further cause dangerous dehydration, of which the symptom for children could be dry mouth and tongue, no tears when crying, no wet diapers for three hours or more, sunken eyes, sunken cheeks, soft spot in the skull, high fever, listlessness, or irritability (NDDIC, 2011). Diarrhea could result in and add severity of undernutrition via causing malabsorption of nutrients and loss of appetite (Mata, 1992). Pinto and his colleagues (1998) use a case control design and document a positive association between stunting, wasting, underweight, and incidences of diarrhea. Similar findings are reported by a national representative survey for the children between 12 and 71 months in Honduras (Nestel *et al.*, 1999).

Pneumonia is a respiratory condition whose common causes are *streptococcus pneumonia, haemophilus influenzae type b (Hib), respiratory syncytial virus*, and *pneumocystis jiroveci* (WHO, 2011a). Pneumonia can be spread via blood and air-borne droplets from cough or sneeze. Patients are likely to have rapid or difficulty in breathing, cough, fever, chills, loss of appetite, or wheezing (WHO, 2011a). Compared to adults, pneumonia for infants and young children is more serious (National Heart Lung and Blood Institute (NHLBI), 2011). Infants suffering from severe pneumonia might not be able to eat or drink and would experience unconsciousness, hypothermia and convulsions (WHO, 2011a). Undernourished children are vulnerable to pneumonia and *vice versa*, evidenced by a quasi‒experimental balanced design collecting data from 1,300 children aged 0~23 months (Fonseca *et al.*, 1996).

Malaria is caused by *plasmodium* which can be carried by infected mosquitoes (WHO, 2012a). The pathogen can reproduce in liver and then infect red blood cells (WHO, 2012a). Persons with malaria would experience fever, headache, and vomiting, and these symptoms usually show between 10 and 15 days after *Anopheles mosquito* bite (WHO, 2012a). Malaria is found associated with stunting (Deen, Walraven, & Seidlein, 2002; Friedman *et al.*, 2005). Malaria might also exaggerate the deficiency of zinc and vitamin A (UNICEF, 2012b).

Measles is caused by *measles virus*, the symptoms of which include fever lasting up to seven days, runny nose, cough and a rash all over the body (CDC, 2012a). Measles is transmitted via air by breathing, coughing or sneezing to the children without proper vaccination (CDC, 2012a). Children undernourished particularly with vitamin A deficiency, unvaccinated, or with weak immune systems are very vulnerable to the disease (WHO, 2012b). Measles could generate appetite loss, decrease the availability of Vitamin A, and defunctionalize the immune system, which might further increase duration, severity, and mortality likelihood of undernutrition (UNICEF, 2012b). By collecting data from 723 children aged 12 to 59 months in Shivpuri district of Madhya Pradesh, India, a cross−section study found an association between undernutrition and incidences of measles (Mishra, Mishra, & Lahariya, 2008). Severe measles, common for children under five, could bring “blindness, encephalitis (an infection that causes brain swelling), severe diarrhea and related dehydration, ear infections, or severe respiratory infections such as pneumonia” (WHO, 2012b).

### *2.2.4 Unhealthy Household Environment*

Unhealthy household environment, mainly poor water condition, sanitation, and hygiene, increase the risk of infection in populations. Keeping environment healthy is crucial to prevent infection. Bednet and clean water are illustrated as examples in this section.

Bednet is effective in stopping the transmission of malaria by mosquitoes. A significant reduction in malaria prevalence and improvement in nutrition is detected one year after Gambia launched a National Insecticide Impregnated Bednet Program for children in 1992

(D'Alessandro *et al.*, 1995). A community randomized controlled trial in western Kenya also finds that insecticide treated bednets can reduce the number of *Anopheles mosquitoes* in houses so as to decrease mortality rate for children after 3−4 year use (Lindblade *et al.*, 2004). The same effect is reported in Tanzania (Killeen *et al.*, 2007). In addition, distributing insecticide-treated bednet is generally cheap (Grabowsky *et al*., 2005).

Poor quality and quantities of water may lead to infection. A systematic review presents that chlorine treated water significantly reduces the likelihood of stored water contaminated by *Escherichia coli* which could cause diarrhea (Arnold & Colford, 2007). Using ceramic filters to treat water might be a more effective way to keep drinking water safe. The experimental design in Bolivia concludes that the filters are better than customary methods in removing the thermotolerant coliforms and can decrease the risk of diarrhea by 83% (Clasen *et al.*, 2004). It is also noticeable that the filters are affordable even for low−income households (Clasen *et al.*, 2004).

Access to toilets and proper disposal of excreta are other two important components of healthy household environment. According to Prado *et al.* (2003), presence of visible sewage nearby and absence of toilet are significantly associated with child infection. A review by Aiello and Larson (2002) also reports that inadequate toilet facilities and unsafe excreta disposal may lead to child infection and further undernutrition.

***2.2.5 Lack of Health Services***

While healthy environment prevents the infections, health service plays the role to both prevent and cure infections. Although mild symptoms can be treated at home, patients with severe diseases, especially infants, are strongly suggested to seek healthcare. However, disadvantaged groups could be deprived of healthcare due to unaffordable fee. Wilkinson and his colleagues (2001) document that when government provides free curative and preventive primary health care services for rural populations, the attendance and new registrations continuously increase.

Travel time might be another factor impeding people accessing healthcare. Travel time from home to healthcare facilities is reported negatively associated with utilizations of healthcare (Buor, 2003; Phibbs & Luft, 1995; Stock, 1983). A research using geographical information system indicates that most of the families in rural South Africa have to spend more than one hour traveling to the nearest clinic (Tansera, Gijsbertsenb, & Herbst, 2006). Therefore, it is advocated that healthcare facilities should be stationed close to deprived populations. A fifteen–year longitudinal study in Gambia reports that well monitored primary healthcare in villages could remarkably reduce mortality rate for young children (Hill *et al.*, 2000).

Access to health services together with household environment could be a relatively distal underlying cause of child undernutrition, as both the associations between child nutrition and the constructs are mediated by infections.

### *2.2.6 Inadequate Care*

The main care practices for young children are breastfeeding and appropriate complementary feeding. The pattern of breastfeeding can be classified as: exclusive breastfeeding (nothing but breastmilk), predominant breastfeeding (only water or teas in addition to breastmilk), partial/complement breastfeeding (other liquids or solids in addition to breastmilk), and not breastfeeding (Bahl *et al.*, 2005). For the infants younger than six months, exclusive breastfeeding is strongly recommended. Breastfeeding can protect infants from sudden death syndrome, especially exclusive breastfeeding (Hauck *et al.*, 2011). By a multi-center randomized controlled trial, non-breastfed infants are 10.5 and 2.5 time higher likely to die compared to the predominant-breastfed and partially-breastfed infants (Bahl *et al.*, 2005).

However, around half of infants under two months in the developing world (Africa, Asia, Latin America, and the Caribbean area) do not receive exclusive breastfeeding (Black *et al.*, 2008). The rate even increases to 70% when babies are two to five months old (Black *et al.*, 2008). A cluster-random trial in Belarus finds that the weight and length of babies with exclusive breastfeeding are significantly higher than the control group in the first month of life (Kramer *et al.*, 2002). The difference is even expanded when retested in the third month (Kramer *et al.*, 2002). Piwoz *et al.* (1995) also report that infants in Peru consuming non-human milk in the first month of life or weaned earlier than six months weighed less at the 1st year. For the infants between six and eleven months, 32% in Latin America and the Caribbean do not get breastfeeding, while the percentages in Africa and Asia are 6% and 10% respectively (Black *et al.*, 2008). Based on the findings of several cohort studies, the rate of exclusive breastfeeding in China is generally lower than the average of Asian countries and is varied across different provinces. The percentage of breastfeeding in the first month is from 54% (Beijing) to 97.3% (Zhuhai) (Xu *et al.*, 2009). The percentage decreases along with the age of infants. At the fourth months, the rate ranges from 10.9% (Xinjiang) to 79.8% (Luzhou) (Xu *et al.*, 2009).

Partial/complement breastfeeding is necessary for babies aged from six months and two years, as children with exclusive breastfeeding would still be stunted (Black *et al.*, 2008). Globally, less than 33% of infants from six to 23 months old meet the minimum criteria for dietary diversity in 2010 (Lutter *et al.*, 2011). The study done by Ouédraogo *et al.* (2008) shows that without proper supplemental diet in the first two years, children are in high risk of undernutrition.

Unhygienic behaviors could also lead to undernutrition. An educational intervention was tried in India to correct three behaviors: not washing hand before preparing food, open defecation by children in the family compound, and inattention to proper disposal of trash and feces (Stanton & Clemens, 1987). After six months, it was found that the frequency of washing hand increases, and the prevalence of diarrhea in the communities intervened is 1.5% lower than that in the control communities without intervention (Stanton & Clemens, 1987). By sampling 942 children under the age of three in Salvador, Brazil, Strina *et al.* (2003) records that the hygienic and unhygienic behaviors by home visit: whether wash hand and food before eating or after defecation, whether bath before meal, whether drink clean water, whether clean or replace utensil, pacifiers, children's bottle if dropped on floor. After controlling for confounding factors, it is found that the prevalence of diarrhea for unhygienic group is 1.9 times of that for hygienic group (Strina *et al.*, 2003). Similar results are reported in Vietnam and Peru (Checkley *et al.*, 2004; Flohr *et al.*, 2006). Studies find that the impact of healthy behaviors and sanitation improvement is significant on reducing diarrhea and other infections (Asaolua & Ofoezie, 2003; Cairncross *et al.*, 2010; Esrey *et al.*, 1991).

**2.3 Asset−based Conceptual Framework**

Income poverty is regarded as the ultimate underlying cause, where "employment, self−employment, dwelling, assets, remittance, pensions, and transfer" are listed to illustrate it (UNICEF, 2012b). Before proposing asset−based framework, it should be noticed that the annotation of income poverty in UNICEF's framework could be confusing. Income and asset are different concepts, as well as income poverty and asset poverty. According to U.S. Census Bureau (2011), income includes "earnings, unemployment compensation, workers' compensation, Social Security, Supplemental Security Income, public assistance, veterans' payments, survivor benefits, pension or retirement income, interest, dividends, rents, royalties, income from estates, trusts, educational assistance, alimony, child support, assistance from outside the household, and other miscellaneous sources; but excludes noncash benefit, tax, and capital gains or losses". Asset is a kind of right over properties excluding the access from others. Income is the flow of wealth, while asset is the stock of wealth. It might be improper that asset can be considered as a part of income.

Additionally, income poverty is usually defined as the status individual or household's income below certain threshold, in other word poverty line, which is usually calculated according to the cost of basic needs. The cost of basic needs covers the expense for maintaining merely physical efficiency plus clothes, housing, and transportations. For example, Ravillion and Chen (2007) calculate the poverty line for both urban and rural China based on the minimum energy requirement, i.e. 2,100 calorie per day per person. The cost is obtained according to the food bundle consumed by those between 15% and 25% poorest, and then adjusted by the rural and urban difference. Non-food expense is finally added based on the consumption habit of the household to form the poverty line. Asset poverty uses asset instead of income to measure poverty (Nam, Huang, & Sherraden, 2008). Although asset poverty might use the same poverty line as the one of income poverty, they are distinguishable (Caner & Wolff, 2004; Haveman & Wolff, 2004; Huang *et al.*, 2011).

### *2.3.1 Income, Assets, and Household Food Security*

Household food security is achieved when people can access food of sufficient quantity and quality. It seems that people with low income are likely poorly−nourished, as they cannot afford to pay for food. However, the food expenditure might increase proportionally against income, but not necessarily the nutrition level. In other word, the increase of income might not lead to the increase of nutrition (Behrman, & Deolalikar, 1987).

The effects of income on nutrition might be discretionary, as people do not choose food only based on nutrition, but also cost, taste, appearance, convenience, and other nonnutritional factors (Wolfe & Behrman, 1983; Behrman & Deolalikar, 1990). Evidence shows that the elasticity of calories to income is higher for the households with lowest income than the households with average income, which means poor populations are sensitive to income change (Ravillion, 1990). Nevertheless, when income grows, non−nutritional factors become more decisive. People tend to increase the food variety, which might not increase energy intake but micronutrient intake (Behrman & Deolalikar, 1987). In other words, poor people are more likely to suffer from the deficiency of micronutrients than macronutrients, as staple food is usually cheap and substitutable.

Second, when food is acquired by household as a whole, the allocation within household might not be equal. The proportion which young children can get is varied. McIntyre *et al.* (2003) followed 141 Canadian single mothers with two or more children under the age of 14 years in household food insecurity for four months. The study reports that most of the mothers reduce food intake to preserve the nutrition for their children (McIntyre *et al.*, 2003). It is also noticed that although the children are generally well−nourished on most of the indicators, zinc and folate acid intake are not adequate (McIntyre *et al.*, 2003). The result confirms that the deficiency of micronutrients is more difficult to correct than the deficiency of macronutrients for poor population. Behrman and Deolalikar (1990) reports gender discrimination in intra−household nutrition allocation based on panel data of 240 households from six different villages in India. The elasticity of nutrient intake to price for females is systematically lower than that for males (Behrman & Deolalikar, 1990). A study in Kenya and Malawi shows that the nutrition status of preschool children in de facto female–headed households (male head of household is absent more than 50% of the time) is significantly better than de jure female–headed households (legal head of household is a woman) and male–headed households, despite that the first group has the lowest income (Kennedy & Peters, 1992). The study also suggests that interventions prompt the incentive to invest on children could improve their health (Kennedy & Peters, 1992).

When arguing that income might not be that a strong determinant for household food security, it should be noted that the effects of asset can also be altered by people's preference and inequality of intra-household food distribution. However, asset might have the following effects to protect household food security and further child dietary intake beyond the economic effects.

First, assets, especially liquid assets, can be cashed if needed and works as "insurances" for unexpected economic hardship. The durable consumption goods, vehicle, and livestock might also be pledged for short– or long–term loan. With assets, people might be able to keep their level of food consumption during natural disaster, famine, or unexpected income loss. Mace (1996) states that people make their decision about whether having another baby depend on household wealth. Although it is not the direct evidence that asset can protect food security for children, it might imply that parents think about the expense of raising children before giving birth. If their value of assets could cover the cost of raising children, of which food expense is a significant part especially during the first several years, they would decide to have babies. It might be implied that parents are willing to and prepare to cash their assets for raising children.

Second, productive asset could directly increase household food security. Gabriele and Schettino (2008) show that with land people can produce enough food or to achieve household food security. Traditionally, rural households in China consume the food grown from own land (Gale, 2005). The households in Malawi also rely heavily on self‒produced food (Douillet, 2012). While those with large land grow diverse crops, smallholder peasants assign most of land to staple food (Douillet, 2012). With the development of urban agriculture, 66% of urban families in Nigeria ensure food security via tilling their own land (Olawepo, 2012). While land usually provides staple food supplying mainly macronutrients, livestock can furnish animal-source food rich in micronutrients (vitamin A, iron, zinc, calcium, and vitamin B series) which are vital for children's physical and cognitive development. It is estimated that globally more than 60% of the resource‒poor rural households keep some types of livestock (Ashley, Holden, & Bazeley, 1999). In 1993, Bangladesh Department of Livestock Services, India, initiates the Smallholder Livestock Development Project to support raising small scale livestock, e.g. poultry, for rural population. A simple pre‒post test presents that beneficiary households eat significantly more animal-source food (eggs, chickens, fishes, meat, and milk) than households in the control group (Alam, 1997). Livestock products, particularly milk and eggs, could even be the substitution of staple food to help mitigate seasonal fluctuation of crops (Wilson *et al.*, 2005). Land and livestock could also generate income and help owners accumulate assets, which further enhances household food security (Alam, 1997; Randolph *et al.*, 2007). Homestead food production program (HFP) in Bangladesh establishes a comprehensive model how productive asset can improve food security. By building productive asset through assisting households planting vegetables and raising livestock rich in micronutrients, HFP increase the quantity and variety of food production and consumption (Iannotti, Cunningham, & Ruel, 2009). The extra income from homestead garden prompts expending on no‒cereal food (Iannotti, Cunningham, & Ruel, 2009).

Third, assets may protect child dietary intake, though the effect has not been verified directly by empirical studies. Assets could bring people self-sufficiency and enhance their aspirations (Lerman & Mckernan, 2008), which can further increase the investment from parents to children. Several articles document that assets, independent of income, are positively associated with child educational outcome (Conley, 2001; Huang, Guo, Kim, & Sherraden, 2010; Zhan & Sherraden, 2003). Using data from 35 countries, Filmer and Pritchett (1999) report that wealth index computed based on asset ownership is associated with school enrollment and education attainment. Evidence also reveals that assets help relieve the discrimination towards girls in education (Deng *et al.*, 2013). Mediated by future aspiration, there might be positive association between assets and child dietary intake and further child nutritional outcome. Jin and Iannotti (2014) report that female-owned/co-owned livestock was positively associated with height-for-age z score mediated by child animal-source food intake.

Fourth, special asset related to food storage, for example, refrigerator, may have a unique effect. A lot of foods, such as green and yellow vegetable, fruit, milk, and meat, are easy to decay. By storing food in refrigerators, the quality of food can be prolonged particularly during hot season. Refrigerators can also keep food away from bugs and mice. By surveying over 1,000 households in Managua, Nicaragua, refrigeration leads to a 9%−10% increase of the consumption of protein and Vitamin A and 1.5% of calorie (Wolfe & Behrman, 1983).

### *2.3.2 Income, Assets, and Care*

Care, breastfeeding, complementary feeding, and hygiene and health seeking behaviors, is the second channel through which income or assets might lead to undernutrition. Breastfeeding is crucial for the children under the age of two. However, considerable amount of mothers stop breastfeeding early. Various factors significantly influence the decision and duration of breastfeeding. First, lack of psychological support, especially father's negative attitude, is listed as one of the most common reasons that bottle−feeding is chosen over breastfeeding, based on the survey to 245 mothers in Pennsylvania, U.S. (Arora *et al.*, 2000). A controlled trial in Italy reports that the training on the management of breastfeeding for fathers results in a higher prevalence of full breastfeeding at the sixth and twelfth months, more support and help in baby feeding, and lower perception of milk insufficiency, than the controlled group (Pisacane *et al.*, 2005). A study in Australia also finds that fathers' preference for breastfeeding and fathers' employment status is associated with the duration of breastfeeding (Scott *et al.*, 1999). Second, seeking employment or return to job after maternal leave is another reason for women to stop breastfeeding, and the eagerness to work along with the duration of breastfeeding, according to the cross−section and cohort studies in U.S., Peru, and Australia (Arora *et al.*, 2000; Ekwo *et al.*, 1984; Matias, Nommsen-Rivers, & Dewey, 2011; Scott *et al.*, 1999; Scott *et al.*, 2006). Third, educational level of mothers is another impact factor for breastfeeding. Low−educated women are unlikely to fulfill the recommended duration of breastfeeding (Kronborg & Væth, 2004; Riva *et al.*, 1999; Scott *et al.*, 1999). It shows that educational programs and knowledge from televisions, magazines, and books can encourage women breastfeeding (Arora *et al.*, 2000; Kronborg & Væth, 2004; Scott *et al.*, 1999).

The common reasons for discontinuing breastfeeding in China includes perceived breast milk insufficiency, mother back to work, and traditional feeding practice. Perceived breastmilk insufficiency is the most important reason for stopping breastfeeding (Dang *et al.*, 2001; Tian & Xie, 2003; Xiang *et al.*, 2001; Xiao, Wu, & Chen, 1998). Returning to work is the second common reason of ceasing breastfeeding. According to *Special Rules on the Labor Protection of Female Employees* issued by Chinese Government (2012), females have at least 98 days of maternal leave, which is much shorter than six months, the recommended length of exclusive breastfeeding by WHO. In urban China, especially developed urban area, mothers have to stop breastfeeding because of returning to work. Chinese traditional feeding practice suggests introducing complementary food before the sixth month, which is another important reason preventing mothers completing the six-month exclusive breastfeeding (Xu *et al.*, 2009). Some mothers thought babies should be weaned before 12$^{th}$ month (Dang *et al.*, 2001).

The determinants of hygienic and health seeking behaviors could be both internal and external. Internal factors are mainly personal financial adequacy and health knowledge, while external factors are unhealthy household environment and lack of health services, which is addressed in the next section.

Van der Stuyft and his colleagues (1996) asked 324 mothers in two villages of Guatemala whether they sought health care for children under the age of five suffered from diarrhea, fever, cough symptoms or worms. Less than 15% of cases are reported yes, even though the health care in that area was easily to access (Van der Stuyft *et al.*, 1996). A lot of parents fail to seek healthcare due to financial hardship. The study by Taffa and Chepngeno (2005) shows that finance is stated by nearly half of women as the reason of not to pursue medical care. Focus group discussion and survey in rural Inner Mongolia, China, also confirms that poor population is less likely to visit doctors (Zhang *et al.*, 2007). Lack of health knowledge could also be the barrier. The perception whether the disease is serious might determine whether the mother will choose health care for their children, so increasing caretakers' skills to recognize disease symptoms is recommended to improve health−seeking behaviors (Taffa & Chepngeno, 2005).

The direct link between income and care behaviors is mainly economic, but assets might impact care behaviors multi−dimensionally. For example, paid maternal leave is usually not enough for women to fulfill the recommended duration of breastfeeding, but with the financial cushion assets provide, families might be able to afford the loss of income so as to extend the length of breastfeeding. In addition, assets can increase parents' aspiration, which might motivate economic and emotional investment on offspring. The positive changes attributed to assets can bring increased support from husband and other family members to back breastfeeding, incentive to learn parenting skills and health knowledge, improve hygienic behaviors, create safe and healthy environment for children, etc. Other than those effects, some assets, such as TVs, radios, computers, and cell phones, can be the channels for people to learn more knowledge about children. However, due to lack of evidence, the proposed effects need to be examined by empirical studies.

### *2.3.3 Income, Assets, and Household Environment*

The third underlying cause of undernutrition is unhealthy household environment (UNICEF, 2012b). Household environment could be interacted with care, especially through hygiene behaviors. Good hygienic behaviors, such as cleaning children' excreta and setting bednet, could keep children out of unhealthy environment and pathogens. Since the above section already addresses the impact of income and asset on care, this part focuses on discussing about how income and assets would influence household environment.

While both income and assets could change household environment via the economic function, certain asset could improve household environment directly. Buckets with a cover and a spout can significantly prevent water contamination to reduce diarrhea for children, found by a random trial in Malawi (Roberts *et al.*, 2001). Improved stoves can reduce in-house air pollution to decrease the risk of respiratory infections, such as pneumonia (Cynthia *et al.*, 2008; Sinton *et al.*, 2004). Some components of household environment can be considered as parts of assets. For example, given other conditions are similar, a house with a toilet could be valued higher than a house without a toilet. The ownership of a toilet is negatively correlated with intestinal infection (Hosain, Saha, & Begum, 2003; Miguel & Kremer, 2004).

### *2.3.4 Income, Assets, and Access to Health Services*

Sufficient income or assets could make a family afford the expense on healthcare. This clears one of the most significant barriers for seeking healthcare. In addition, people tend to have precautionary saving against the uncertainty of future healthcare expense (Palumbo, 1999), which is one of the motivations for accumulating assets. With assets, people could perceive an increase of healthcare access. Durable assets might help with the access to health service. For instance, when long travel time from home to healthcare facilities prohibits people seeking healthcare, the ownership of vehicles might be a direct solution, though it is acknowledged that vehicles might bring on air pollution, which could be a hazard to environment.

## 2.4 Asset Effects and Asset-based Framework of Alleviating Undernutrition

In sum, despite that both income and assets could provide financial support to alleviate undernutrition, asset might have unique influences. First, assets can lead to positive attitude and behavior changes, which provides a foundation to eliminate undernutrition. Second, specific assets could target some causes of undernutrition, for example, animal-source food supplemented by livestock, transportation supplied by vehicles, water contamination prevented by buckets with covers. Based on these effects and UNICEF’s conceptual framework, the statement proposes an Asset-based framework of alleviating undernutrition (Figure 2.5).

Scholars have begun to check the association between undernutrition and wealth (measured mainly by assets) (de Onis, Frongillo, & Blössner, 2000). However, the evidence is still limited, which leads to the goals of the proposed study. According to the possible pathways between assets and undernutrition raised in this section, with controlling for confounding factors, the following hypotheses are proposed: first, assets protect household food security and further dietary intake of preschoolers; second, assets increase child care; third, assets improve household environment and access to health service, and then reduce infections for young children. The positive impact of assets would ultimately lead to better nutritional outcomes of young children.

Finally, it should be noted that the emphasis on the effectiveness of asset building does not deny or devalue other preventions and inventions to undernutrition. Building assets might not show its impacts in a short time, as it could take a relatively long period to accumulate assets to trigger the significance and then change behaviors (if what are hypothesized are verified). The positive impact of assets to child nutrition might decay along the long pathways as well. Assets are better treated as preventions or long-term interventions but not short-term interventions. If undernutrition is already present and threatening health, urgent interventions, such as nutrition supplementation and healthcare, are necessary to be provided and more effective. The perfect performance could be achieved if an Asset-based prevention/invention is combined with other short-term ones.

# Chapter III: Methods

## 3.1 Overview

The primary goal of the project is to examine the impact of assets on young child nutritional status, particularly specifying the difference between income and assets. Three hypotheses corresponding to each proposed pathway from assets to children nutrition are first tested. First, assets protect household food security and further dietary intake of preschoolers. Second, assets increase child care. Third, assets improve household environment and access to health services, and then reduce infections for young children. Finally, the overall impact of assets is examined. The proposed study conducts a secondary data analysis using China Health and Nutrition Survey (CHNS).

## 3.2 China Health and Nutrition Survey

CHNS is an ongoing longitudinal data project launched collaboratively by Carolina Population Center at the University of North Carolina at Chapel Hill and the National Institute of Nutrition and Food Safety at the Chinese Center for Disease Control and Prevention (CHNS, 2012). By a multistage, random cluster process, both urban and rural households from high, middle, and low income level are selected to ensure the national representativeness. The sample contains about 4,400 households and 26,000 individuals from nine provinces, representing eastern/coastal (Heilongjiang, Liaoning, Shandong, and Jiangsu), middle (Henan, Hubei, and Hunan), and western areas (Guizhou and Guangxi). The survey asks individual, household, and community level information including basic demographics, health and nutrition, food intake, breastfeeding, hygienic behaviors, household income and assets, and community infrastructure and services. At present, there are eight waves fully available for public use and the newest wave is 2009.

CHNS dataset is selected for this project for the following reasons. First, also the most important, CHNS have individual and household level information which is necessary to test the asset-based conceptual framework of undernutrition. Second, CHNS adopts a random sampling strategy to achieve national representativeness, so external validity could be of less concern. Third, CHNS dataset contains the most updated information. The project collects data every two to four years and the newest available wave of CHNS is 2009.

The disadvantage of CHNS is that the dataset does not have monetary measures of assets, therefore, the study cannot use the traditional asset measures, such as net worth, net worth without home equity, and liquid assets. However, it might be common that a large-scale dataset does not have good measures for both assets and nutritional status, such as Demographic and Health Survey data available for over 90 countries funded by USAID and implemented by ICF international (Measure DHS, 2013). The available dichotomous measure of asset ownership, particularly asset holdings, could be used to form a wealth index assisted by Principal Component Analysis (PCA) (Filmer & Pritchett, 2001). Since recommended by Filmer and Prichett, the approach has been adopted by scholars and many international organizations, such as the World Bank (Howe, Hargreaves, & Huttly, 2008). Therefore, CHNS data could still be considered plausibly answering the research question.

**3.3 Data**

The data are requested from the Carolina Population Center at the University of North Carolina at Chapel Hill and downloaded from the official website of CHNS project (http://www.cpc.unc.edu/projects/china) as the format of Statistical Analysis System (SAS) files. For the purpose of the study, only children younger than the age of five and their families are included in the analyzed sample. Waves 2004 and 2009 which are the two most recent waves with at least five years apart are pooled for a larger sample size and reflecting the current context of China, while the data of asset holdings and household income and from the previous waves, Wave 2000 and 2006, respectively, are also used to test the causality and duration of asset/income effects. The sample sizes of the two waves are generally balanced, while other statistics are also very similar across the two waves (Table 3.1).

## 3.4 Measures

The measures of each constructs are built based on the data availability and theory. The following paragraphs present the details of each measure which are summarized in Table 3.2 in the appendix.

### *3.4.1 Constructs in the Framework*

*Child nutritional outcomes* are measured by anthropometric indicators, namely z score of weight for height (WHZ), z score of weight for age (WAZ), and z score of height for age (HAZ). WHZ, WAZ, and HAZ is calculated based on the most updated reference provided by WHO 2006 Growth Standards (WHO Multicentre Growth Reference Study Group, 2006) and child age, height, and weight provided by the data. Stunting, wasting, and underweight are defined as the status two z scores lower than the median HAZ, WHZ, and WAZ of the reference population respectively, while severe stunting, wasting, and underweight are considered to be the status three z scores lower (UNICEF, 2012c). Stunting reflects chronic undernutrition, wasting is usually the result of acute undernutrition, and underweight is the mixture of chronic and acute undernutrition (Svedberg, 2000).

*Child dietary intake* is measured by four continuous variables: the average daily child intake of calorie in kcal, carbohydrate in grams, fat in grams, and protein in grams. The variables are provided directly by CHNS project calculated based on child daily food intake by 72 hours recall.

*Household food security* is evaluated in two dimensions: food quantity and food quality. Food quantity is measured by the total amount of food purchased, self-grown, and stored per day averaged by 72 hours recall. Food quality is assessed by Food diverse score, which is available food group count based on U.S. department of agriculture (USDA) food coding scheme (Ruel, 2003; USDA, 2013). The food category is recoded from the food code provided by the data according to the Chinese Food Composition Table (National Institute of Nutrition and Food Safety of Chinese Center for Disease Control and Prevention, 2002 &2004). The total amount of animal-source food per day measures both food quantity and quality. Animal-source food includes meat, poultry, fish and mixtures, eggs, milk and products. The value is obtained by 72 hours recall.

*Care* is measured by breastfeeding and care time. Breastfeeding is measured by the breastfeeding time in months. Care time is also measured by the total hours child is cared for by mother per day and the total hours cared for by other household members per day. Both the indicators are calculated by averaging the total hours adults spent on care for the children under the age of five during the past week.

*Infections* that affect nutritional status are measured by two dummy variables: whether a child had diarrhea in the past four weeks and whether a child had fever (a typical symptom for all the four common child infections) in the past four weeks.

*Access to health services* includes both financial accessibility and physical accessibility. Financial accessibility is evaluated by whether a child is covered by any kind of health insurance.

Physical accessibility is measured by the time taken from home to healthcare facilities in minutes.

*Household environment* has three related indicators available in the dataset. All the indicators are measured according to the observations of interviewers. The first one is whether the household has access to tap water. The original responses of “in-house tap water” and “in-yard tap water” are grouped as accessible to tap water while the options of “in-yard well” and “other place” are recoded as “not accessible”. The second one is whether a household has access to toilet with flushing. The original options of the question asking the type of toilet facilities includes “in-house toilet with flushing”, “public toilet with flushing”, “no toilet”, “in-house toilet without flushing”, “public toilet without flushing”, “cement openpit”, “earth openpit”, and “other”. The first two are grouped as accessible to toilet with flushing while the others are grouped as not accessible. The last one is whether any excreta are present around the dwelling place. The original responses are “no excreta”, “very little excreta”, “some excreta”, and “much excreta”. The first option is recoded as no excreta present around the dwelling place and the others are recoded as present.

*Assets* are measured by the wealth index, which is calculated based on the dichotomous information of the ownership of asset holdings by *principle component analysis*. The durable assets used for obtaining wealth index are tricycle, bicycle, motorcycle, car, VCR, color TV, washing machine, refrigerator, air conditioner, microwave, sewing machine, fan, camera, electric pot, pressure pot, computer, phone, and VCD. The wealth index, the component with the largest eigenvalue of 3.68, explains 20.45% of the total variance. The internal validity of the measure is measured by the method used in the studies by Córdova (2009) and Vyas and Kumaranayake (2006). The households are divided into five quintiles according to the wealth index. The percentages of ownership of durable assets are tabulated based on the quintiles. Details are present in Table 3.2.

### *3.4.2 Confounding Factors*

Control variables include individual and household demographics: child sex, child age in months, whether a child is the only child in a family, mother's educational level in years, mother's employment status (whether employed or not at the time of survey), mother's body mass index (BMI), father's education level in years, father's employment status (whether employed or not at the time of survey), annual household income, household size, whether the household lives in urban or rural area, the area where the household lives (eastern, middle, or western area), and wave (whether the case is from Wave 2004 or Wave 2009).

## 3.5 Data Analysis Plan

Data are managed and analyzed by STATA 12. First, univariate statistics present a description of each variable. Second, t-test or chi-square test is utilized to roughly compare the observations of the same variables between the two waves. Third, linear regression or logistic regression is performed to roughly check each pathway from asset holdings to child nutrition.

Based on the results of bivariate and simple multivariate analysis, Structural Equation Model (SEM) techniques are used to examine the effects of asset holdings on child nutritional outcomes by STATA 12. First, the full statistical model (Figure 3.4) based on the proposed Asset-based framework is divided into three sub-models: asset – household food security – child dietary intake, asset – care, asset − household environment & access to health services – infections. Each pathway is examined by SEM separately, as illustrated in Figure 3.5, 3.6, and 3.7. A stepwise testing strategy is adopted due to the complexity of the proposed framework. Finally, SEM is attempted to examine the comprehensive model.

Chi-square value and root mean square error of approximation (RMSEA) are used as the two main criteria for model diagnosis. A good-fit model is indicated by a small chi-square value and a RMSEA less than .06 with upper bound of 90% confidence interval smaller than .08 (Hu & Bentler, 1999). As there is no agreement on which criteria is best for model diagnosis, several other commonly-used indicators are also reported which include Comparative Fit Index (larger than .95 indicating a good fit), Tucker Lewis Index or Non-normed Fit Index (larger than .95 indicating a good fit), and Standardized Root Mean Squared Residual (smaller than .08 indicating a good fit) (Hu & Bentler, 1999).

The benefit of using SEM in this study is that it allows for testing the pathways between asset holdings and nutritional outcomes both separately and as a whole with control variables added and structurally examining how the effects of asset holdings, if it exists, flow along the pathways. Because the analyses involve multidimensional constructs, SEM is the most suitable analysis technique that addresses all measurement and structural relationships completely and simultaneously.

## Chapter IV: Results

### 4.1 Overview

This chapter first provides the descriptive characteristics of the sample. Wave 2004 and Wave 2009 are compared over the descriptive statistics, since the study pooled the two waves together for analysis. Then, it presents the results of multivariate analysis including regressions and SEM of each pathways. Finally, the findings from the full model are summarized.

### 4.2 Sample Description

Table 4.1 presents the descriptive statistics of all the independent, dependent, and control variables for the full, Wave-2004-only, and Wave-2009-only samples.

#### *4.2.1 Child Characteristics*

The average age of full sample is 3.46 (SD=1.00), while Wave-2004-only sample (M=3.32, SD=1.08) is slightly but statistically significantly younger than Wave-2009-only sample (M=3.60, SD=.91) ($t=-3.33$, $p<.001$). About 45 percent of the cases in the full sample are girls, and the ratio is generally the same across the two waves. About seven out of ten children are the only child in their households. Mothers on average have about nine years of education (SD=3.51), equivalent to graduation from middle school in China. Those from Wave 2009 (M=9.33, SD=3.37) are slightly better educated than those from Wave 2004 (M=8.46, SD=3.59) ($t=-2.77$, $p<.01$). Compared to mother's, father's education level is higher (M=9.39, SD=3.00) and consistent across the two waves. More fathers (90.50%) are employed than mothers (69.88%). The average BMI of mothers is 22.25 (SD=3.26) indicating a normal weight status.

The mean HAZ of −.64 shows that the children in the sample are chronically worse nourished than the world average whose HAZ is zero. However, the chronic nutritional indicator is improved significantly from Wave 2004 (M=−.90, SD=1.43) to Wave 2009 (M=−.38, SD=1.30) ($t$=−4.16, $p$<.001). In Wave 2004, 22.22% of the children are chronic undernourished, while 9.47% are in severe condition. In Wave 2009, the rates have significantly decreased to 8.47% and 5.08% respectively.

Child's short-term nutrition status is better than their long-term nutrition status. The weight of children (M=−.09, SD=1.14) is about equal to the world average. The mean WAZ of Wave 2009 is larger than the mean WAZ of Wave 2004, though the difference is not significant. The ratio of underweight in 2009 is also about 3% less than the ratio in 2004. Rare cases are reported in severe underweight. A typical child in the sample is not in acute undernutrition (M=.31, SD=1.25). The children from Wave 2004 (M=.44, SD=1.19) are better nourished than the children from Wave 2009 (M=.18, SD=1.30) by the WHZ indicator ($t$=2.28, $p$<.05). 4.22% of the children in Wave 2009 are wasted compared to 1.65% in Wave 2004.

Regarding child daily intake, the statistics of relevant variables from Wave 2004 and Wave 2009 is not statistically different. The children on average take 1,172.93 Kcal of calorie (SD=686.55), 161.93 grams of carbohydrate (SD=91.75), 41.08 grams of fat (SD=34.09), and 38.31 grams of protein (SD=26.37). The mean length of breastfeeding for the full sample is 11.78 months (SD=5.84) which is consistent across the two waves. With no significant difference between the two waves, the children receive 2.76 hours (SD=3.46) and 2.95 hours (SD=4.16) of care from their mother and other household members respectively. About half of the children are covered by various types of insurance. The coverage increased significantly from 20.30% in Wave 2004 to 78.04% in Wave 2009. The mean time of traveling to healthcare facilities is about 11 minutes (SD=12.84) and this measure is not available in Wave 2009. Two percent of the children had diarrhea in the past four weeks and the percentage of Wave 2009

(2.98%) is 2.5 times of the percentage of Wave 2004 (1.21%). For both the waves, about 18% of the children had fever in the past four weeks.

***4.2.2 Household Characteristics***

The households from Wave 2004 are significantly poorer than the households from Wave 2009 according to both wealth index ($t$=−4.77, $p$<.001) and household income ($t$=−6.12, $p$<.001). The median wealth index and household income of Wave 2009 is .37 (M=.71, SD=1.82) and 5,980.65 (M=8,348.85, SD=490.40) U.S. dollar in 2011 respectively, while they are −.37 (M=−.06, SD=2.02) and 3,632.17 (M=4,920.86, SD= 259.72) U.S. dollar in 2011 for Wave 2004 respectively. For a typical household in the sample, their wealth index (M=−.40, SD=1.87) and household income (M= 4,328.07, SD= 4,494.02) of the previous wave are both smaller than those of the current wave.

Regarding the measures of household food security, the total food available of the households in Wave 2004 (M=7,181.82, SD=3,813.84) is statistically the same as that of the households of Wave 2009 (M=7,132.77, SD=3,478.31). Compared to the amount of Wave 2004 (M=375.50, SD=469.55), the mean animal-source food available of the households in Wave 2009 (M=473.78, SD=545.07) is significantly higher ($t$=−2.48, $p$<.05). The average Food diverse score of Wave 2004 is 5.78 (SD=1.57), significant lower than the average Food diverse score of Wave 2009, 6.48 (SD=1.42) ($t$=−6.03, $p$<.001).

Nearly three out of four households in the sample have access to clear water. The percentage in Wave 2009 (76.41%) is higher than the percentage in Wave 2004 (71.07%), though the difference is insignificant. Nearly half of the households from Wave 2009 are accessible to toilet with flushing, and the ratio of Wave 2004 is about 8% less. About 31% of the households are found to have excreta present around and the percentage is consistent across the two waves.

Household size increase significantly ($t$=−4.24, $p$<.001) from Wave 2004 (M=4.56, SD=1.54) to Wave 2009 (M=5.13, SD=1.90). Nearly two thirds of the households in Wave 2004 are from rural sites, while the ratio in Wave 2009 is 70.88%. A balanced distribution is reported among eastern, middle, and western areas for both Waves 2004 and 2009.

## 4.3 Pathway: Asset Holdings – Household Food Security – Child Dietary Intake

### *4.3.1 Linear Regressions: Asset Holdings and Household Food Security*

Table 4.3 summarizes the linear regressions predicting the three proposed measures of household food security. For each measures, three regressions are run using the economic information of current wave, previous wave, and current and previous waves together respectively. The findings show that the area where the households live significantly explains variance of all the measures of household food security. The households from western areas have less food available and smaller Food diverse score compared with the households from middle and eastern areas. The households from the middle area have less animal-source food available than those from the other two areas. As expected, household size is positively associated with both total food available and animal-source food. Compared to the households from Wave 2004, the households from Wave 2009 have less total food but more food categories available per day. The education of mother and father are not significantly associated with any of the measures across all the models.

The household income of current wave is significant predictor for animal-source food available (Model IV and VI, Table 4.3) but not total food available or Food diverse score. The household income of previous wave is significantly associated at the level of .1 with total food available (Model III, Table 4.3) and animal-source food available (Model V, Table 4.3). In contrast, asset holdings are significantly positively associated with animal source food and food categories available but not total food available. Compared to the wealth index of the previous wave, the wealth index of the current wave appears a better predictor for both animal-source food available and Food diverse score, as the coefficients of the wealth index of the current wave are larger and with higher significant level.

### *4.3.2 Linear Regressions: Asset Holdings and Child Dietary Intake*

The results of linear regressions are shown in Table 4.4. Regarding child dietary intake, geographic disparity is not statistically clear for total calorie intake, total carbohydrate intake, or total protein intake in all the corresponding regressions. Children from the middle area have about seven grams less of fat intake than the children from eastern area when the economic information of previous wave are controlled. Significant urban-rural disparity is reported in both total carbohydrate intake and protein intake. With the economic information of the previous wave controlled, children from rural area has about 29 grams less intake of carbohydrate compared to their urban counterparts. In all the three regressions predicting total protein intake, the children from rural households eat about 1.7 grams of protein per day less than the children from urban households.

Mother's education level only significantly predicts total calorie and carbohydrate intake when the wealth index and income of the previous wave are added in the models. Each year increase in mother's education is significantly associated with 26.96 Kcal increase in calorie intake and about 4 grams increase in carbohydrate intake. Father's education level is a stronger predictor for all the four measures of child dietary intake than mother's education level. With each year increase in father's education level, a typical child takes about 43 more Kcal of calorie, 4.5 more grams of carbohydrate, 1.9 more grams of fat, and 1.7 more grams of protein by simply averaging the coefficients, given that the coefficients are very close.

Child age is another significantly positive predictor for all the measures except protein intake. Gender disparity is not found for any of the measures. Being the only child in the family is not significantly related with child dietary intake as well. Income, neither of the current nor previous wave, is significantly associated with child dietary intake. Assets of the current and previous wave have different impact on child intake. Assets of the previous wave negatively predict total calorie intake and total carbohydrate intake, while assets of the current wave are positively associated with total fat intake and total protein intake.

#### *4.3.3 SEM Models: Asset Holdings – Household Food Security – Child Dietary Intake*

The results of linear regressions guide building SEM models. The different pattern in the regressions hints that the indicators of household food security can be categorized into two different groups as well as the indicators of child dietary intake. The amount of animal-source food (ASF) available and Food diverse score are posited on one dimension of household food security while the total food available measures another. For the indicators of child dietary intake, calorie and carbohydrate intake are in one group while the other two are the other.

All the possible combinations are tried in the measurement models to test the pattern. Table 4.5 provides a summary of the model statistics. The models with ASF amount available and Food diverse score measuring household food security and fat and protein measuring child dietary intake have RMSEA lower than cutoff point and smallest chi-square value. Both the models also have other model-fitting indices close to the cutoff points. However, the model with the economic status of previous wave controlled is not converged. None of the other models fits the data well.

Figure 4.6 presents the best-fitted model with the economic information of the current wave as the main explanatory variables. The findings are consistent with the results of linear regressions. The structural model predicting household food security explains 43.28% of the variance, while the one predicting child dietary intake explains 26.49%. Although both the assets and income of current wave are significantly associated with child dietary intake mediated by household food security, the strength of assets is stronger than the strength of income. The indirect standardized association between assets and child dietary intake is .15 ($z$=3.62, $p$<.001), while the indirect effect of household income is .05 ($z$=2.03, $p$<.05). Geographic disparity is consistently reported for household food security. The households in the eastern area are securer in food than those in other areas. Children who are older, live in rural area, and with better-educated fathers have more dietary intake than their counterparts. Child sex, whether being the only child, and mother education are not significantly associated with child dietary intake. All the indicators strongly load on their corresponding constructs.

Figure 4.7 shows the SEM model with the assets and income of the previous wave controlled. The pattern is similar. The structural models explain less variance of both household food security and child dietary intake, compared to the models in Figure 4.6. The indirect effects of the assets of the previous wave on child dietary intake is significant but weaker ($r$=.10, $z$=2.02, $p$<.05) than the effects of the assets of the current wave. The indirect effects of the income of the previous wave on child dietary intake is not significant ($r$=.03, $z$=1.60, $p$=.11).The geographic disparity are stronger as well as the rural-urban disparity. In contrast, the association strength of assets and income both become weaker. The significance of child age does not stay.

## 4.4 Pathway: Asset Holdings – Care

### *4.4.1 Linear Regressions: Asset Holdings – Care*

Geographic disparity is present in predicting breastfeeding time and child care time by mothers with the coefficients consistent across the regressions. The average length of breastfeeding for the children from the western area is about 2.5 months less than the length of breastfeeding for the children from the eastern area, with other co-variants hold constant. Compared to the children from eastern area, the children from middle area are cared for 1.2 more hours by mothers per day. Rural-urban disparity is present in child care time by other household members at .1 level only when wealth index and household income of the current wave are controlled. The rural children are cared for about one hour less than the urban children.

Employment status and education level of mothers are the two prominent predictors for child care time. By simply averaging the coefficients, children with mothers employed receive about 2.4 hours less of care from mothers and one hour more of care from other household members than their counterparts with mothers unemployed. Each year increase in mothers' education is associated with about a quarter hour more of care per day by other household members.

When the economic status of the current wave are controlled, the employment status of fathers is significant associated with both breastfeeding time and care hours by mothers at .1 level. Children with employed fathers have on average about four months of breastfeeding time and 1.69 hours more of care by mothers than children with unemployed fathers.

Child sex is found significantly predicting breastfeeding time in all the three regressions. Girls are about two months less breastfed than boys. Being the only child is also correlated with less time of breastfeeding. Child age is significant associated with care time. Older children receive less care from both mothers and other household members. Neither wave difference nor mother BMI is significantly associated with three measures of child care. Household size is positively associated with child care time by other household members, as the dependent variable is not adjusted by household size.

None of the three measures is significantly associated with wealth index of the current or previous wave or the household income of the current wave. Only household income of the previous wave significantly predicts child care time by other household members. With every ten times increase in household income of the previous wave, the children get about .7 hours more of the care time by other household members.

***4.4.2 SEM Models: Asset Holdings – Care***

All the possible combinations of wealth index, household income, and indicators for the construct "care" are tried out for the final model selection. Table 4.9 summarizes the model diagnosis statistics. None of the models have the upper bound of 90% CI of RMSEA value below the cutoff point.

Figure 4.10 shows the model which only controls the assets of current wave fits the data best. Only the 90% CI upper bound value exceeds the suggested cutoff point, .08. With the breastfeeding time constrained for estimation, care hours by mothers is significantly loaded on care at .05 level. The structural model explains 84.13% of the variance of care. Geographic disparity is not significant for the construct "care" as well as assets or most of the other predictors. The employment status of mother and father's education level are the only two significant explanatory variables. Children with employed mothers and better-educated fathers receive less care than their counterparts.

The model with both the assets and income of current wave has slightly worse model-fitting indices than the above model (Figure 4.11). Less variance of care is explained by the structural model compared to the model in Figure 4.10. The pattern is generally the same except that the association of father education does not stay. The association strength of mother employment increase by .02.

### 4.5 Asset Holdings – Household Environment & Access to Health Service – Infections

#### *4.5.1 Logistic Regressions: Asset holdings – Household Environment*

Household environment is measured by the three dichotomous indicators: whether a household has access to tap water, whether a household has access to toilet with flushing, and whether a household has excreta present around. Table 4.12 provides a summary of the linear regressions. Geographic disparity is statistically clear. The households from both western and middle area more likely accessible to toilets with flushing, while the households from western area also more likely have tap water as water sources and excreta present around dwelling. Rural-urban disparity is also prominent. The environment of urban households are healthier than the environment of rural households across all the three dependent variables according to the findings from all the nine regressions.

The education level of mothers and fathers are not statistically associated with the dependent variables. The only exception is that households with higher-educated mothers more likely have access to toilets with flushing. Each year increase in mother’s education is associated with about 16% increase in the likelihood of accessing to toilets with flushing. When the assets of current wave solely are controlled, household size is a significant predictor for the first two dependent variables at .1 level. Households with larger size are less likely accessible to tap water and toilets with flushing.

Household income is not associated with any indicator for household environment. In contrast, assets significantly predict all the three dependent variables. The wealth index of the current wave is positively associated with both whether accessible to tap water and toilet with flushing meanwhile negatively associated with whether excreta present around dwelling. The wealth index of the previous wave has similar pattern of the associations with the dependent variables. The significance of the coefficients of both the assets of current and previous wave stays for all the indicators except whether accessible to tap water, when both the explanatory variables are controlled.

#### *4.5.2 Logistic Regressions: Asset Holdings – Access to Health Services*

The two groups of regressions predicting the two indicators of accessing to health services apparently have different patterns. None of the explanatory variables is significant in the regressions with time of visiting health facility. For the other indicator, whether covered by insurance, both the wealth index of the current and previous wave do not significantly explain the variance of the dependent variable. Household income of the previous wave is another significant predictor. Each ten times increase in the independent variable is associated with about 40% increase in the likelihood of insurance coverage.

Wave is the strongest determinant. Children from Wave 2009 are about twelves times more likely covered by health insurance. Mother's employment status is positively associated with the dependent variable. With employed mothers, the likelihood of covered by insurance increases more than 100%. Child age is the other significant predictor at .1 level. Each year increase in child age is associated with about 37% increase in the likelihood of covered by insurance.

### *4.5.3 Logistic Regression: Asset Holdings – Infections*

In the logistic regressions predicting whether having fever in the past four weeks, area is a consistent significant predictor. Children in middle and western area are less likely having fever. Father's education is the other significant predictor when the economic information of the current wave are controlled. Each year increase in father's education is associated with 13% decrease in the risk of having fever. Neither assets nor household income is significant in the models. However, none of the models significantly explains the variance of the outcome variable.

For predicting whether having diarrhea in the past four weeks, various variables are omitted in the model, as the dependent variable has limited case of "yes". Among all the models, only the one with the assets of current wave have two significant explanatory variables. The children in Wave 2009 is eight times more likely infected by diarrhea than the children in Wave 2004. When a mother get one more year of education, the risk of her child having diarrhea decreases 94%.

### *4.5.3 SEM Models: Asset Holdings – Household Environment & Access to Health Services – Infections*

Six SEM models well fits the data based on chi-square and RMSEA value (Table 4.15). However, the models with both indicators loaded on the construct "access to health services" and economic information of the current wave controlled are not converged. Figure 4.16(a) and 4.17(a) present the two similar models both with "access to toilet with flushing" and "access to tap water" loading on household environment. The two models are distinguished by whether the assets and income of current or previous wave controlled. The pattern are almost the same. Rural households are found to have worse environment than urban households. The difference in household environment between households in eastern and western area is also significant. The other Households with higher-educated mothers have better environment. Assets, but not income, has a significantly positive association with household environment. With “access to toilet with flushing” constrained, the other indicator “access to tap water” significant loads on household environment. The loading of “whether had fever in the past four weeks” on the construct “infections” is not significant with the other indicator “whether had diarrhea in the past four weeks” constrained. The only prominent difference between the two models is that “whether covered health insurance” is a significant predictor at .1 level for infection in the model with assets and income of the previous wave controlled (Figure 4.17(a)) but not for the other model (Figure 4.16(a)).

Figure 4.16(b) and 4.17(b) present the other two similar models both with “access to toilet with flushing” and “excreta present around household” loading on household environment. The two models are also different by whether the economic status of the current or previous wave is controlled. “Excreta present around household” significantly loads on household environment with the other measure constrained. The directions and strength of all the coefficient are generally the same with those in the models presents in Figure 4.16(a) and Figure 4.17(a), except that the negative associations between employment status of father and household environment are significant.

The model with all the proposed indicators loading on the construct “household environment” and assets and income of the previous wave also fits the data well (Figure 4.18). Both the two indicators significantly load on household environment with “access to toilet with flushing” constrained. Consistent with the two models in Figure 4.16(b) and Figure 4.17(b), assets, employment status of fathers, mother education, whether the child is in rural or urban site, whether the child is in western area are significantly associated with household environment. Whether covered by health insurance is positively associated with infection with significance at .1 level.

Compared the above models, the models presenting in Figure 4.16 explains the larger variance of household environment but less variance of infections than their corresponding models in Figure 4.17. Regardless the difference in measuring the constructs, the models with "access to toilet with flushing" and "excreta present around household" loading on household environment explain more variance of the latent variables.

Figure 4.19 shows the fitted model with both "time of traveling to healthcare facility" and "health insurance covered" loaded on the construct "access to healthcare". The model has the best model-fitting indices. However, with "time of traveling to healthcare facility" added which is available only in Wave 2004, the sample size used for SEM modeling is significantly reduced. The coefficients of the predictors are different from the previous models. The significance of mother education and rural-urban disparity stays, while the others including assets do not. With "excreta present" constrained, "access to tap water" significantly loads on household environment. Health insurance coverage weakly loads on "access to healthcare" while "time of traveling to healthcare facility" is constrained. For the construct "infections", the load of whether having fever in the past four weeks is not significant and the other indicator is constrained.

## 4.6 Full Models

### *4.6.1 Height for Age Z score*

All the explanatory variables are added into linear regressions predicting HAZ (Table 4.19). Consistently reported by all the three regressions, children from the eastern area have higher HAZ than those from the middle and western areas. Rural-urban disparity is found insignificant across the models. HAZ of children in Wave 2009 is about on average .4 larger than HAZ of children in Wave 2004. Child sex is found significant when only the assets and income of current wave are controlled. Girls' HAZ are about .4 smaller compared to boys' HAZ. The assets of current and previous wave are both positively associated with HAZ when each is independently controlled. When both of them are added to the model, the assets of the current wave is not significant and the other is significant at .1 level, though the linear model is not significant. Neither indicator of income is significant in any of the models.

The findings of linear regressions and the SEM models of pathways guide constructing the full model predicting HAZ. The best models including all the three pathways are selected based on the model-fitting indices and present in Figure 4.21 (a). The results are consistent with the findings of the linear regressions. A significant pathway from the assets of current wave to HAZ is reported. Assets are positively associated with household food security at the significance level of .001, while the latter is positively associated with child dietary intake at the level of .01. The indirect effects of assets on child dietary intake is .25 ($z$=2.73, $p$<.01).The effects then flow to HAZ via child dietary intake, though is not significant ($r$=.09, $z$=.71, $p$=.48). The mediating effects of care is not found, as care is not significantly associated with either assets or HAZ. As the association between household environment and infection is not significant, the pathway via household environment and infection is not significant as well, though assets of current wave is positively associated with household environment at the significance level of .001. The income of current wave is not statistically associated with either household food security or household environment. Direct sex disparity is found significant on HAZ. Girls' HAZ is .52 less than Boys'. Children from Wave 2009 is .71 more HAZ than children from Wave 2004. Significant geographic disparity is reported on household food security but not household environment. Families from eastern area are securer in food than those from other two areas. In contrast, urban-rural disparity is found in household environment but not food security. The impact of fathers and mothers is mainly on child dietary intake and care. Children with higher-educated mothers have more dietary intake. Children with an employed mother, an unemployed father, or a higher-educated father receive less care. While Food diverse score, fat, access to toilet with flushing, and care time by mothers are constrained, ASF amount, protein, excreta present around houses, and breastfeeding time all significantly load on their respective construct. Neither "whether having fever in the past four weeks" nor "whether having diarrhea in the past four weeks" significantly correlates with their measured construct. The negative interaction between child dietary intake and infection is supported by the SEM model.

To compare the above model, the similar model with the assets and income of previous wave controlled is present in Figure 4.21(b). The model does not fit the data well based on the RMSEA value and none of the pathways is significant. Although the assets of previous wave are significantly associated with both household environment and food security, the end of each pathway, infection and child dietary intake, is not statistically correlated with HAZ. The interaction of infection and child dietary intake is not evident in the model either. The association between household food security and child dietary is not significant as well. The income of previous wave is positively correlated with household food security at the significance level of .01. In addition, several coefficients become insignificant.

#### *4.6.2 Weight for Age Z score*

The linear regressions shows that neither assets nor income is significantly correlated with WAZ. Geographic disparity is prominent for WAZ. By averaging the coefficients of the three regressions, the mean WAZ of children in middle and western areas is respectively .5 and 1.1 less than the mean WAZ of children in eastern area. Child age is the other significant variable across all the regressions. Each year increase in child age significantly associates with .13 decrease in WAZ. Significant difference of WAZ by sex is found when the assets and income of the previous wave are controlled. Girls' mean WAZ .23 higher than boys'. Being the only child is correlated with .26 increase in WAZ. Whether mother is employed or not is significantly associated with WAZ only when assets and income of the current wave is controlled. The mean WAZ of the children whose mothers are employed is .26 less than the mean WAZ of the children whose mothers are unemployed. Mothers' BMI is also significantly associated with WAZ, when the assets and income of current wave are controlled.

SEM models reveal the consistent patterns with the linear regressions (Figure 4.22). Although both the assets of current and previous wave are significantly associated with household environment and food security, child dietary intake does not significantly predict WAZ while the interaction between infection and child dietary intake is also not supported. Weak geographic disparity is found in both models for household food security given that the households in middle area are less secure than the households in eastern area. Rural households have unhealthier environment than urban households. The association between employment status of fathers and care is significant in both SEM models.

Despite the similar pattern of the two models, the model with the assets and income of current wave fits the data well but the other does not. Rural-urban difference is reported for child dietary intake by the model with the assets and income of previous wave controlled but not the other. The coefficients of father's education and mother's employment status is significant for child care in the first model but not in the model with the assets and income of previous wave.

Additionally, breastfeeding time does not significantly load on care in the second model (Table 4.22(b)) but not in the first model (Table 4.22(a)).

### *4.6.3 Weight for Height Z score*

Both the assets of current and previous wave are negatively associated with WHZ when each group is independently controlled. When both of them are controlled, the significance of assets of current wave does not stay while the strength of assets of previous wave is also weaken. Neither income of current or previous wave is significant. The significance of household size, father's employment status, and child sex exists across all the regression. Each person increase in household size is associated with more than .1 increase in WHZ. The mean WHZ of the children with employed fathers is over .5 larger than the mean WHZ of the children with unemployed fathers meanwhile girls' WHZ is about .3 higher than boys'. Geographic difference is only found significant when assets and income of previous wave are controlled. Children from western area are on average about .4 less WHZ than children from eastern area. In contrast, the education level of fathers and BMI of mothers are significant only when the assets and income of current wave are controlled. With each additional year of education a father gets, WHZ of his child increase on average .06. Each point increase in mother BMI is significantly associated with .06 increase in child's WHZ. When the assets and income of previous wave are added, the coefficient of whether the only child or not is significant.

Shown by both the SEM models (Figure 4.23), the assets of current and previous wave are significantly associated with household food security and environment. However, the effects may not go through the corresponding pathways to WHZ. The associations between household environment and infection, between infection and child dietary intake, and between child dietary intake and WHZ are not significant with infection constrained on WHZ. The pathway of care is not significant at all. Neither income of current or previous wave is not significantly associated with household food security or environment.

In the model with the assets and income of current wave controlled, geographic disparity is found minor for household food security and insignificant for household environment. Rural-urban difference and the employment status of fathers is reported significant for household environment. Both the education level of fathers and the employment status of mother are negatively associated with care, while the employment status of father is positively associated. With one of measures constrained on each corresponding construct, the loading of the other one is significant. The exception is infection neither measure of which is significant.

With the assets and income of previous wave controlled, the model does not fit the data well based on the RMSEA value (Figure 4.23(b)). The geographic disparity on household food security is more prominent. Both the households from western and middle areas are worse in food security than the households from eastern area. The Rural-urban difference and child age are the two significant predictors on child dietary intake indicating rural and younger children have less intake than urban and older children. None of the employment status and education of parents is significant in the model. Breastfeeding time does not significantly load on child care.

### 4.7 Summary

The chapter presents both the sample description and multivariate analysis by linear regressions and SEM models. Except child nutrition, the statistics of other indicators are the same between Wave 2004 and 2009. Child nutritional status has been improved significantly from 2004 to 2009. The rate of underweight and wasting is relatively low. However, a considerable amount of children are still chronically undernourished.

SEM models are compared and selected mainly based on RMSEA value. All the fitted SEM models of the pathways via household food security or environment are shown in the figures. None of SEM models of the pathway via care fits the data well, so the best models are present. For the full models, only the models with the assets and income of current wave fit the data well, though the models with the assets and income of previous wave are also introduced for comparison.

Comparing the SEM models of each pathways and the full models, both the asset holdings of current and previous wave are positively associated household food security and environment. The asset holdings of current wave are also found have significantly positively correlation with HAZ by linear regressions, though the indirect effect is not significant reported by the full SEM models. In contrast, the income of current or previous wave is not correlated with household food security or environment. Neither of them correlate with any indicator of child nutrition either according to the results of both linear regressions and full SEM models. The associations between the asset holdings of previous wave and dependent variables are similar and weaker to the associations of the asset holdings of current wave.

Geographic disparity in household food security is consistent in linear regressions and fitted SEM models of the pathway "household food security – child dietary intake". The disparity is also found significantly in HAZ and WAZ by linear regressions. The children from eastern area on average have the largest HAZ and WAZ compared to the children from middle and western area. Rural-urban disparity in household environment is reported in all the fitted full models. Sex disparity is prominent in the linear regression and full SEM model only when the assets and income of current wave is controlled.

Fathers and mothers have reversed impact on the pathways. According to the full SEM model in Figure 4.21(a), the employment status of mothers are negatively associated with care, while a child with an employed father gets more care. The association between mother's education level and child dietary intake is positive, and the association between father's education level and child care is negative.

# Chapter V: Discussion

## 5.1 The Pathway: Household Food Security and Child Dietary Intake

### *5.1.1 The Effect of Asset Holdings and Income of the Current Wave*

Linear regressions report that assets of current wave are significantly associated with the indicators for ASF amount, Food diverse score, child intake of fats and protein (Table 4.3 and 4.4). The well-fitted SEM model (Figure 4.6) shows the same result. In the model, household food security is measured by ASF amount and Food diverse score. The construct, child dietary intake, is measured by fat and protein intake.

The amount of ASF available, Food diverse score, fat intake, and protein intake all could be considered as measures of high quality food or food quality, while the rest proposed indicators, i.e. total food available, calorie intake, and carbohydrate intake, measures staple food or food quantity. ASF is usually more expensive than staple food in developing area and considered as “high quality food”. ASF contains crucial nutrients for child development including vitamin A, B12, iron, and zinc as discussed in Chapter II. These nutrients are usually in highly bioavailable matrices helping better absorption and metabolism for young children and (Neumann *et al.*, 2003). Various studies have found association between ASF and child nutrition. For example, Sari *et al.* (2010) reports that the household expenditure on ASF is negatively associated with stunting of children age from 0 to 59 months in Indonesia. The association is more prominent for the children living in urban poor areas (Sari et al., 2010). Livestock ownership is found significantly correlated with HAZ mediating by child ASF intake for preschoolers in Kenya (Jin & Iannotti, 2014). Food diverse score is another indicator for food quality. A higher score namely means that the household have more kinds of food available, which could help to achieve a balanced nutrient intake. A study based on a nationally representative data of South Africa reports that food diverse score is associated with micronutrient adequacy, HAZ, and WAZ for children from 1 to 8 years old (Steyn *et al.*, 2006). Iannotti and Devesh (2013) used food diverse score to measure dietary quality and finds that household dietary diversity significantly mediates the association between highly pathogenic avian influenza and child nutrition.

Protein is usually rich in ASF, legumes, nuts and seeds (CDC, 2012b), while healthy fats, i.e. polyunsaturated fats and monounsaturated fats, are often contained in fishes, nuts, and seeds as well (CDC, 2012c). As these foods also contains various micronutrients, the intake of protein and fats could be good proxies of the intake of micronutrient. Neumann, Harris, and Rogers (2002) states that protein deficiency usually co-exists with micronutrient undernutrition. Given these kinds of food are relatively expensive, protein, fats, and micronutrients could be considered as “high quality nutrients” compared to staple nutrient, i.e. carbohydrate. Therefore, the first hypothesis to the first research question is partially supported. It could be concluded that assets are positively associated the food quality and the quantity of micronutrient-rich food of household food security, i.e. household high quality food security, and the positive association is extended to child high quality dietary intake.

Compared to assets, the effect of income is different. Linear regressions (Table 4.3 and 4.4) find that income of current wave is not significantly correlated with all the four indicators measuring food quality except food diverse score which is associated with income at the significance of .1 level. When the indicators are combined to measure the latent construct, the SEM model reports that the coefficient of income predicting household food security is significant, though the strength is much weaker than the strength of assets (Figure 4.6). Thus, income may be associated with the food quality of household food security but not child dietary intake. In addition, income might increase the food quantity of household, as it is significantly correlated with the amount of total food available at .1 level. However, the mediating effect of total food available is not significant, as income is not statistically associated with the intake of total calorie and carbohydrate.

The difference between the impact of assets and income is generally consistent with the discussion in Chapter II. Assets, as the stock of wealth, could serve as the fund for buffering the economic hardship and personal/family development. Improving nutrition, especially child nutrition, could be an important development goal. Households with more assets could invest more on high quality food and then increase the child intake of high quality nutrition. The other possible mechanism via which assets may increase child dietary intake is improving the priority of children in the intra-household food distribution.

Compared to assets, the effect of income could be mainly material. The increase of income could motivate people consume more, but the consumption might not clearly target development. It is consistent with the findings that income might improve household food security, especially food quantity, but the impact is relatively weak and does not extend to child dietary intake.

### *5.1.2 The Effects of Asset Holdings and Income of the Previous Wave*

The impact of asset holdings of the previous wave are also tested to answer the question when to start building assets, with the income of previous wave controlled. As the assets of current wave, the assets of previous wave is significantly associated with household food security. However, the association is weaker than the association of the assets of current wave based on the findings of both the linear regressions and SEM model (Table 4.3 and Figure 4.7). Further, different impact is reported for child dietary intake. The assets of current wave is positively and significantly associated with the two measures of food quality, i.e. intake of fats and protein, while the assets of previous wave are not (Table 4.4). For the other two indicators, the assets of current wave is not statistically associated, while the assets of previous wave is negatively associated (Table 4.4). The findings may suggest that the positive impact of assets on food quality of household food security and child dietary intake does not take several years but just relatively short-time to be effective. The weaker and positive impact of the assets of previous wave on household food security and child dietary intake may due to the positive association between the asset of current and previous wave ($r(458)=.76$, $p<.001$). However, the statement need to be further tested, as the amount of the missing values in the assets of previous wave is considerable.

The duration of income effect is not asked by the study. Income, as the flow of wealth, has hypothetically short-term effects. The findings are consistent with theory. Linear regressions report insignificant associations with six out of seven indicators (Table 4.3 and 4.4). SEM reports that the association between the income of previous wave and household food security is at the significance level of .1, smaller than the strength and significance level of the association between the income of current wave and household food security. The effect could be attributed to the association between the income of previous and current wave ($r(461)=.24$, $p<.001$) as well, though the statement may not be conclusive due to the large amount of missing.

## 5.2 The Pathway: Care

### *5.2.1 The Effects of Assets and Income of the Current Wave*

Both the linear regressions and SEM models report that asset holdings of the current wave are not significantly associated with the construct “care” or any of the three indicators (Table 4.8, Figure 4.10, and Figure 4.11). As assets can be used as the fund for unexpected hardship, one of the proposed channels via which assets can increase care is that a family may cash assets to bail out mother's time, in other words, keeping the mother out of work, for breastfeeding or general child care. According to the insignificant associations with mother's employment status ($t(431)=-.70$, $p=.48$), the hypothesis is not be supported by the findings. The result implies that increasing time for breastfeeding or child care may not be considered as that kind of hardship necessary to cash assets. However, the statement can be questioned from the following three points. First, the SEM models do not well fit the data, as the upper bound of 90% confidence interval of RMSEA is over .08. Therefore, the results could be unreliable. Second, the measure of mother's employment status may not be valid for examining the hypothesis. The answer of "yes" to question of "whether you are employed" does not exclude the status of "maternal leave" or "part-time work". Additionally, the answer indicate the employment status at the point of survey which may be different from the employment status during breastfeeding. Third, returning to work is not the primary reason for stopping breastfeeding in China. Perceived breast milk insufficiency is the most common cause, while the feeding culture is the third (Dang *et al.*, 2001; Tian & Xie, 2003; Xiang *et al.*, 2001; Xiao, Wu, & Chen, 1998). For both the causes, assets might have little impact. Therefore, even if assets could help mothers postpone returning to work, the effect might not be large enough to be statistically significant.

The other proposed channel via which assets might increase care is parents' aspiration. This mechanism is not well supported either, as assets are not significantly associated with care time by mothers or other household members in addition to breastfeeding time.  In sum, the findings does not support the hypothesis for the second question that assets, independent of income, could increase child care.

Regarding income, insignificant associations with breastfeeding and care time are reported by the linear regressions (Table 4.8). Care which has breastfeeding time and care hours by mothers loaded on is not significantly associated with income as well (Figure 4.11). In addition, income is positively associated with mother's employment status ($t(482)=-2.08$, $p<.05$), which implies that the families do not use household income to help mothers out of their jobs. The association between income and father's employment status is not significant either ($t(416)=-1.30$, $p=.19$). Therefore, it may be concluded that income does not have positive impact on child care.

### *5.2.2 The Effects of Assets and Income of the Previous Wave*

All of the associations between the assets of previous wave and the indicators of child care are insignificant (Table 4.8). Further, none of the SEM models with the assets and income of previous waves fits the data well (Table 4.9). In addition, neither the employment status of father nor the employment status of mother is significantly correlated with the assets of previous wave. Therefore, it might be concluded that the assets of previous wave cannot improve child care, though the same argument for the impact of the assets of current wave could be applicable as well.

The effects of the income of previous and current wave on breastfeeding time and care hours by mothers are consistent. The income of previous wave is found significantly associated with care hours by other household members. However, the association is not verified by the SEM models, as all the models with care hours by other household members do not fit the data based on RMSEA value. The effect cannot be well explained by theory or existing evidence and need to be further investigated.

## 5.3 The Pathway: Household Environment, Access to Healthcare, and Infections

### *5.3.1 The Effects of Asset Holdings and Income of the Current Wave*

Clear difference is found between the effects of assets and income for household environment by the linear regressions (Table 4.12). Assets are found significantly correlated with all the three indicators of household environment, while the income of current wave is not. Households with more assets are likely to have better household environment.

The results of SEM models are consistent with the findings of linear regressions. Two models have the value and 90% CI of RMSEA below the recommended threshold for good fitting (Figure 4.16). Both have only whether a child is covered by health insurance as the proxy of access to health services. "Time to healthcare facilities" is left out maybe because the measure is only available for Wave 2006, so introducing it to the model can significantly reduce the sample size. For the measures of household environment, one model has whether accessible to tap water and toilet with flushing, while the other has whether accessible to toilet with water flushing and whether excreta present around households grouped.

Both the fitted models (Figure 4.16) report that assets but not income is significantly associated with household environment. The positive effects of assets on household environment supports the hypothesis for the third research question. The significance may be the results of the following two impacts of assets. First, assets could increase parents' aspiration for their children and motivate them to create a healthy household environment. Income may not have the same effects. Second, whether accessible to tap water and toilets with water flushing, especially tap water and toilets within the dwelling place, could also be parts of household assets. However, the dataset may not have the proper information available to distinguish the two effects.

The impact of assets does not further lead to the reduction of infection, as the association between household environment and infection is not significant. There might be three possible explanations. First, whether having diarrhea and fever during the past four weeks may not be valid or reliable measures for infection, as neither significantly loads on the construct. Second, the indicators of household environment are mainly about water and sanitation, but do not well cover other important dimensions of household environment, such as air pollution and bednet protecting children from mosquitos. Third, children can get infections outside their households, for example, in daycares or parks.

Regarding access to health services, neither the assets nor income of current wave is significantly associated with whether a child is covered by insurance. The findings could be attributed to the health insurance system in China. As Chinese government provide public health insurance for urban employees, urban dependents, and rural residents, people rarely buy commercial health insurance. Therefore, assets and income may not make significant difference for health insurance coverage. Whether the case is from Wave 2009 is the strongest determinant for whether covered by health insurance. It may attribute to the health reform occurring after 2006. In 2007, China started providing health insurance for urban dependents who include young children (The State Council of P.R. China, 2007). In March of 2009, the State Council issued a bill promoting universal health insurance for all the citizens. By 2009, about 1.2 billion people, over 90% of the total population, are covered by some kind of insurance (National Health and Family Planning Commission of P.R. China, 2010). Therefore, wave is the determining predictor in the logistic models.

For the time of traveling to health facility, neither assets nor income is a significant predictor (Table 4.13). In China, most of the quality healthcare facilities locates in urban areas.

Therefore, urban residents are usually closer to healthcare facilities than rural residents, irrespective of their economic status. T-test shows that “the time to health facility” and whether a child lives in urban or rural area are significantly associated ($t(193)=1.91$, $p<.1$). Consistently, the coefficient of whether a child lives in rural or urban area is the largest and negative in the regressions. The insignificance for the models may be due to the small sample size used.

***5.3.2 The Effects of Asset Holdings and Income of the Previous Wave***

The asset holdings of previous wave are significantly associated with all the indicators of household environment but not the indicators of access to health services or either indicator of infections (Table 4.12, 4.13, and 4.14). However, the models with the assets of current wave independently controlled explain more variance than others based on chi-square value. Comparing the paired models in Figure 4.16 and 4.17, the strength of the association of assets of previous wave on household environment is .03 smaller than the strength of the association of assets of current wave. The significant but weaker association could be likely attribute to the strong association between the assets of the current and previous wave as well.

As the income of current wave, the income of previous wave does not have positive impact on household environment and further infections based on the findings of linear regressions (Table 4.12 and 4.14) and the SEM models (Figure 4.17 and 4.18). Regarding access to health services, the income of previous wave significantly predicts the likelihood of whether the child covered by insurance (Table 4.13). The significance might be due to its association with employment status. Child’s health insurance is usually affiliated with parent’s health insurance, especially mother’s. Before the reform of universal health insurance coverage completed, people mainly get health insurance via employment, as discussed in the previous section. Therefore, household income of previous wave (Wave 2000 and Wave 2006), as a proxy of employment, could be a significant predictor. The interpretation can be further verified by the fact that the significance level and strength of mother's employment status decrease when the income of previous wave is added to the model.

### 5.4 The Effects of Asset Holdings and Income on Child Nutrition

Based on the findings and discussion about each pathway to child nutrition, the research questions could be answered as following. First, assets can protect household high quality food security, and further increase child intake of high quality food. Income also has similar positive impact on household high quality food security, but the strength is weaker and the impact does not extend to child dietary intake. Second, neither assets nor income significantly improves child care. Third, assets but not income can ameliorate household environment, but both the impact of assets and income on access to health services are limited. However, neither assets nor income could reduce infections.

The further and also core research question of the study is whether assets, independent of income, can promote child nutrition. The linear regressions and SEM models consistently report that assets have different impacts on child nutrition. The association between assets and HAZ is positive and significant in the linear regressions. The full SEM models also find a significant pathway between assets and HAZ. Statistical insignificance is found between assets and WAZ consistently in both linear regressions and full SEM models. For WHZ, significantly negative association is reported by the linear regressions though not the full SEM models.

Low HAZ marks chronic undernutrition and can be viewed as an indicator for child poverty. As discussed in Chapter II, assets as the stock of wealth reflect the long-term economic status. This conceptual connection is generally consistent with the significant association between assets and HAZ. Compare to HAZ, WHZ measures short-term nutrition status while

WAZ is a composite indicator of HAZ and WHZ. Therefore, the association strength of assets is weaker.

According to the findings by SEM, there are two pathways starting from the assets of current wave to HAZ where all the chains are significant (Figure 4.21(a)). The first one is "assets – household food security – child dietary intake – HAZ" and the second one is "assets – household food security – child dietary intake <–> infection – HAZ". Household food security is measured by the amount of ASF available and Food diverse score. Child dietary intake is loaded by fat and protein intake. As discussed in Section 5.1, all these indicators measures food quality or the amount of high quality food in which micronutrients are rich. Given the importance of micronutrients, protein, and fats to child growth, the impact of assets can further lead to the increase of HAZ, which means the reduction of chronic undernutrition.

Assets may significantly increase HAZ via infections. Through the significant negative interaction between infections and child dietary intake, the positive effect of assets on improving child dietary intake can decrease infections and further result in better nutrition. However, the effect is not confirmative, as neither indicators of infections significantly loads on the construct and the association between infections and HAZ is constrained.

Assets and income are not significantly associated with WAZ and WHZ. Underweight and wasting can be reduced by increasing food intake. However, both assets and income are significantly on high quality food intake but not general food intake. In addition, few cases in the sample have low WAZ and WHZ. While more than 15% of children are stunted, only about 5%, and 3% of the children in the sample are underweight and wasted respectively. Other than undernutrition, China also has increasing prevalence of overnutrition. The prevalence of overweight has increased from 4.5% based on 2002 China National Nutrition and Health Survey

(Li *et al.*, 2007) to 6.6% based on the most updated statistics by UNICEF (2013). Studies in developed countries reveal that child overweight is inversely correlated with family socioeconomic status (Ball & Crawford, 2005). In contrast, the rate of child overweight is larger in higher socioeconomic status group in developing areas (He *et al.*, 2014; Jones-Smith *et al.*, 2011; Wang, Monteiro, & Popkin, 2002). Assets can be one of the proxy of socioeconomic status (McKernan & Sherraden, 2008), and China is in the transition from a developing country to a developed country. Therefore, both the association of assets between WAZ and WHZ could be nonlinear.

None of the full SEM models with the assets and income of the previous wave fits the data well based on RMSEA value. Therefore, the findings about the associations may not be appropriate for the comparison. Based on the results of linear regressions and SEM models of each pathways, the impact of assets and income of previous wave is generally insignificant or weaker than the impact of assets and income of current wave. It might be implied that first, the effects of assets and income do not last for three to four years given the interval of two neighbored waves in CHNS; second, the impact of assets and income take effects relatively quickly.

## 5.5 The Role of Parents

### *5.5.1 Mothers*

As primary caregivers, mothers play a crucial role in child growth. A powerful and better-educated mother could bring positive nutritional outcome to her baby. The study partially supports the existing evidence. Mother education are reported positively associated with child dietary intake by the full SEM model (Figure 4.21(a)) and with household environment by both the partial SEM model (Figure 4.16). With education, mothers could have good knowledge on choosing food and feed their children with nutrient-rich food. Education can also help mothers who usually do most of the housekeeping work better aware their household environment.

Empirical evidence shows that education is positive associated with breastfeeding engagement (Kronborg & Væth, 2004; Riva *et al.*, 1999; Scott *et al.*, 1999). However, this study finds that the impact of education on child care by mothers is not significant, which might be due to the dual effects of education. Although education may add the knowledge about the breastfeeding and then motivate mothers continuing breastfeeding, higher-educated females are also more likely to have a job. Returning to work is the second most important reason of discontinuing breastfeeding earlier than the recommended length. Nevertheless, controlling for employment status of mother may not be able to clarify the ambiguity, because the measure may only indicate the work status at the time of survey but not breastfeeding as discussed in Section 5.2. The argument can be supported by the findings that the association between employment status of mother and breastfeeding time is insignificant but the association between employment status of mother and care time by mothers is significant.

Regarding the care time by mothers, the coefficient of mother education is not significant while the employment status is the most prominent in both the linear models (Table 4.8) and SEM models (Figure 4.10, 4.11, and 4.21). The linear regressions also find that mother education is significantly positively associated with child care time by other household members (Table 4.8). However, the association is not verified by SEM, as the models with "care time by other household members" do not fit the data well (Table 4.9). The pattern may indicate that when jobs take most of the mother's time, the positive impact of education on the rest time of mother may be limited but well-educated mothers could ask other household members to take care their children to compensate for the loss of her care time.

The impact of mother's employment is significant for whether a child is covered by health insurance as well. The significance is likely due to the health insurance system in China. As mentioned in Section 5.3, pilot health insurance scheme for urban residents was launched in 2007. Both the scheme for urban and rural residents has not been universally extended to every citizen until 2009. Before the reform completed, children are usually covered by their employed parent's, especially mother's health insurance, under the mini-welfare system operated by state−owned enterprises (Gu, 2002).

Mother's BMI is not significantly associated with child care according to the results of linear regressions (Table 4.8) and SEM models (Figure 4.10, 4.11, and 4.21). However, the association is consistently positive especially for breastfeeding time. BMI may not be able to comprehensively describe the health condition of mothers, which could result in the insignificance but still positive association with child care.

### *5.5.2 Fathers*

Few studies have investigated the role of fathers on child nutrition. The study finds that the employment status and education of fathers have different impact on the pathways to child nutrition. Father's education is found positively associated with all the four indicators of child intake by the linear regressions (Table 4.4). A significant association between father's education and child dietary intake is reported by the SEM model (Figure 4.6) as well. The findings could be explained that fathers, usually higher status than mothers in a family, when better-educated, can make bigger impact on child dietary intake. However, the full linear regressions and SEM models do not report the same effect. The complexity of the model may result in the insignificance.

Father's employment is also found significantly associated with household environment by the full SEM model (Figure 4.21(a), 4.22(a), and 4.23(a)) but not the partial models or linear regressions. Such negative impact has not been reported by other studies or theory. The association may be due to their associations with a confounding variable. A follow−up research is necessary to investigate the issue.

The impact of father's employment on child care is relatively clear. Both the linear regressions (Table 4.8) and the full SEM model (Figure 4.21(a), 4.22(a), and 4.23(a)) present a significantly positive association between father's employment status and child care. The result is consistent with the findings of Scott *et al.* (1999). When fathers hold jobs and make income for their households, mothers could be willing or have to spend more time on child care.

Father's education is negatively associated with child care showed in the full SEM model (Figure 4.21(a), 4.22(a), and 4.23(a)), which is not consistent with the discussion in Chapter II. Higher education may not mean that fathers have more knowledge about child care. An alternative explanation could be that the continuous measure of father's education may capture the rest variance of the dichotomous measure of mother's employment, given that the positive association between the two variables ($t(394)=-1.68$, $p<.1$). Better-educated mothers are more likely to work and stop breastfeeding earlier. The association between father's education and employment status is not significant ($t(418)=-.35$, $p=.73$).

## 5.6 Disparity on Nutritional Status by Demographics

### *5.6.1 Sex Disparity*

Sex disparity is found significant directly on HAZ by both the full linear regressions (Table 4.20) and SEM model (Figure 4.21(a)). Controlling other variables, the average HAZ of girls is .55 less than the average HAZ of boys. The gender disparity is embedded in Chinese culture, as a boy will carry a family's surname and be considered as the backbone of a family. This pro-son culture can result in unfavorable decisions for girls during family planning and resource allocation. With the effects of only-child policy, females could be maltreated from the beginning of their life. Sex-selective abortion and undocumented birth of girls frequently happen, especially in rural area (Chu, 2001). Boys in rural areas are found more likely to be sent to school than their counterparts, while the expenditure related to schooling on boys is higher than the expenditure on girls (Gong, Van Soest, & Zhang, 2005). The reported sex disparity on HAZ which is the indicator of chronic undernutrition and child poverty is expected with the son priority structurally rooted in Chinese culture and consistent with the findings by Liu *et al.* (2008).

Sex disparity is not significantly on WAZ and WHZ, which may reflect the improvement on sex equality in China. Empirical evidence shows that parents from single−child families in urban China have the same aspiration for boys and girls (Tsui & Rich, 2002). Families in rural China spend equally on sons and daughters (Gong, Van Soest, & Zhang, 2005; Lee, 2008). The limited improvement can show effects on WAZ and WHZ which are the proxies of relatively short-term nutritional status but not on HAZ which are the indicator of long-term nutritional status and child poverty.

#### *5.6.2 Urban-rural disparity*

Urban-rural disparity is noticeable in the findings as well, particularly for household environment. It shows that rural households have lower access to tap water and toilet with water flushing and more likely have excreta present around than urban households. The findings are consistent with existing evidence. A national survey in 2006 reports that about 45% of the rural households do not have access to a centralized pipe water supply while the percentage of urban households is 6% (National Bureau of Statistics of China, 2008; Zhang *et al.*, 2009). Further, about half of the water samples from rural areas are not safe for drinking, mainly due to the contamination by untreated sewage (Zhang *et al.*, 2009). 57% of rural households, much lower than the ratio in urban area, are covered by improved sanitation (Zhang *et al.*, 2010). Carlton and her colleagues (2012) report that in 2008 about 62,000 deaths and 2.3 million disability−adjusted life years of children under the age of five are attributed to unsafe water, poor sanitation and hygiene. In addition to water and sanitation which are investigated in the study, air pollution is another health risk disproportionally influencing rural residents (Zhang *et al.*, 2010).

Beyond the disparity on household environment, the disadvantages of rural residents on access to health services also needs attention. Rural children are less likely covered by health insurance and their time of travelling to healthcare facilities is longer than urban children, though none of the coefficients is significant in the models (Table 4.13). According to the statistics by National Health and Family Planning Commission (2012), national expense per capita for rural residents in 2011 is 145 dollars, about one third of that for urban residents. Most of the quality healthcare facilities are located in urban areas (National Health and Family Planning Commission, 2012). The inequality on health resource distribution and household environment contributes to disproportionally burden of young child mortality. The rate of rural children under the age of five is 1.62%, about triple of the rate of urban preschool children (National Health and Family Planning Commission, 2012).

### *5.6.3 Geographic Disparity*

Geographic disparity is prominent for all the anthropometric indicators in the full regression models (Table 4.20). The children from eastern area are best nourished, the children from middle area are secondly best, and those from western area are worst, which is consistent with Liu *et al.* (2008). The full SEM model (Table 4.21(a)) reveals that the disparity is significant for household food security. It is agreed that the regional disparity is mainly caused by both the geographic factors and regional development policies favorable to coastal areas since 1980s, the beginning of economic reform (Chen & Zheng, 2008; Demurger, 2001; Demurger *et al.*, 2002). The unfavorable policy to inland area could further lead to the low productivity of cultivated land in interior areas due to lack of capital (Chen *et al.*, 2009), which is a constraint factor for promoting household food security.

## 5.7 Limitations and Unanswered Questions

### *5.7.1 Sample Size*

Sample size is a concern for the study. Although the total number of cases in Wave 2004 and 2009 is nearly 700, one of the measures of access to health services, time of travelling to healthcare facilities, is only available for Wave 2004, which is significantly reduce the sample size for the analysis including the measure. The number of missing observations also decrease the sample size available for analysis. The three indicators of care also have a lot of observations missed, particularly time of breastfeeding. Due to attrition, nearly one third of the observations of previous wave are missed.

Table 5.1 summaries the results of examining missing pattern. Whether a case is missed on all the indicators of care is not significantly associated with child nutrition. In contrast, the HAZ of the missing group on the variables of mother's information is significantly lower than the HAZ of the non-missing group. A similar pattern is found for the assets and income of previous wave. Thus, the estimation, especially of the variables of mother's information and economic status of previous wave, could be biased.

The same full models are estimated again by the option of Maximum Likelihood with Missing Values using Full Information Maximum Likelihood (FIML) method to sensitively examine the influence of missing values (StataCorp, 2013). The coefficients of the associations are generally consistent with and even more significant than the estimates by the method of Maximum Likelihood (ML) which uses pairwise deletion to treat the missing values, especially the estimates of the associations between assets, household food security, care, and household environment (Figure 5.2, 5.3, and 5.4).

In the models predicting HAZ, the one with the assets and income of the current wave explains 54.45% of the variance, about 5% more compared to the other one in Figure 5.2. The assets of the current wave also has a significant indirect effect on HAZ ($r$=.19, $z$=3.16, $p$<.01) mediated significantly by household food security and child dietary intake. The income of the current wave has the same but much weaker effect on HAZ ($r$=.02, $z$=1.80, $p$<.10). The assets of the previous wave also has a significant indirect effect on HAZ ($r$=.17, $z$=3.52, $p$<.001) (Figure 5.2(b)).

The same models explains less variance of WAZ and WHZ (Figure 5.3 and 5.4). Both the assets of current and previous wave are reported having significant indirect effects on WAZ ($r$=.17, $z$=2.78, $p$<.01; $r$=.06, $z$=1.93, $p$<.10). Neither the income of current nor previous wave has the same effect.

Compared to the findings by SEM using Maximum Likelihood and FIML, it could be claimed that the large amount of missing observations and unavailable data reduce the power of statistical analysis, particularly the full SEM models and the models testing the pathways via care and access to health services. FIML can produce unbiased and more efficient estimates than listwise and pairwise deletion if the missing is at random or completely at random (Enders &

Bandalos, 2001). However, as the assumption of missing at random or completely at random is not testable generally (Gill, van der Laan, & Robins, 1997; Manski, 2003), the estimates by FIML for this study may be biased. In addition, none of the models estimated by FIML is converged. Since the findings by the method of Maximum Likelihood are generally consistent with and conservative compared to the findings by FIML, the interpretation and discussion is made based on the findings by the method of Maximum Likelihood.

#### *5.7.2 Measurement Errors*

Measurement errors could be another limitation of the study, which may be fully or partially responsible for the insignificance in the pathways via care, household environment, and infections. As discussed in previous sections, the variables “whether the mother is employed” and “whether the father is employed” probably have an issue of validity when their associations with breastfeeding time is examined.

The measurement issues in the pathway ended with infections have not been fully discussed. Fever and diarrhea does not cover all the symptoms of common diseases for young children and may not well reflect the infectious status. In addition, weekly or two-week recall is preferable and recommended in collect information on childhood disease (Lee *et al.*, 2010). Four-week recall could lead to decrease the reporting of diarrhea as people may forget (Lee *et al.*, 2010). Due to data availability, some potential indicators are left out which could lead to the validity issue in measuring the construct “household environment”, such as indoor air pollutions. Insurance coverage may not be a good proxy of access to health services. The measure counts any kinds of insurance in China. However, the public insurance for urban employees, urban dependents, and rural residents, and commercial insurance could be very different from each other on premium, reimbursement rate and cap, and access to what kind of healthcare facilities

(Yip & Hsiao, 2008). Even with the same scheme, the premium and reimbursement rate and cap can be varied across provinces and cities (State Council of P.R. China, 2007). If available in the data, a better measure of access to health service than insurance coverage could be total out of pocket payment on healthcare.

### *5.7.3 Unanswered Questions*

Although SEM could be better than other statistical methods for testing causality, legitimate conclusions of causal relationship may not be drawn without the support of theory (Bullock, Harlow, & Mulaik, 1994; Markus, 2010). Together with the conceptual framework of undernutrition, the findings of this secondary data analysis suggest a causal relationship between assets and child nutritional outcomes. However, the causation is necessarily to be further verified.

Two other questions have to be answered before the findings can better guide practice. The first one is when to start building assets. The impact of assets and income of previous wave is examined to answer the question, but as the interval between two closest waves is two years, it may be only concluded that the impact could be effective in less than two years. Nevertheless, two years are still relatively long and a more accurate span is needed for practice. The other question is the magnitude of asset effect. Wealth index is a proxy of assets calculated by PCA but cannot be directly transferred to monetary value which is more frequently used in the practice of asset. To answer the questions together with causality, a study with careful control and design in field is necessary. A possible study could investigate the effects of assets by comparing the nutrition status of children and their parents who would be randomly assigned to different treatments. The treatments would be differentiated by time (when to start building assets) and methods of building assets or increasing income, for example, opening a “child nutrition saving account", opening a "child nutrition saving account" with the motivation of initial deposit, opening a "child nutrition saving account" with the motivation of matching saving (can be different level), opening a "child nutrition saving account" with an education program on child nutrition for parents, unconditional income transfer, and income transfer conditioning on nutrition related purpose.

### 5.8 Implications

The findings initiate the first step to setting an asset-based prevention or/and intervention to child undernutrition, especially chronic undernutrition. The study shows that assets could have a positive impact on child HAZ via household food security, child dietary intake, and maybe infections. Based on the findings, policy makers and practitioners could identify the vulnerable population to undernutrition. Undernourished children are more likely girls, those from rural and/or inland area, those with low-educated mothers, those with mothers employed, and those from low-asset households.

Once the causality, duration and magnitude of asset effect are verified and examined, an asset-based prevention or/and intervention can be established and applied to the vulnerable population. Based on the findings, asset-based programs are suggested to be combined with other interventions, particularly those improving mother's education and employment. Extended maternal leave or flexible working schedule should be provided for mothers during breastfeeding. Programs improve parents' knowledge of child nutrition and parenting skills can also be beneficial.

Asset-based prevention/interventions may also be applicable to other countries with heavy burden of child undernutrition, especially south Asian countries, as those countries share similar "pro-son" culture (Sen, 1990) and are in the relatively same development stage based on

Human Development Index (United Nations Development Program, 2014), such as India, Bangladesh, and Pakistan.

**5.9 Summary**

The findings of linear regressions support that assets, independent of income, have positive impact on child long-term nutritional outcome measured by height for age z score. The SEM models report that this positive impact mainly flows through the pathway of household high quality food security, child high quality dietary intake, and infections. Compared to assets, the effect of income is much weaker and the association between income and any of the nutritional indicators is not significant. The pattern is consistent with the theory. Assets, as the stock of wealth, could serve as the fund for personal development and increase the parents' aspiration, which motivates parents to expend more on nutrient-rich food and protect the priority of children during intra-household food distribution. In contrast, income, as the flow of resources, might not have the same impact. The other two hypotheses are not fully supported by the findings. The association between assets and care is positive but not significant in the full model. The significantly positive correlation between assets and household environment is consistently reported by the linear regressions, the SEM models of the corresponding pathway, and the full models. However, the positive impact does not reach infections, as the correlation between household environment and infections are insignificant.

The findings also indicate the importance of parents on child nutrition, especially via child care. Employment could take significant amount of mother's time and reduce care time by mothers, while the employed status of fathers may support mothers for prolonging breastfeeding and spending more time on child care. The education level of fathers is found negatively associated with child care. The result may be explained by the association between the education level of fathers and the employment status of mothers. It may be also implied that better education may not be equivalent to more knowledge on child care. The education level of mothers is reported positively associated with child dietary intake by the full SEM model predicting HAZ (Figure 4.21(a)), as mothers well educated would pay attentions on child dietary and feed their children with high quality food. Although the study also finds that the households with employed fathers are more likely to have unhealthy environment, the result is lack of support by theory and empirical evidence.

The research also reports significant sex disparity on HAZ, Rural-urban disparity on household environment, and geographic disparity on household food security and further HAZ. Children who are female, from rural or inland area are particularly vulnerable to chronic undernutrition.

The above results could be weakened by the considerable amount of missing values and measure errors. There are also unanswered questions about causality, the duration and magnitude of asset effects. However, supported by the similar findings by FIML and theory, it is worth continuing exploring an Asset-based prevention/intervention for reducing child chronic undernutrition. The study suggests policy makers and practitioners combining Asset-based programs and interventions on parents, especially mothers, to alleviate child undernutrition in developing areas.

# Chapter VI: Conclusions

Undernutrition, especially chronic undernutrition, is a serious threat to the physical and mental development of children, and the adverse outcomes can be extended to adulthood and next generation. About 45% of child deaths are attributed to undernutrition (Black *et al.*, 2013). Worldwide, more than 200 million children under the age of five are undernourished (Black *et al.*, 2013). Thus, there is an urgent call for preventions/interventions, particularly to chronic undernutrition.

According to the conceptual framework of undernutrition by UNICEF (2012b), the causes of undernutrition are various including infections, insufficient dietary intake, inadequate care, household food insecurity, unhealthy household environment, and lack of access to health services. Preventions or interventions correcting one or some of the causes may not be efficient, as children may still expose to other risk factors. Therefore, a program targeting poverty which underlies these risk factors could be promising to alleviate undernutrition, especially chronic undernutrition.

Assets, as the stock of wealth, could work as an economic cushion during unexpected hardship. Assets can also support personal and family's development and promote aspiration for future. Building assets could be an effective tool against poverty (McKernan & Sherraden, 2008; Sherraden, 1991) and demonstrated to improve children educational outcomes (Deng *et al.*, 2013; Zhan & Sherraden, 2003). The study aims at exploring the effects of assets on child nutritional outcome. Based on the UNICEF's (2012b) conceptual framework, it is hypothesized that assets can ameliorate child nutrition by the positive impact on household food security, care, household environment, and access to health services.

Using CHNS data collected via a multi-stage random cluster sampling strategy, the study testifies the hypotheses. The findings of linear regressions present that assets are positively associated with HAZ, while SEM models report significant pathways mediated by household food security, child dietary intake, and infections. In contrast, the relations between WAZ, WHZ, and assets are not significant. HAZ reflects the long-term nutritional status and low HAZ indicates a child is in poverty. WAZ and WHZ measures relatively short-term nutritional status. China, experiencing a rapid social transition and development, have a dual burden of undernutrition and overnutrition. The WAZ and WHZ of children reach to and even higher than the world average, but the status of chronic undernutrition is still serious. The findings suggest that asset-based programs could be promising in promoting nutritional status for undernourished children, especially those in chronic undernutrition. The effects on on average- or well-nourished children may be limited and need further investigation. The findings could be weakened by the considerable amount of missing values and measurement errors. Supported by the consistency with the estimates by FIML and the theory, the findings by SEM still confidently claims a causal relation between assets and child nutritional status.

The study also shows that the impact of assets may take effect quickly but not last for more than three years. Given the importance of the 1000-day window, i.e. from conception to a child's second birthday, for prevention or intervention for child undernutrition (Black *et al.*, 2013), building assets is suggested to begin at least by the time of conception. The families in China with a baby girl, employed mothers, low-educated mothers, unemployed fathers, from rural area, or from inland region are the high risk group which should be targeted for Asset-based preventions and interventions.

The asset-based interventions may be also applicable to other countries with significant issue of child undernutrition, especially those in Asia. South Asian countries are one of the areas where child undernutrition disproportionally affects. Many countries in those areas have the same “pro-son” culture. They are also in the similar stage of social development based on human development index as China. Studies are necessary to further examine the validity and reliability of asset-based prevention in different economic, social, and cultural contexts.

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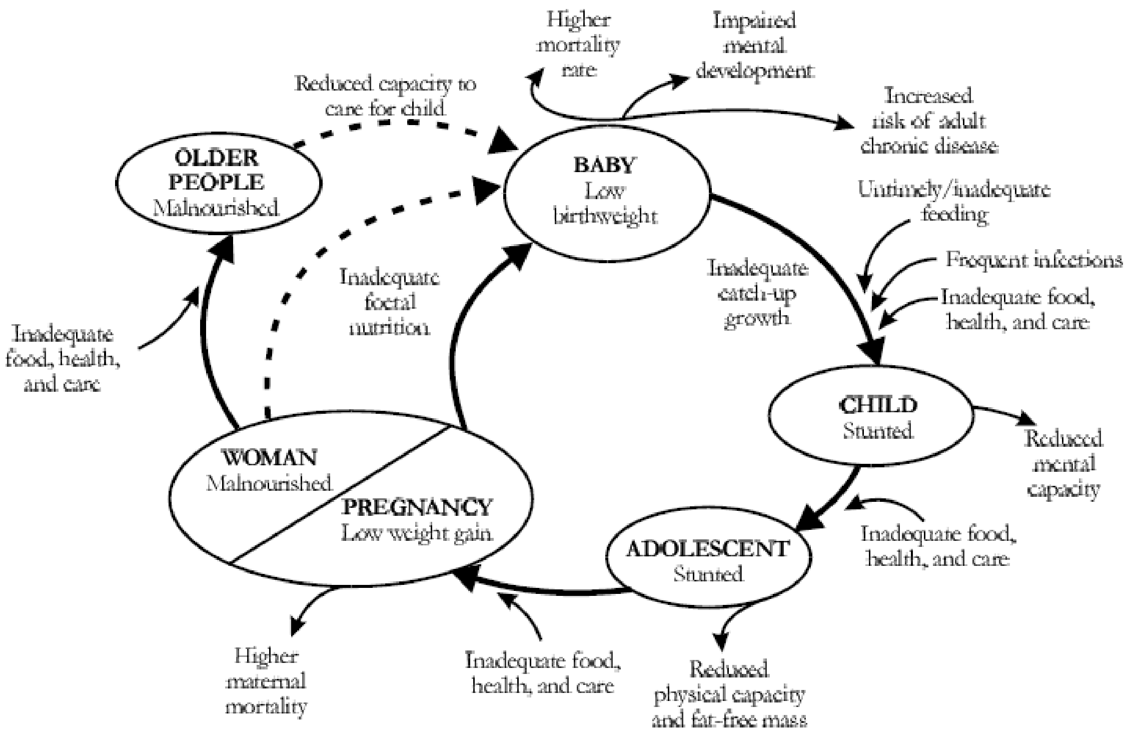
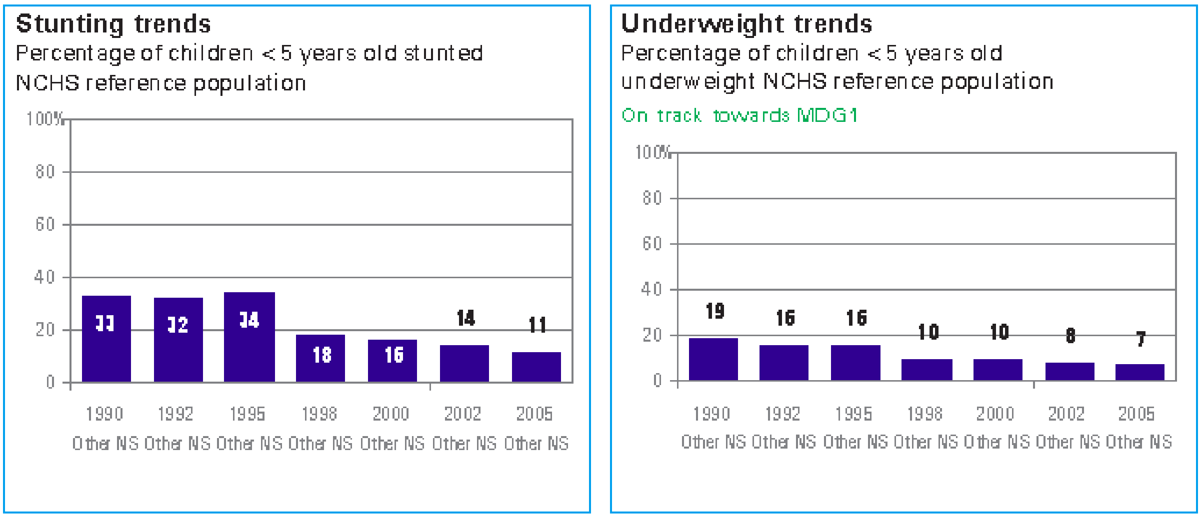
## Appendix

Figure 1.1: Undernutrition throughout the life cycle




Source: ACC/SCN, 2000

Figure 1.2: Trend of undernutrition for children in China



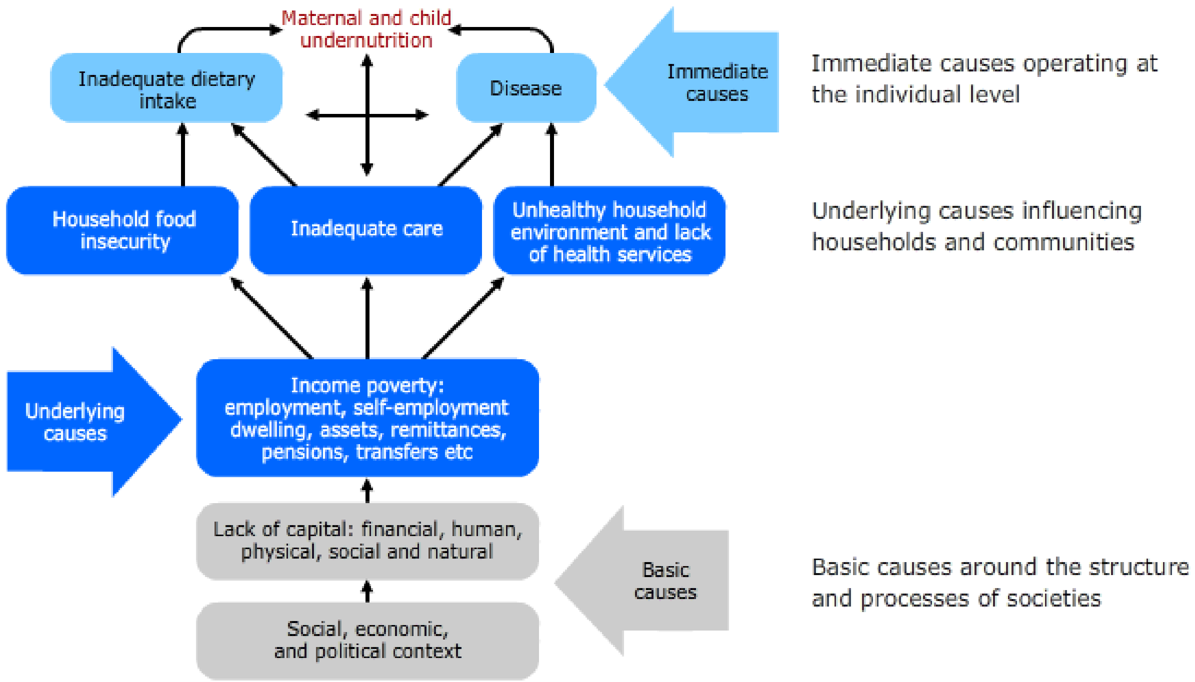

Source: UNICEF, 2009b

Table 1.3: The stunting prevalence of Chinese children under 5 years in 2008

| Age /Month | Eastern Area | | | Midland | | | Western Area | | | All | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Urban | Rural | Total | Urban | Rural | Total | Urban | Rural | Total | Urban | Rural | Total |
| 0−11 | 2.3 | 1.8 | 1.9 | 1.4 | 8.9 | 7.6 | 2.0 | 10.0 | 9.0 | 2.0 | 7.1 | 6.1 |
| 12−23 | 2.3 | 7.5 | 6.1 | 1.8 | 16.6 | 15.0 | 3.1 | 20.2 | 18.1 | 2.3 | 15.0 | 12.9 |
| 24−35 | 2.0 | 4.0 | 3.5 | 4.3 | 10.3 | 9.9 | 1.7 | 12.2 | 10.9 | 2.6 | 9.0 | 7.9 |
| 36−47 | 0.2 | 6.8 | 5.1 | 2.9 | 12.8 | 11.8 | 2.4 | 15.7 | 14.1 | 1.5 | 12.0 | 10.2 |
| 48−59 | 1.4 | 9.9 | 7.7 | 4.0 | 16.3 | 15.2 | 3.2 | 19.1 | 17.1 | 2.6 | 15.3 | 13.1 |
| All | 1.6 | 6.0 | 4.9 | 2.9 | 12.9 | 11.8 | 2.5 | 15.5 | 13.9 | 2.2 | 11.7 | 9.9 |

Source: Liu *et al.*, 2008

Figure 2.1: UNICEF's conceptual framework of undernutrition



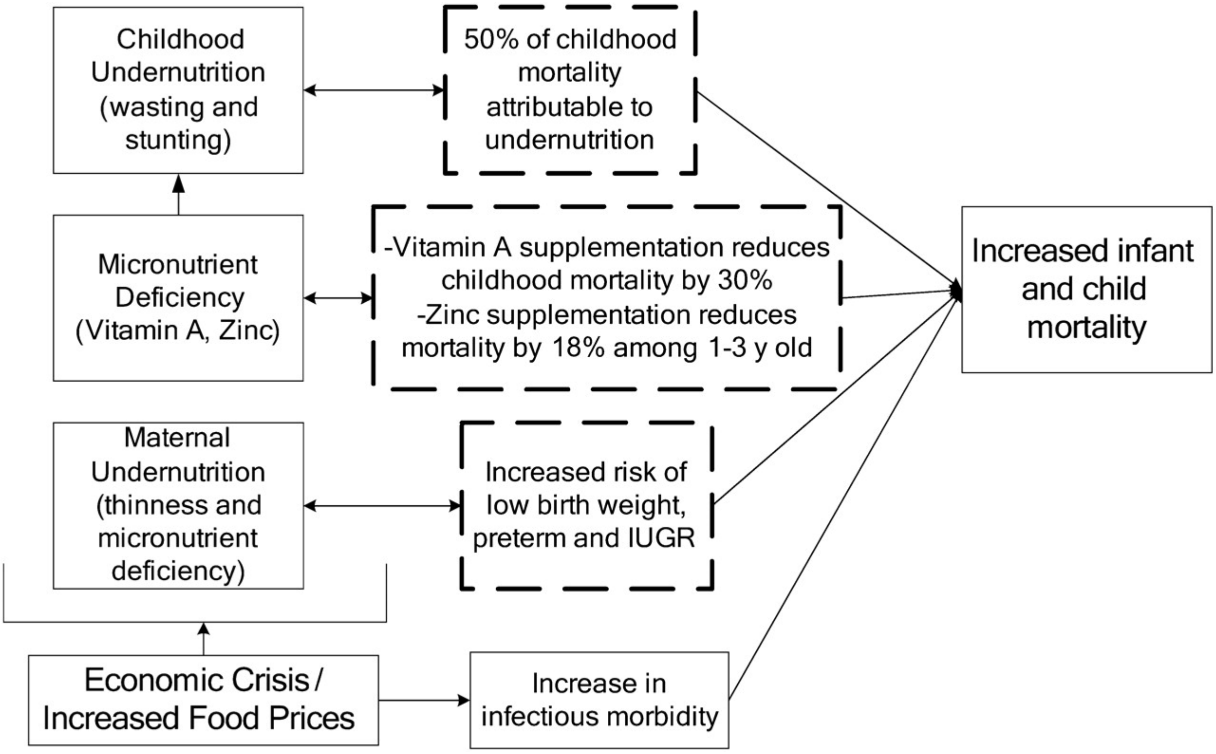

Resource: UNICEF, http://www.unicef.org/nutrition/training/2.5/4.html

Table 2.2: Energy requirements of breastfed, formula−fed and all infants < 1yr

| Age Month | Breastfeeding | | Formula−fed | | All | |
|---|---|---|---|---|---|---|
| | Boys | Girls | Boys | Girls | Boys | Girls |
| KJ/KG/Day | | | | | | |
| 1 | 445 | 415 | 510 | 490 | 475 | 445 |
| 2 | 410 | 395 | 460 | 455 | 435 | 420 |
| 3 | 380 | 375 | 420 | 420 | 395 | 395 |
| 4 | 330 | 335 | 360 | 370 | 345 | 350 |
| 5 | 330 | 330 | 355 | 365 | 340 | 345 |
| 6 | 325 | 330 | 350 | 355 | 335 | 340 |
| 7 | 320 | 315 | 340 | 340 | 330 | 330 |
| 8 | 320 | 320 | 340 | 340 | 330 | 330 |
| 9 | 325 | 320 | 340 | 340 | 330 | 330 |
| 10 | 330 | 325 | 340 | 340 | 330 | 335 |
| 11 | 330 | 325 | 340 | 340 | 330 | 335 |
| 12 | 330 | 325 | 345 | 340 | 330 | 335 |

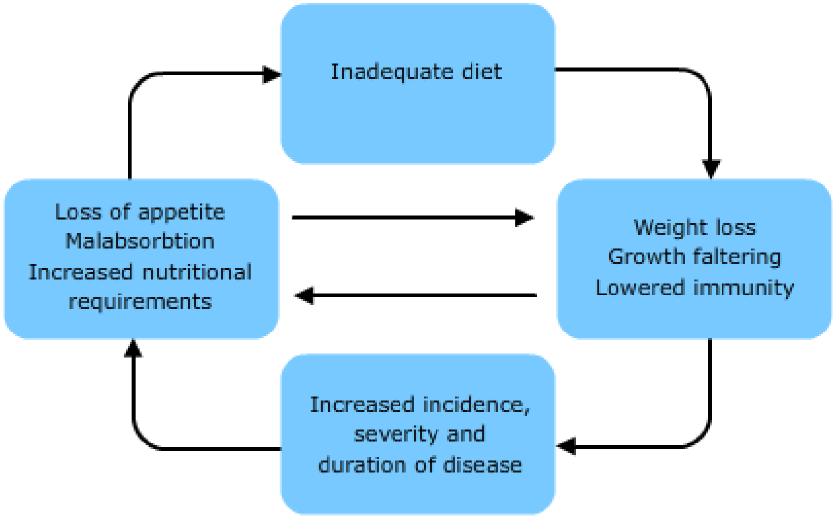
Source: FAO, 2001

Figure 2.3: Nutritional pathways




Source: Christian, 2010

Figure 2.4: The infection–undernutrition cycle




Source : http://www.unicef.org/nutrition/training/2.5/6.html

Figure 2.5: Asset-based framework for alleviating undernutrition

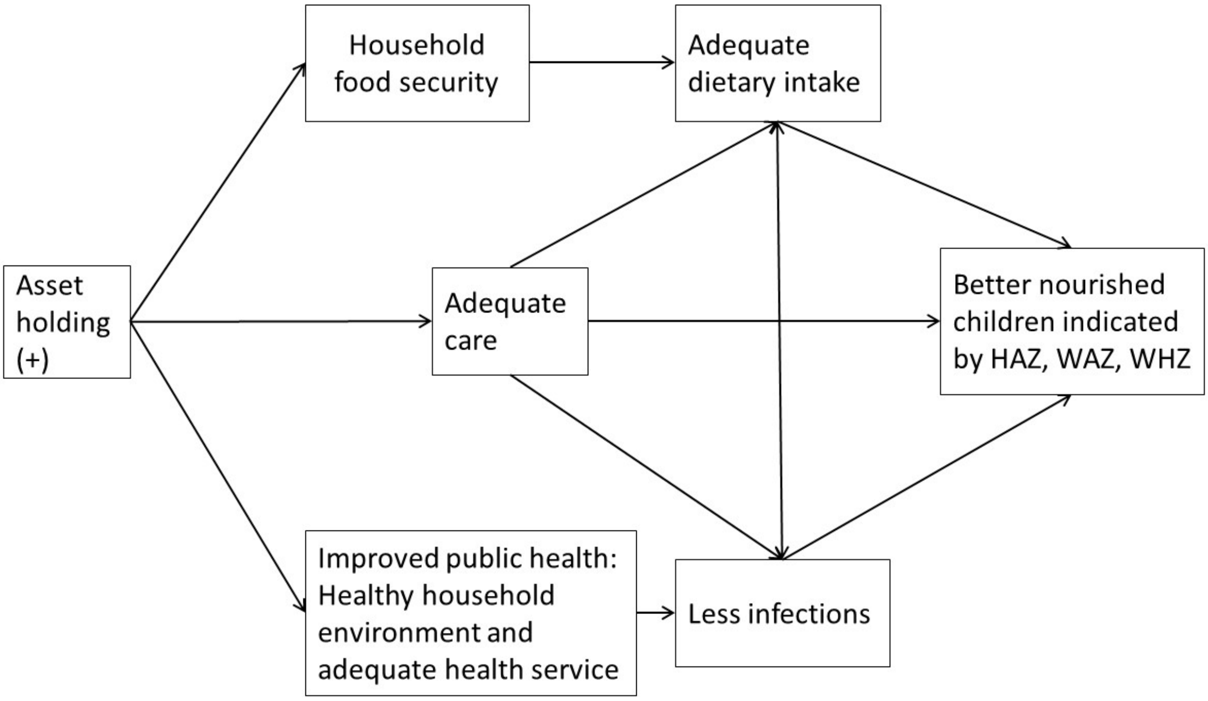


Table 3.1: Descriptions of the sample

| | Wave 2004 | Wave 2009 |
|---|---|---|
| Overall Size | 340 | 342 |
| Age in years | 3.32 (1.08) | 3.60 (.91) |
| Girls, % | 45.61 | 44.12 |
| Rural, % | 65.20 | 70.88 |
| Eastern Area, % | 38.89 | 35.88 |
| Middle Area, % | 29.82 | 32.94 |
| Western Area, % | 31.29 | 31.18 |

Note: Standard deviation of age is provided in parentheses.

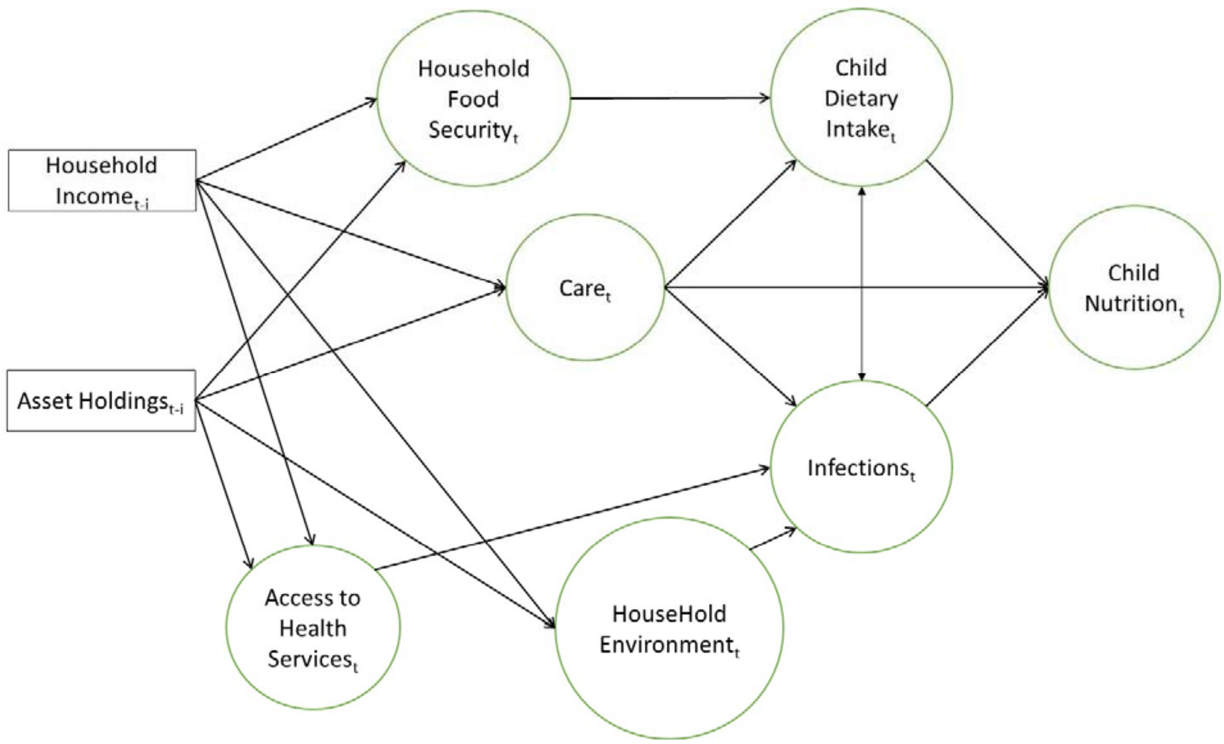
Table 3.2: Summary of measures

| Level | Construct | Measures |
|---|---|---|
| Individual | Child nutritional status | Height for Age Z Score |
| | | Weight for Age Z Score |
| | | Weight for Height Z Score |
| Individual | Child dietary intake | The daily intake of calorie (Kcal) |
| | | The daily intake of carbohydrate (grams) |
| | | The daily intake of fat (grams) |
| | | The daily intake of protein (grams) |
| Household | Household food security | The total amount of food purchased, self–grown, and stored per day averaged by 72 hours recall |
| | | The total amount of animal-source food purchased, self–grown, and stored per day averaged by 72 hours recall |
| | | Food diverse score |
| Individual | Care | The breastfeeding time in month |
| | | The total hours be cared per day by mothers |
| | | The total hours be cared per day by other household members |
| Individual | Infections | Whether a child had diarrhea in the past four weeks |
| | | Whether a child had fever in the past four weeks |
| Individual | Access to health services | Whether a child covered by health insurance |
| | | The time taken from home to healthcare agency in minutes |
| Household | Household Environment | Whether a household has access to tap water |
| | | Whether a household has access to toilet with flushing |
| | | Whether any excreta is present around the house |
| Household | Asset holdings | Wealth index |
| Individual | Child age | Child age in years |
| Individual | Child gender | Boy or girl |
| Individual | Only child | Whether a child is the only child in a family |
| Household | Mother's education | Mother's education in years |
| Household | Mother's employment status | Whether the mother of a child is employed |
| Household | Mother's BMI | Mother's body mass index |
| Household | Father's education | Father's education in years |
| Household | Father's employment status | Whether the father of a child is employed |
| Household | Income | Annual household income |
| Household | Size | Household size |
| Household | Site | Whether the household lives in urban or rural site |
| Household | Area | Whether the household lives in eastern, middle, or western area |
| Household | Wave | Whether the case is from Wave 2004 or Wave 2009 |

Table 3.3: Constructing and validating wealth index

| Durable assets | Loadings on wealth index | Validity of wealth index: Percentage of ownership by wealth quintiles | | | | |
|---|---|---|---|---|---|---|
| | | 1st | 2nd | 3rd | 4th | 5th, highest |
| Tricycle | −.0454 | 16.81 | 17.86 | 23.89 | 19.64 | 7.14 |
| Bicycle | .0312 | 53.98 | 65.18 | 59.29 | 58.04 | 70.54 |
| Motorcycle | .0717 | 26.55 | 49.11 | 53.98 | 48.21 | 55.36 |
| Car | .1128 | 2.65 | 1.79 | 4.42 | 16.07 | 13.39 |
| VCR | .1316 | .00 | .89 | 4.42 | 4.46 | 12.50 |
| Color TV | .1999 | 72.57 | 100.00 | 100.00 | 100.00 | 98.21 |
| Washing machine | .2866 | 31.86 | .60 | 84.07 | 94.64 | 98.21 |
| Refrigerator | .3777 | 1.77 | 17.86 | 65.49 | 93.75 | 98.21 |
| Air conditioner | .3218 | .00 | .89 | 9.73 | 35.71 | 74.11 |
| Microwave | .3636 | .00 | .00 | 4.42 | 17.86 | 75.00 |
| Sewing machine | .0178 | 33.63 | 41.07 | 38.05 | 35.71 | 38.39 |
| Electric fan | .1313 | 69.03 | 75.00 | 84.07 | 92.86 | 90.18 |
| Camera | .3331 | .00 | 1.79 | 1.77 | 13.39 | 60.71 |
| Electric rice cooker | .2372 | 34.51 | 66.96 | 71.68 | 90.18 | 96.43 |
| Pressure cooker | .2228 | 20.35 | 28.57 | 41.59 | 64.29 | 72.32 |
| Computer | .3359 | .00 | .00 | 1.77 | 14.29 | 69.64 |
| Telephone | .2692 | 12.39 | 54.46 | 66.37 | 77.68 | 95.54 |
| VCD or DVD | .2040 | 14.16 | 50.00 | 54.87 | 71.43 | 75.89 |
| Largest eigenvalue | 3.68 | | | | | |
| Proportion of variance explained | 20.45% | | | | | |

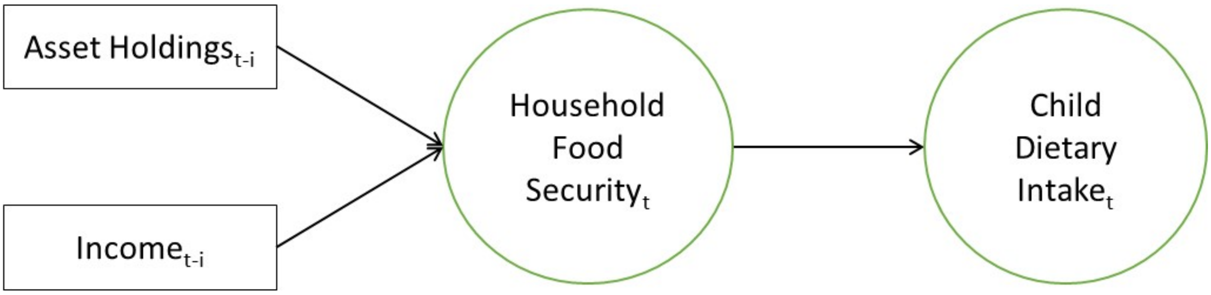
Figure 3.4: Full SEM model




Legend: control variables and undecided measures with related error terms omitted

| | |
|---|---|
| ▭ | : observed variable; |
| ◯ | : construct or latent variable; |
| → | : direct effect; |
| ↔ | : correlation; |
| t | : current wave in the subsample; |
| t−i | : $i^{th}$ wave before in the subsample, i=0,1. |

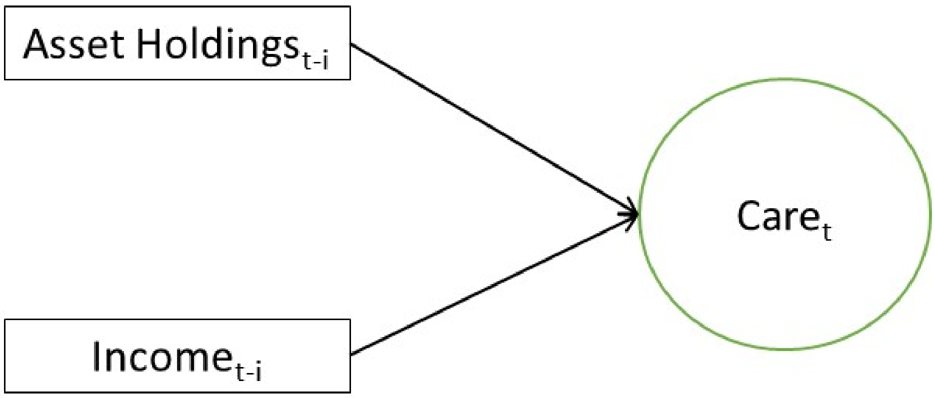
Figure 3.5: Sub−model: Asset holdings – household food security – child dietary intake




Legend: control variables and measures with related error terms omitted

| | |
|---|---|
| ▭ | : observed variable; |
| ◯ | : construct or latent variable; |
| → | : direct effect; |
| ↔ | : correlation; |
| t | : current wave in the subsample; |
| t−i | : $i^{th}$ wave before in the subsample, i=0,1. |

Figure 3.6: Sub−model: Asset holdings – care

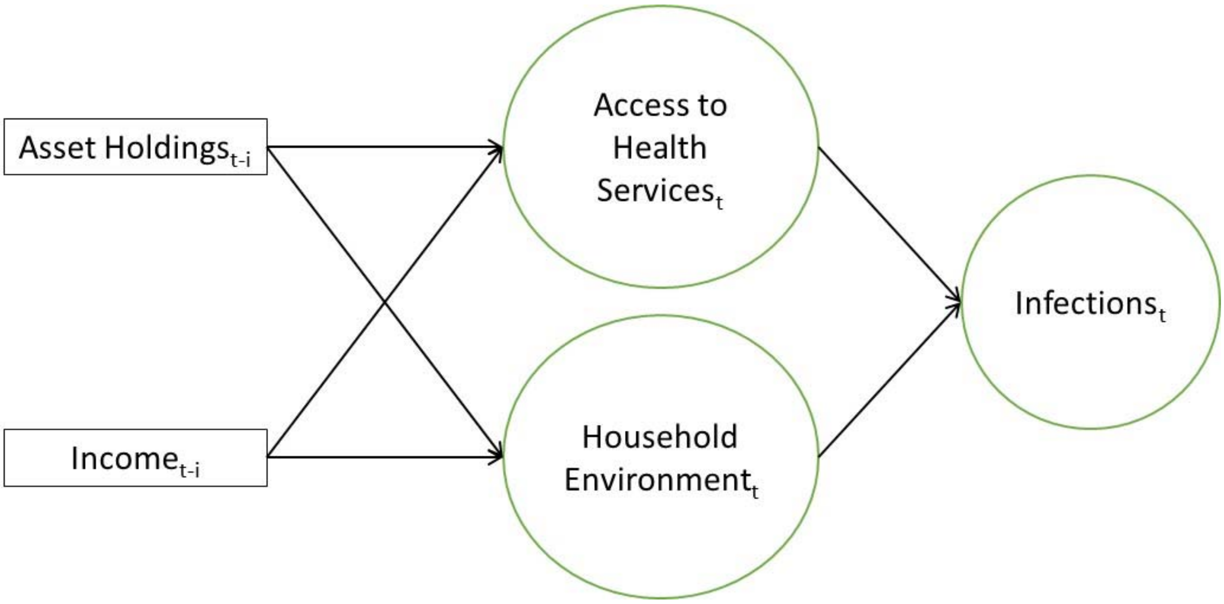



Legend: control variables and measures with related error terms omitted

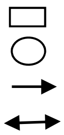
| | |
|---|---|
| ▭ | : observed variable; |
| ◯ | : construct or latent variable; |
| → | : direct effect; |
| ↔ | : correlation; |
| t | : current wave in the subsample; |
| t−i | : i[th] wave before in the subsample, i=0,1. |

Figure 3.7: Sub−model:

Asset holding – household environment & access to health services – infections




Legend: control variables and measures with related error terms omitted



: observed variable;
: construct or latent variable;
: direct effect;
: correlation;
t : current wave in the subsample;
t−i : $i^{th}$ wave before in the subsample, i=0,1.

Table 4.1: (to be continued) Child descriptive characteristics of the full, wave 2004-only, and wave 2009-only samples

| Child Characteristics | Full Sample (n=342) | | Wave 2004 (n=340) | | Wave 2009 (n=342) | | $p$−value ‡ |
|---|---|---|---|---|---|---|---|
| | % or M(SD) | Range | % or M(SD) | Range | % or M(SD) | Range | |
| Demographics | | | | | | | |
| Age (years) | 3.46(1.00) | .12~5.00 | 3.32(1.08) | .12~5.00 | 3.60(.91) | 1.22~5.00 | <.001 |
| Gender (1=females) | 44.87 | / | 45.61 | / | 44.12 | / | .69 |
| Only child (1=yes), % | 71.90 | / | 73.99 | / | 69.72 | / | .25 |
| Mother Demographics | | | | | | | |
| Education level (years) | 8.90(3.51) | 0−18 | 8.46(3.59) | 0~18 | 9.33(3.37) | 0~17 | <.01 |
| Employed (1=yes), % | 69.88 | / | 70.33 | / | 69.42 | / | .83 |
| Body Mass Index | 22.25(3.26) | 15.33~36.53 | 22.22(3.33) | 16.02~36.53 | 22.28(3.19) | 15.33~33.19 | .87 |
| Father Demographics | | | | | | | |
| Education level (years) | 9.39(3.00) | 0~18 | 9.34(3.07) | 0~17 | 9.46(2.94) | 3~18 | .69 |
| Employed (1=yes), % | 90.50 | / | 88.58 | / | 92.57 | / | .16 |
| Nutritional Status | | | | | | | |
| Height−for−age z score | −.64(1.39) | −5.33~3.13 | −.90(1.43) | −4.77~3.13 | −.38(1.30) | −5.33~2.42 | <.001 |
| Stunted (1=yes), % | 15.45 | / | 22.22 | / | 8.47 | / | <.001 |
| Severe stunted (1=yes), % | 7.31 | / | 9.47 | / | 5.08 | / | <.10 |
| Weight−for−age z score | −.09(1.14) | −3.10~3.39 | −.17(1.13) | −2.80~3.20 | −.01(1.14) | −3.10~3.39 | .11 |
| Underweight (1=yes), % | 4.44 | / | 5.91 | / | 2.89 | / | .10 |
| Severe underweight (1=yes), % | .20 | / | .00 | / | .41 | / | .48 |
| Weight−for−height z score | .31(1.25) | −3.54~4.84 | .44(1.19) | −3.54~4.84 | .18(1.30) | −2.76~4.62 | <.05 |
| Wasted (1=yes), % | 2.92 | / | 1.65 | / | 4.22 | / | <.10 |
| Severe wasted (1=yes), % | .42 | / | .82 | / | .00 | / | .50 |

‡ Probability values indicating whether Wave 2004 and Wave 2009 are statistically significantly different on each of the variables in the models; M = Mean; SD = Standard deviation

Table 4.1: (continued) Child descriptive characteristics of the full, wave 2004-only, and wave 2009-only samples

| Child Characteristics | Full Sample (n=342) | | Wave 2004 (n=340) | | Wave 2009 (n=342) | | *p*−value ‡ |
|---|---|---|---|---|---|---|---|
| | % or M(SD) | Range | % or M(SD) | Range | % or M(SD) | Range | |
| Daily Intake | | | | | | | |
| Calorie (Kcal) | 1172.93 (686.55) | 187.02~ 5316.54 | 1187.32 (769.81) | 239.98~ 5316.54 | 1158.45 (591.91) | 187.02~ 4488.42 | .58 |
| Carbohydrate (grams) | 161.93 (91.75) | 29.48~ 933.44 | 165.75 (102.69) | 34.54~ 933.44 | 158.09 (79.21) | 29.48~ 600.22 | .28 |
| Fat (grams) | 41.08 (34.09) | 1.51~ 297.64 | 41.12 (38.59) | 3.37~ 297.64 | 41.04 (28.92) | 1.51~ 233.40 | .98 |
| Protein (grams) | 38.31 (26.37) | 5.25~ 267.51 | 37.87 (30.34) | 6.28~ 267.51 | 38.74 (21.69) | 5.26~ 146.58 | .67 |
| Care | | | | | | | |
| Breastfeed (months) | 11.78(5.84) | 0~36 | 11.88(6.33) | 0~36 | 11.58(4.65) | 0~24 | .72 |
| Care hours by mother | 2.76(3.46) | 0~17.14 | 2.77(3.55) | 0~17.14 | 2.75(3.38) | 0~15 | .94 |
| Care hours by others members | 2.95(4.16) | 0~24.29 | 2.94(4.31) | 0~24.29 | 2.96(4.02) | 0~24 | .97 |
| Access to Health Services | | | | | | | |
| Insured (1=yes), % | 49.48% | / | 20.30% | / | 78.04% | / | <.001 |
| Time of traveling to healthcare facilities (minutes) | 10.87(12.84) | 0~115 | 10.87(12.84) | 0~115 | / | / | / |
| Infections | | | | | | | |
| Had diarrhea (1=yes), % | 2.10% | / | 1.21% | / | 2.98% | / | .11 |
| Had fever (1=yes), % | 17.96% | / | 18.07% | / | 17.86% | / | .94 |

‡ Probability values indicating whether Wave 2004 and Wave 2009 are statistically significantly different on each of the variables in the models; M = Mean; SD = Standard deviation

Table 4.2: Household descriptive characteristics of the full, wave 2004-only, and wave 2009-only samples

| Household Characteristics | Full Sample (n=342) | | Wave 2004 (n=340) | | Wave 2009 (n=342) | | *p*−value ‡ |
|---|---|---|---|---|---|---|---|
| | % or M(SD) | Range | % or M(SD) | Range | % or M(SD) | Range | |
| Economic Status | | | | | | | |
| Assets: Wealth Index | .33(1.96) | −3.77~5.31 | −.06(2.02) | −3.77~5.22 | .71(1.82) | −3.74~5.31 | <.001 |
| Assets: Wealth Index (Previous Wave) | −.40(1.87) | −3.74~5.12 | −.93(1.78) | −3.74~4.43 | .09(1.83) | −3.73~5.13 | <.001 |
| Income (log)* | 8.34(1.05) | 2.75~11.41 | 8.10(.99) | 2.75~10.43 | 8.58(1.06) | 3.97~11.41 | <.001 |
| Income (Previous Wave) (log)* | 7.93(1.15) | 0~10.79 | 7.86(.98) | 4.43~10.42 | 7.99(1.29) | 0~10.79 | .22 |
| Food Security | | | | | | | |
| Total food available | 7,156.85 (3,644.15) | 0~ 30,473.33 | 7,181.82 (3,813.84) | 893.33~ 30,473.33 | 7,132.77 (3,478.31) | 0~29,576.6 7 | .86 |
| Animal-source food available | 425.83 (511.61) | 0~3,513.33 | 375.50 (469.55) | 0~3,033.33 | 473.78 (545.07) | 0~3,513.33 | <.05 |
| Food diverse score | 6.14(1.54) | 0~9 | 5.78(1.57) | 2~9 | 6.48(1.42) | 0~9 | <.001 |
| Environment | | | | | | | |
| Clear water (1=yes), % | 73.76 | / | 71.07 | / | 76.41 | / | .15 |
| Toilet with flushing (1=yes), % | 42.55 | / | 38.57 | / | 46.48 | / | <.10 |
| Excreta present around (1=yes), % | 31.38 | / | 33.21 | / | 29.58 | / | .35 |
| Demographics | | | | | | | |
| Household size | 4.85(1.76) | 1~13 | 4.56(1.54) | 1~10 | 5.13(1.90) | 2~13 | <.001 |
| Site: Rural(1=yes), % | 68.04 | / | 65.20 | / | 70.88 | / | .11 |
| Area | | | | | | | |
| Eastern area, % | 37.39 | / | 38.89 | / | 35.88 | / | .63 |
| Middle area, % | 31.38 | / | 29.82 | / | 32.94 | / | .63 |
| Western area, % | 31.23 | / | 31.29 | / | 31.18 | / | .63 |

‡ Probability values indicating whether Wave 2004 and Wave 2009 are statistically significantly different on each of the variables in the models; M = Mean; SD = Standard deviation
* in 2011 U.S. dollar (1 U.S. dollar = 6.3440 Chinese Yuan)

Table 4.3 (to be continued): Pathway: Asset holdings – household food security

| Variable | Total food available (grams) | | | Animal-source food available (grams) | | |
|---|---|---|---|---|---|---|
| Models | I | II | III | IV | V | VI |
| Wealth index | −54.35 | / | −119.91 | 61.10*** | / | 51.36* |
| Wealth index (previous wave) | / | −70.43 | 15.35 | / | 55.01** | 16.35 |
| Household income | 16.44 | / | −152.32 | 74.87** | / | 68.44* |
| Household income (previous wave) | / | 327.59 | 354.28† | / | 46.33† | 36.89 |
| Household size | 891.48*** | 775.82*** | 792.56*** | 62.68*** | 95.98*** | 89.32*** |
| Middle area (1=yes) | −303.18 | −437.02 | −509.36 | −178.79** | −214.89** | −189.13** |
| Western area (1=yes) | −2,141.28*** | −2,052.21*** | −2,114.68*** | 9.22 | −29.19 | −10.92 |
| Rural (1=yes) | 87.63 | 283.34 | 204.68 | −23.24 | −42.25 | −22.47 |
| Mother education | 43.37 | 46.47 | 58.62 | 14.12 | 10.67 | 4.38 |
| Father education | 54.15 | 79.36 | 91.81 | −.57 | 6.25 | .94 |
| Wave 2009 (1=yes) | −399.85 | −527.12 | −445.14** | 18.89 | 72.57 | 38.58 |
| Constant | 2,947.79 | 799.39 | 1,716.97 | −650.99* | −439.50 | −851.10* |
| Model Statistics | $F$(9,339) = 6.95***; $r^2$=15.58% | $F$(9,265) = 4.43***; $r^2$=13.08% | $F$(11,262) = 3.68***; $r^2$=13.39% | $F$(9,339) = 10.88***; $r^2$=22.41% | $F$(9,265) = 7.33***; $r^2$=19.93% | $F$(11,262) = 7.04***; $r^2$=22.81% |

†: <.1; *: <.05; **: <.01; ***: <.001.

Table 4.3 (continued): Pathway: Asset holdings – household food security

| Variable | Food diverse score | | |
|---|---|---|---|
| Models | VII | VIII | IX |
| Wealth index | $.16^{**}$ | / | .06 |
| Wealth index (previous wave) | / | $.13^{*}$ | .09 |
| Household income | .12 | / | .09 |
| Household income (previous wave) | / | .07 | .05 |
| Household size | −.01 | .03 | .02 |
| Middle area (1=yes) | $-.94^{***}$ | $-.98^{***}$ | $-.93^{***}$ |
| Western area (1=yes) | $-.65^{***}$ | $-.68^{***}$ | $-.63^{**}$ |
| Rural (1=yes) | −.22 | $-.36^{\dagger}$ | −.30 |
| Mother education | .01 | .04 | .03 |
| Father education | −.00 | .01 | −.00 |
| Wave 2009 (1=yes) | $.66^{***}$ | $.68^{***}$ | $.65^{***}$ |
| Constant | $5.48^{***}$ | $5.57^{***}$ | $5.00^{***}$ |
| Model Statistics | $F(9,339) = 12.70^{***}$; $r^2$=25.22% | $F(9,265) = 10.53^{***}$; $r^2$=26.35% | $F(11,262) = 8.75^{***}$; $r^2$=26.86% |

†: <.1; *: <.05; **: <.01; ***: <.001.

Table 4.4 (to be continued): Pathway: Asset holdings – child dietary intake

| Variable | Total calorie intake (Kcal) | | | Total carbohydrate intake (grams) | | |
|---|---|---|---|---|---|---|
| Models | I | II | III | IV | V | VI |
| Wealth index | 22.00 | / | 40.60 | −1.81 | / | 1.68 |
| Wealth index (previous wave) | / | −33.93 | $-58.11^{*}$ | / | $-9.06^{*}$ | $-10.58^{*}$ |
| Household income | −5.43 | / | 2.70 | 2.45 | / | 4.04 |
| Household income (previous wave) | / | 9.39 | 9.49 | / | 1.74 | 1.14 |
| Household size | 13.49 | 13.67 | 14.87 | 3.74 | 5.52 | 5.28 |
| Middle area (1=yes) | −60.05 | −121.53 | −120.35 | −3.31 | −11.58 | −10.90 |
| Western area (1=yes) | 50.74 | −14.72 | −12.86 | 7.80 | −3.58 | −2.78 |
| Rural (1=yes) | −70.31 | −129.16 | −121.77 | −13.42 | $-27.41^{*}$ | $-27.80^{*}$ |
| Mother education | 9.23 | $24.51^{\dagger}$ | 18.15 | 2.11 | $4.16^{\dagger}$ | $3.87^{\dagger}$ |
| Father education | $37.92^{**}$ | $43.74^{**}$ | $42.74^{**}$ | $3.64^{*}$ | $4.87^{*}$ | $4.65^{*}$ |
| Child age (in years) | $83.49^{**}$ | $77.91^{*}$ | $80.33^{*}$ | $9.89^{*}$ | $12.47^{*}$ | $12.83^{*}$ |
| Child sex (1=girls) | −37.65 | −22.35 | −26.82 | −9.64 | −12.77 | −13.36 |
| Only child (1=yes) | 43.44 | 78.72 | 73.67 | 5.94 | 12.05 | 11.79 |
| Wave 2009 (1=yes) | −56.58 | −26.41 | −30.30 | −10.97 | −4.94 | −6.40 |
| Constant | 330.85 | 58.09 | 63.26 | 29.75 | −5.36 | −30.36 |
| Model Statistics | $F(12,313) = 3.99^{***}$; $r^2$=13.26% | $F(12,241) = 3.65^{***}$; $r^2$=15.37% | $F(14,238) = 3.26^{***}$; $r^2$=16.09% | $F(12,313) = 2.03^{*}$; $r^2$=7.22% | $F(12,241) = 3.05^{***}$; $r^2$=13.19% | $F(14,238) = 2.64^{**}$; $r^2$=13.43% |

†: <.1; *: <.05; **: <.01; ***: <.001.

Table 4.4 (continued): Pathway: Asset holdings – child dietary intake

| Variable | Total fat intake (grams) | | | Total protein intake (grams) | | |
|---|---|---|---|---|---|---|
| Models | I | II | III | IV | V | VI |
| Wealth index | 2.33* | / | 2.59* | 2.06** | / | 2.65* |
| Wealth index (previous wave) | / | .13 | −1.22 | / | .29 | −1.20 |
| Household income | −1.46 | / | −1.29 | −.50 | / | −.46 |
| Household income (previous wave) | / | .07 | .30 | / | .45 | .55 |
| Household size | −.54 | −.93 | −.74 | .85 | −.00 | .12 |
| Middle area (1=yes) | −4.32 | −6.79† | −6.94* | −1.98 | −3.54 | −3.56 |
| Western area (1=yes) | 2.88 | .62 | .48 | −1.69 | −1.64 | −1.63 |
| Rural (1=yes) | .68 | .58 | 1.43 | −5.67* | −6.44† | −5.82† |
| Mother education | .10 | .65 | .19 | −.02 | .65 | .24 |
| Father education | 1.91*** | 1.92** | 1.92** | 1.55*** | 1.74*** | 1.70** |
| Child age (in years) | 4.06** | 2.61† | 2.67† | 1.80 | 1.06 | 1.18 |
| Child sex (1=girls) | .82 | 3.67 | 3.54 | −1.59 | −1.06 | −1.28 |
| Only child (1=yes) | .96 | 2.13 | 1.82 | 2.83 | 2.90 | 2.58 |
| Wave 2009 (1=yes) | −.85 | −.71 | −.48 | −1.26 | −.05 | −.09 |
| Constant | 15.80 | 4.82 | 14.52 | 17.22 | 9.08 | 13.49 |
| Model Statistics | $F$(12,313) = 4.94***; $r^2$=15.91% | $F$(12,241) = 3.22***; $r^2$=13.83% | $F$(14,238) = 3.10***; $r^2$=15.43% | $F$(12,313) = 5.81***; $r^2$=18.21% | $F$(12,241) = 4.51***; $r^2$=18.33% | $F$(14,238) = 4.30***; $r^2$=20.19% |

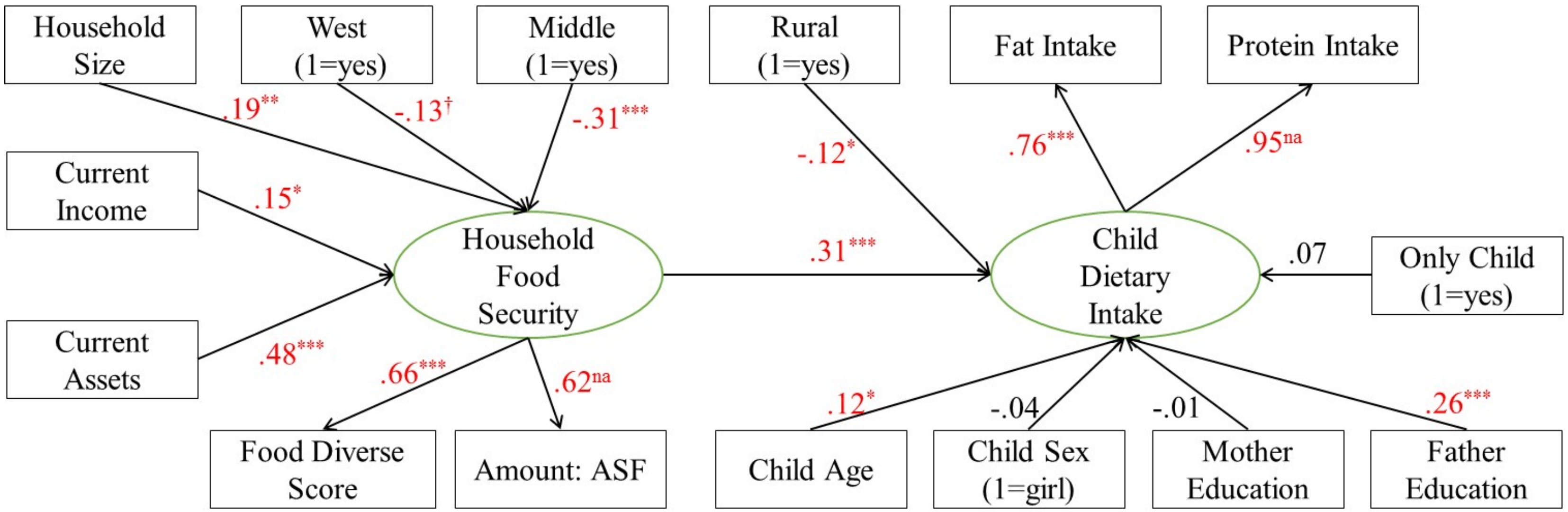
†: <.1; *: <.05; **: <.01; ***: <.001.

Table 4.5: Summary of SEM model diagnosis for the pathway: Asset holdings – household food Security – child dietary intake

| Models with the economic information of current wave as main predictors | | $\chi^2$ df; value | CFI | TLI | SRMR | RMSEA (90% CI) |
|---|---|---|---|---|---|---|
| Household Food Security | Child Dietary Intake | | | | | |
| All indicators | All indicators | 84; 5,790.40 | .000 | −.351 | .264 | .458 (.000, .) |
| All indicators | Calorie and carbohydrate | 52; 801.10 | .113 | −.024 | .113 | .211 (.198, .224) |
| All indicators | Fat and protein | 47; 132.49 | .849 | .807 | .045 | .075 (.126, .150) |
| Total food available | All indicators | 59; 3,956.35 | .105 | .090 | .176 | .452 (.000, .) |
| Total food available | Calorie and carbohydrate | 30; 549.21 | .176 | .094 | .185 | .231 (.214, .248) |
| Total food available | Fat and protein | 24; 110.49 | .748 | .653 | .061 | .105 (.086, .126) |
| ASF amount and Food diverse score | All indicators | 62; 7,811.47 | .000 | −1.088 | .404 | .621 (.000, .) |
| ASF amount and Food diverse score | Calorie and carbohydrate | 34; 598.93 | .254 | −.009 | .137 | .226 (.211, .243) |
| ASF amount and Food diverse score | Fat and protein | 34; 62.02 | .941 | .913 | .026 | .050 (.030, .070) |
| **Models with the economic information of previous wave as main predictors** | | **$\chi^2$ df; value** | **CFI** | **TLI** | **SRMR** | **RMSEA (90% CI)** |
| Household Food Security | Child Dietary Intake | | | | | |
| All indicators | All indicators | 88; 24,787.73 | .000 | −6.133 | .484 | 1.055 (.000, .) |
| All indicators | Calorie and carbohydrate | 49; 112.95 | .907 | .886 | .050 | .072 (.055, .089) |
| All indicators | Fat and protein | 55; 5,471.45 | .000 | −12.903 | .252 | .625 (.000, .) |
| Total food available | All indicators | 53; 2,660.20 | .238 | .138 | .112 | .442 (.000, .) |
| Total food available | Calorie and carbohydrate | 24; 88.10 | .880 | .835 | .056 | .103 (.080, .126) |
| Total food available | Fat and protein | 23;74.02 | .809 | .727 | .056 | .094 (.070, .118) |
| ASF amount and Food diverse score | All indicators | 62; 5,014.06 | .000 | −.697 | .368 | .563 (.000, .) |
| ASF amount and Food diverse score | Calorie and carbohydrate | 32; 77.44 | .929 | .897 | .042 | .075 (.054, .097) |
| ASF amount and Food diverse score | Fat and protein | 34; 47.87 | .963 | .945 | .031 | .040 (.000, .065) |

Note: The models marked in red are present in the following figures.
*Chi-square: lower value indicating good fit; CFI (Comparative Fit Index): cut off point: >=.9 (fair fit), >=.95 (good fit);*
*TLI (Tucker Lewis Index or Non−normed Fit Index): cut off point: >=.9 (fair fit), >=.95 (good fit);*
*SRMR (Standardized Root Mean Squared Residual): cut off point for good fit: <.08*
*RMSEA (Root Mean Square Error of Approximation): cut off point for good fit: <=.06 with upper bound of 90% CI <=.08.*
(Bentler & Bonett, 1980; Browne & Arminger, 1995; Hu & Bentler, 1999; Iacobucci, 2010; Marsh & Balla, 1994; Schreiber, J.B., et al, 2006; Steiger, 1990;)

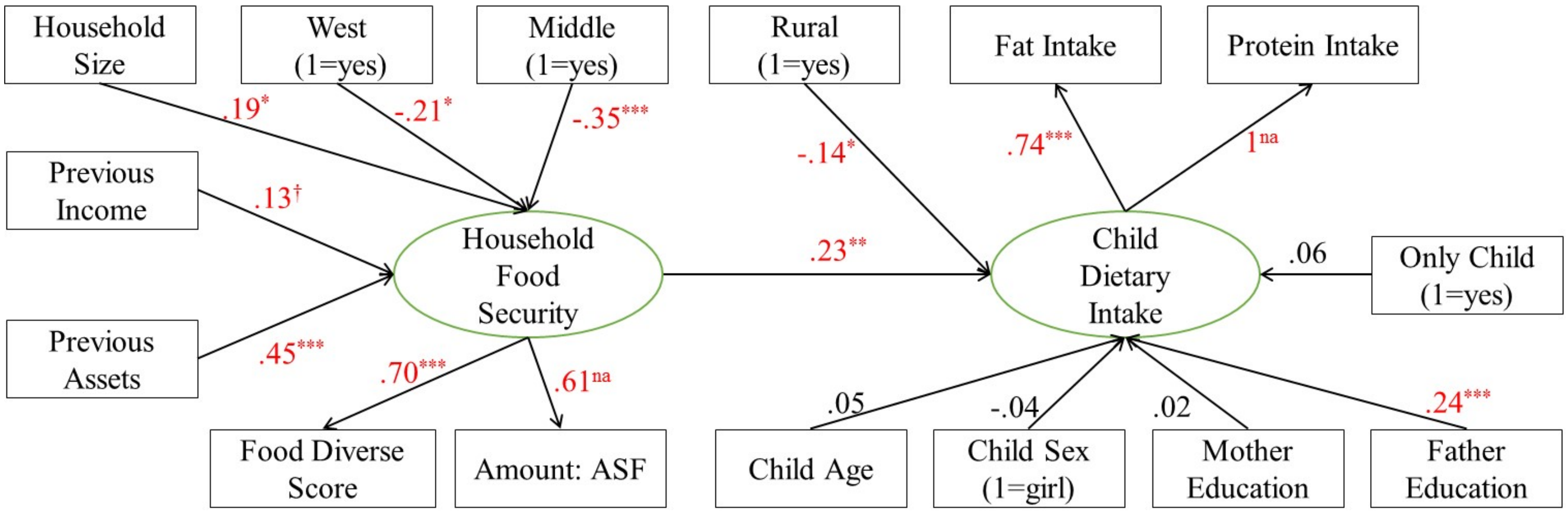
Figure 4.6: SEM Model: Asset holdings of current wave – household food security – child dietary intake




| Household food security | Coefficient | Std. Error | Child dietary intake | Coefficient | Std. Error |
|---|---|---|---|---|---|
| Structural model (43.28% of the variance explained) | | | Structural model (26.49% of the variance explained) | | |
| Assets | .24*** | .04 | Household food security | 6.61*** | 1.65 |
| Income | .15* | .07 | Child age | 2.40* | 1.09 |
| Household size | .14** | .05 | Child sex (1=girl) | −1.50 | 2.13 |
| Middle (1=yes) | −.63*** | .16 | Only child (1=yes) | 2.94 | 2.42 |
| West (1=yes) | −.27† | .16 | Father education in years | 1.69*** | .45 |
| | | | Mother education in years | −.06 | .43 |
| | | | Rural (1=yes) | −5.29* | 2.65 |
| Measurement model | | | Measurement model | | |
| ASF amount available | 353.66*** | 55.00 | Fat | .91*** | .11 |
| Food diverse score | 1 | (constrained) | Protein | 1 | (constrained) |

Standardized coefficients present in the figure; unstandardized coefficients present in the table.
†: <.1; *: <.05; **: <.01; ***: <.001.

Figure 4.7: SEM Model: Asset holdings of previous wave – household food security – child dietary intake




| Household food security | Coefficient | Std. Error | Child dietary intake | Coefficient | Std. Error |
|---|---|---|---|---|---|
| Structural model (40.06% of the variance explained) | | | Structural model (21.23% of the variance explained) | | |
| Assets | .25*** | .04 | Household food security | 4.68** | 1.64 |
| Income | .12† | .07 | Child age | 1.06 | 1.32 |
| Household size | .16* | .06 | Child sex (1=girl) | −1.74 | 2.59 |
| Middle (1=yes) | −.78*** | .19 | Only child (1=yes) | 2.63 | 2.81 |
| West (1=yes) | −.48* | .20 | Father education in years | 1.72*** | .53 |
| | | | Mother education in years | .15 | .51 |
| | | | Rural (1=yes) | −7.12* | 3.23 |
| Measurement model | | | Measurement model | | |
| ASF amount available | 299.97*** | 52.54 | Fat | .79*** | .11 |
| Food diverse score | 1 | (constrained) | Protein | 1 | (constrained) |

Standardized coefficients present in the figure; unstandardized coefficients present in the table.
†: <.1; *: <.05; **: <.01; ***: <.001.

Table 4.8 (to be continued): Pathway: Asset holdings – care

| Variable | Breastfeeding (months) | | | Child care time by mothers (hours) | | |
|---|---|---|---|---|---|---|
| Models | I | II | III | IV | V | VI |
| Wealth index | −.04 | / | .39 | .01 | / | .07 |
| Wealth index (previous wave) | / | −.34 | −.59 | / | −.20 | −.30 |
| Household income | −.08 | / | .30 | .39 | / | .28 |
| Household income (previous wave) | / | .44 | .33 | / | .33 | .30 |
| Household size | .08 | .32 | .24 | −.24 | −.12 | −.13 |
| Middle area (1=yes) | .20 | −.54 | −.55 | .98$^{\dagger}$ | 1.31$^{*}$ | 1.35$^{*}$ |
| Western area (1=yes) | −2.40$^{\dagger}$ | −2.62$^{*}$ | −2.60$^{\dagger}$ | −.57 | −.21 | −.16 |
| Rural (1=yes) | .99 | −.15 | .11 | .44 | −.06 | −.20 |
| Mother employed (1=yes) | −1.56 | −.94 | −.95 | −2.62$^{***}$ | −2.19$^{***}$ | −2.42$^{***}$ |
| Mother education | .23 | .01 | −.07 | .07 | .10 | .08 |
| Mother BMI | .11 | .16 | .14 | .08 | .07 | .10 |
| Father employed (1=yes) | 3.82$^{\dagger}$ | 2.46 | 2.60 | 1.69$^{\dagger}$ | 1.50 | 1.49 |
| Father education | −.23 | .07 | −.09 | −.13 | −.03 | −.04 |
| Child age (in years) | .71 | .71 | .73 | −.41$^{\dagger}$ | −.43 | −.37 |
| Child sex (1=girls) | −1.68$^{\dagger}$ | −2.06$^{*}$ | −2.07$^{*}$ | .57 | .68 | .60 |
| Only child (1=yes) | −2.61$^{\dagger}$ | −2.62$^{*}$ | −2.86$^{*}$ | .27 | .24 | .24 |
| Wave 2009 (1=yes) | −1.15 | .06 | .04 | −.32 | .65 | .56 |
| Constant | 8.23 | 3.48 | 3.02 | 1.62 | .11 | −2.19 |
| Model Statistics | $F(15,120) = 2.07^{*}$; $r^2$=20.55% | $F(15,93) = 2.17^{***}$; $r^2$=25.96% | $F(17,90) = 1.84^{*}$; $r^2$=25.82% | $F(15,227) = 3.36^{***}$; $r^2$=18.15% | $F(15,168) = 2.31^{***}$; $r^2$=17.09% | $F(17,165) = 2.14^{**}$; $r^2$=18.06% |

†: <.1; *: <.05; **: <.01; ***: <.001.

Table 4.8 (continued): Pathway: Asset holdings – care

| Variable | Child care time by others (hours) | | |
|---|---|---|---|
| Models | VII | VIII | IX |
| Wealth index | −.11 | / | −.12 |
| Wealth index (previous wave) | / | −.22 | −.19 |
| Household income | .42 | / | .15 |
| Household income (previous wave) | / | .69** | .69** |
| Household size | .76*** | .64* | .64** |
| Middle area (1=yes) | −.70 | −.53 | −.52 |
| Western area (1=yes) | −.42 | −.50 | −.47 |
| Rural (1=yes) | −.98† | −.94 | −1.13 |
| Mother employed (1=yes) | 1.13* | 1.22* | 1.09† |
| Mother education | .23** | .29* | .30* |
| Mother BMI | .06 | .03 | .05 |
| Father employed (1=yes) | −.67 | −.49 | −.44 |
| Father education | .02 | .06 | .06 |
| Child age (in years) | −.52* | −.92*** | −.90** |
| Child sex (1=girls) | −.27 | −.50 | −.55 |
| Only child (1=yes) | .76 | .73 | .82 |
| Wave 2009 (1=yes) | −.12 | −.03 | −.08 |
| Constant | −5.47 | −6.01† | −7.51† |
| Model Statistics | $F(15,227) = 4.15$***; $r^2$=21.52% | $F(14,169) = 4.38$***; $r^2$=26.62% | $F(17,165) = 3.74$***; $r^2$=27.82% |

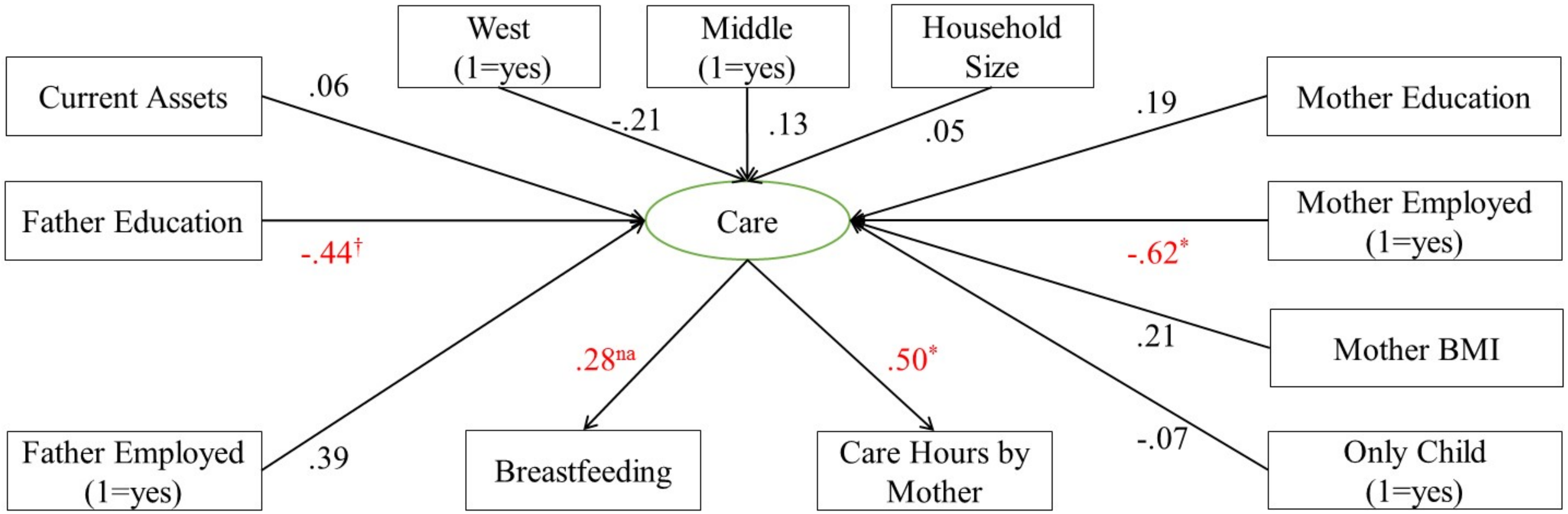
†: <.1; *: <.05; **: <.01; ***: <.001.

Table 4.9: Summary of SEM model diagnosis for the pathway: Asset holdings – care

| Models with the economic status of current wave as predictor | | $\chi^2$ | CFI | TLI | SRMR | RMSEA |
|---|---|---|---|---|---|---|
| Structural Model | Measurement Model | df; value | | | | (90% CI) |
| Both assets and income | All indicators | 21; 42.69 | .576 | .334 | .057 | .092 (.052, .132) |
| Both assets and income | Breastfeeding and care by mothers | 10; 14.87 | .839 | .629 | .036 | .063 (.000, .126) |
| Both assets and income | Breastfeeding and care by others | 10; 16.31 | .804 | .550 | .034 | .072 (.000, .133) |
| Both assets and income | Care by mothers and others | 11; 108.88 | .000 | −1.762 | .070 | .187 (.156, .220) |
| Only assets | All indicators | 18; 34.09 | .671 | .451 | .056 | .086 (.039, .130) |
| Only assets | Breastfeeding and care by mothers | 9; 12.74 | .870 | .697 | .037 | .059 (.000, .126) |
| Only assets | Breastfeeding and care by others | 9; 16.23 | .772 | .468 | .037 | .081 (.000, .144) |
| Only assets | Care by mothers and others | 10; 68.19 | .100 | −.709 | .061 | .151 (.119, .186) |
| Only income | All indicators | 19; 101.34 | .000 | −1.218 | .092 | .181 (.147, .217) |
| Only income | Breastfeeding and care by mothers | 9; 46.23 | .000 | −1.463 | .061 | .177 (.129, .229) |
| Only income | Breastfeeding and care by others | 10; 49.35 | .016 | −.869 | .081 | .173 (.126, .222) |
| Only income | Care by mothers and others | 9; 91.37 | .216 | −.655 | .069 | .179 (.147, .213) |
| **Models with the economic status of current wave as predictor** | | **$\chi^2$** | **CFI** | **TLI** | **SRMR** | **RMSEA** |
| **Structural Model** | **Measurement Model** | **df; value** | | | | **(90% CI)** |
| Both assets and income | All indicators | 23; 429.74 | .000 | −14.766 | .194 | .436 (.401, .473) |
| Both assets and income | Breastfeeding and care by mothers | 9; 17.30 | .592 | .049 | .042 | .100 (.016, .170) |
| Both assets and income | Breastfeeding and care by others | 9; 19.13 | .602 | .071 | .054 | .110 (.038, .179) |
| Both assets and income | Care by mothers and others | 11; 551.99 | .000 | −20.623 | .059 | .505 (.469, .541) |
| Only assets | All indicators | 21; 86.58 | .000 | −1.734 | .094 | .182 (.143, .223) |
| Only assets | Breastfeeding and care by mothers | 8; 16.89 | .581 | .005 | .044 | .109 (.031, .181) |
| Only assets | Breastfeeding and care by others | 9; 375.92 | .000 | −34.301 | .212 | .659 (.603, .716) |
| Only assets | Care by mothers and others | 10; 34.69 | .392 | −.154 | .049 | .113 (.073, .155) |
| Only income | All indicators | 19; 41.28 | .385 | .029 | .064 | .112 (.065, .159) |
| Only income | Breastfeeding and care by mothers | 9; 15.22 | .666 | .295 | .046 | .086 (.000, .159) |
| Only income | Breastfeeding and care by others | 8; 15.54 | .684 | .249 | .051 | .101 (.004, .175) |
| Only income | Care by mothers and others | 10; 40.93 | .363 | −.211 | .057 | .126 (.087, .167) |

Note: The models marked in red are present in the following figures.

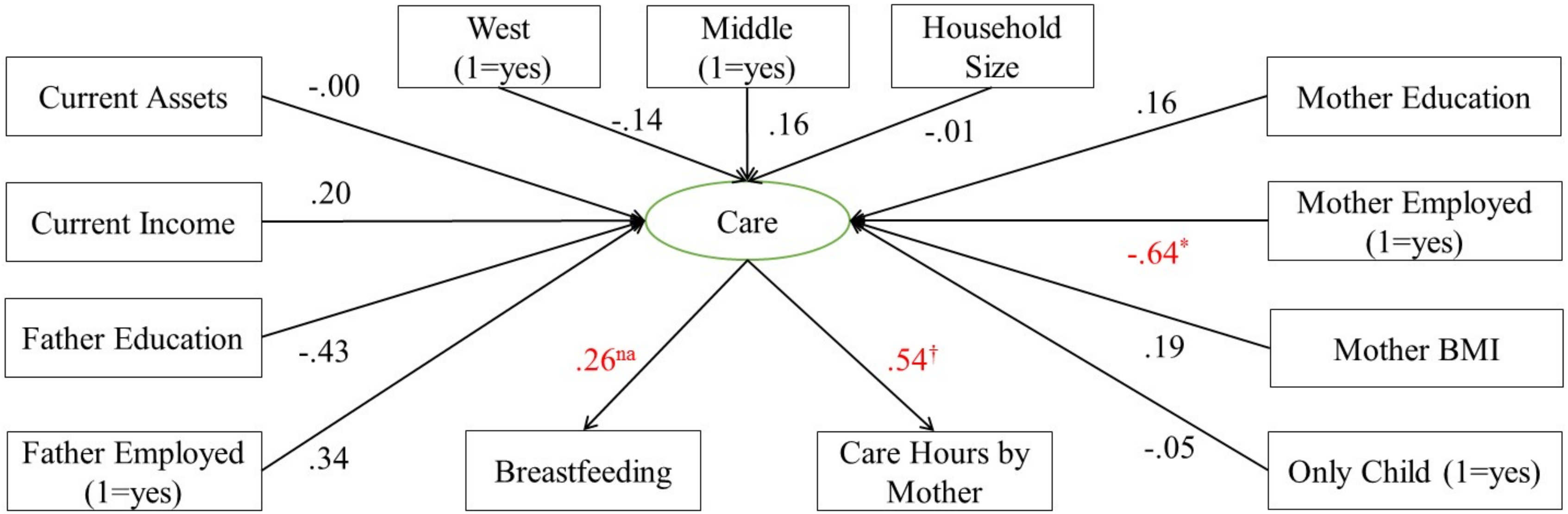
Figure 4.10: SEM model: Asset holdings of current wave – care




| Structural model | Coefficient | Std. Error | Measurement model | Coefficient | Std. Error |
|---|---|---|---|---|---|
| (84.13% of the variance explained) | | | | | |
| Assets | .05 | .19 | Breastfeeding time | 1 | Constrained |
| Household size | .07 | .22 | Care hours by mother | 1.10* | .51 |
| Middle area (1=yes) | .47 | .64 | | | |
| Western area (1=yes) | −.78 | .78 | | | |
| Only child (1=yes) | −.28 | .73 | | | |
| Mother employed (1=yes) | −2.30** | .90 | | | |
| Mother education | .10 | .14 | | | |
| Mother BMI | .10 | .09 | | | |
| Father employed (1=yes) | 2.79 | 1.78 | | | |
| Father education | −.25† | .15 | | | |

Standardized coefficients present in the figure; unstandardized coefficients present in the table.
†: <.1; *: <.05; **: <.01; ***: <.001.

Figure 4.11: SEM model: Asset holdings and income of current wave – care




| Structural model | Coefficient | Std. Error | Measurement model | Coefficient | Std. Error |
|---|---|---|---|---|---|
| (77.90% of the variance explained) | | | | | |
| Assets | −.00 | .17 | Breastfeeding time | 1 | Constrained |
| Income | .33 | .28 | Care hours by mother | 1.30† | .68 |
| Household size | −.01 | .20 | | | |
| Middle area (1=yes) | .52 | .59 | | | |
| Western area (1=yes) | −.49 | .70 | | | |
| Only child (1=yes) | −.17 | .63 | | | |
| Mother employed (1=yes) | −2.21* | .99 | | | |
| Mother education | .08 | .12 | | | |
| Mother BMI | .09 | .08 | | | |
| Father employed (1=yes) | 2.22 | 1.68 | | | |
| Father education | −.22 | .14 | | | |

Standardized coefficients present in the figure; unstandardized coefficients present in the table.
†: <.1; *: <.05; **: <.01; ***: <.001.

Table 4.12: Pathway: Asset holdings – household environment

| Variable | Accessible to tap water (1=yes) | | | Toilet with flushing (1=yes) | | | Excreta present (1=yes) | | |
|---|---|---|---|---|---|---|---|---|---|
| Model | I | II | III | IV | V | VI | VII | VIII | IX |
| Wealth index | $1.60^{***}$ | / | $1.42^{*}$ | $2.25^{***}$ | / | $1.61^{**}$ | $.63^{***}$ | / | $.72^{*}$ |
| Wealth index (previous wave) | / | $1.51^{***}$ | 1.26 | / | $2.28^{***}$ | $1.73^{***}$ | / | $.66^{***}$ | $.78^{\dagger}$ |
| Household income | 1.01 | / | 1.00 | 1.15 | / | 1.04 | 1.03 | / | 1.15 |
| Household income (previous wave) | / | .83 | .81 | / | .90 | .90 | / | $1.35^{\dagger}$ | 1.30 |
| Household size | $.81^{\dagger}$ | .87 | .84 | $.80^{\dagger}$ | .88 | .88 | 1.05 | 1.06 | 1.05 |
| Middle area (1=yes) | .78 | .61 | .64 | $2.88^{**}$ | $2.18^{\dagger}$ | $2.49^{*}$ | .97 | 1.39 | 1.43 |
| Western area (1=yes) | $6.15^{***}$ | $6.39^{***}$ | $7.31^{***}$ | $7.04^{***}$ | $6.49^{***}$ | $7.47^{***}$ | $2.23^{*}$ | $1.95^{\dagger}$ | $2.07^{\dagger}$ |
| Rural (1=yes) | $.25^{**}$ | $.30^{*}$ | $.40^{\dagger}$ | $.32^{***}$ | $.41^{*}$ | $.48^{\dagger}$ | $2.14^{*}$ | $2.34^{*}$ | $2.32^{\dagger}$ |
| Mother education | .98 | 1.06 | 1.02 | $1.16^{*}$ | $1.22^{**}$ | $1.16^{*}$ | .98 | .93 | .97 |
| Father education | 1.06 | 1.04 | 1.04 | .99 | 1.00 | .99 | .94 | .94 | .94 |
| Wave 2009 (1=yes) | 1.63 | 1.43 | 1.29 | 1.08 | .58 | .54 | 1.46 | 1.51 | 1.61 |
| Constant | 8.23 | $23.62^{\dagger}$ | 28.60 | .09 | .62 | .47 | .22 | $.02^{*}$ | $.01^{*}$ |
| Model Statistics | $\chi^2(9) = 97.05^{***}$; | $\chi^2(9) = 72.39^{***}$; | $\chi^2(11) = 78.98^{***}$; | $\chi^2(9) = 176.80^{***}$; | $\chi^2(9) = 135.54^{***}$; | $\chi^2(11) = 145.07^{***}$; | $\chi^2(9) = 75.47^{***}$; | $\chi^2(9) = 58.29^{***}$; | $\chi^2(11) = 64.80^{***}$; |

†: <.1; *: <.05; **: <.01; ***: <.001.

Table 4.13: Pathway: Asset holdings – access to health services

| Variable | Insurance covered (1=yes) | | | Time of visiting health facility | | |
|---|---|---|---|---|---|---|
| Model | I | II | III | IV | V | VI |
| Wealth index | 1.16 | / | 1.06 | −.10 | / | .51 |
| Wealth index (previous wave) | / | 1.14 | 1.12 | / | −.80 | −1.30 |
| Household income | 1.01 | / | .86 | .88 | / | .25 |
| Household income (previous wave) | / | $1.37^{*}$ | $1.41^{*}$ | / | 1.96 | 2.16 |
| Household size | .96 | 1.02 | 1.03 | −.76 | −1.53 | −1.57 |
| Middle area (1=yes) | 1.73 | 1.87 | 1.79 | −1.61 | −1.74 | −1.45 |
| Western area (1=yes) | 1.19 | 1.04 | .98 | 2.08 | 3.68 | 3.73 |
| Rural (1=yes) | .77 | .61 | .61 | −3.59 | −3.70 | −4.16 |
| Mother employed (1=yes) | $2.22^{*}$ | $2.02^{\dagger}$ | $2.16^{\dagger}$ | .40 | .87 | .19 |
| Mother education | .94 | .91 | .90 | .03 | .05 | −.07 |
| Father employed (1=yes) | 1.28 | .70 | .68 | −4.93 | −5.80 | −5.04 |
| Father education | .96 | .98 | .99 | −.51 | −.62 | −.65 |
| Child age | $1.30^{\dagger}$ | $1.41^{\dagger}$ | $1.40^{\dagger}$ | / | / | / |
| Child sex (1=girl) | .89 | .64 | .64 | / | / | / |
| Only child (1=yes) | 1.36 | 1.41 | 1.44 | / | / | / |
| Wave 2009 (1=yes) | $13.57^{***}$ | $13.16^{***}$ | $13.94^{***}$ | / | / | / |
| Constant | .08 | $.01^{*}$ | .03 | 19.00 | 15.76 | 13.22 |
| Model Statistics | $\chi^2(14) = 125.81^{***}$; | $\chi^2(14) = 102.43^{***}$; | $\chi^2(16) = 102.37^{***}$; | $F(10,96) = .47$; $r^2$=4.63% | $F(10,71) = .47$; $r^2$=6.19% | $F(12,68) = .41$; $r^2$=6.70% |

†: <.1; *: <.05; **: <.01; ***: <.001

Table 4.14: Pathway: Asset holdings – infections

| Variable | Fever (1=yes) | | | Diarrhea (1=yes) | | |
|---|---|---|---|---|---|---|
| Model | I | II | III | IV | V | VI |
| Wealth index | 1.08 | / | 1.16 | .67 | / | .1.88 |
| Wealth index (previous wave) | / | 1.04 | .97 | / | .58 | .36 |
| Household income | .91 | / | .98 | 2.84 | / | 9.65 |
| Household income (previous wave) | / | 1.04 | 1.00 | / | 1.16 | .93 |
| Household size | .90 | 1.10 | 1.09 | .61 | .85 | .59 |
| Middle area (1=yes) | .67 | .42$^{\dagger}$ | .43$^{\dagger}$ | o | o | o |
| Western area (1=yes) | .36$^{*}$ | .30$^{*}$ | .31$^{*}$ | 1.13 | .66 | 3.97 |
| Rural (1=yes) | 1.01 | .94 | 1.17 | 1.98 | o | o |
| Mother employed (1=yes) | 1.51 | 1.34 | 1.47 | .06$^{*}$ | .29 | .08 |
| Mother education | 1.10 | 1.11 | 1.11 | .94 | .75 | .52 |
| Father employed (1=yes) | .83 | .69 | .68 | o | o | o |
| Father education | .87$^{*}$ | .92 | .91 | 1.15 | 1.17 | 1.26 |
| Child age | .80 | .78 | .77 | 3.96$^{\dagger}$ | 1.43 | 1.87 |
| Child sex (1=girl) | .76 | .72 | .76 | .19 | .19 | .13 |
| Only child (1=yes) | .84 | .81 | .74 | 1.73 | 1.59 | 2.27 |
| Wave 2009 (1=yes) | .91 | 1.08 | 1.11 | 9.24$^{\dagger}$ | o | o |
| Constant | 4.10 | .42 | .55 | .00$^{\dagger}$ | .11 | .00 |
| Model Statistics | $\chi^2(14)$ = 16.23; $p$=.30 | $\chi^2(14)$ = 15.50; $p$=.35 | $\chi^2(16)$ = 16.54; $p$=.42 | $\chi^2(12)$ = 14.83; $p$=.25 | $\chi^2(10)$ = 4.87; $p$=.90 | $\chi^2(12)$ = 8.11; $p$=.78 |

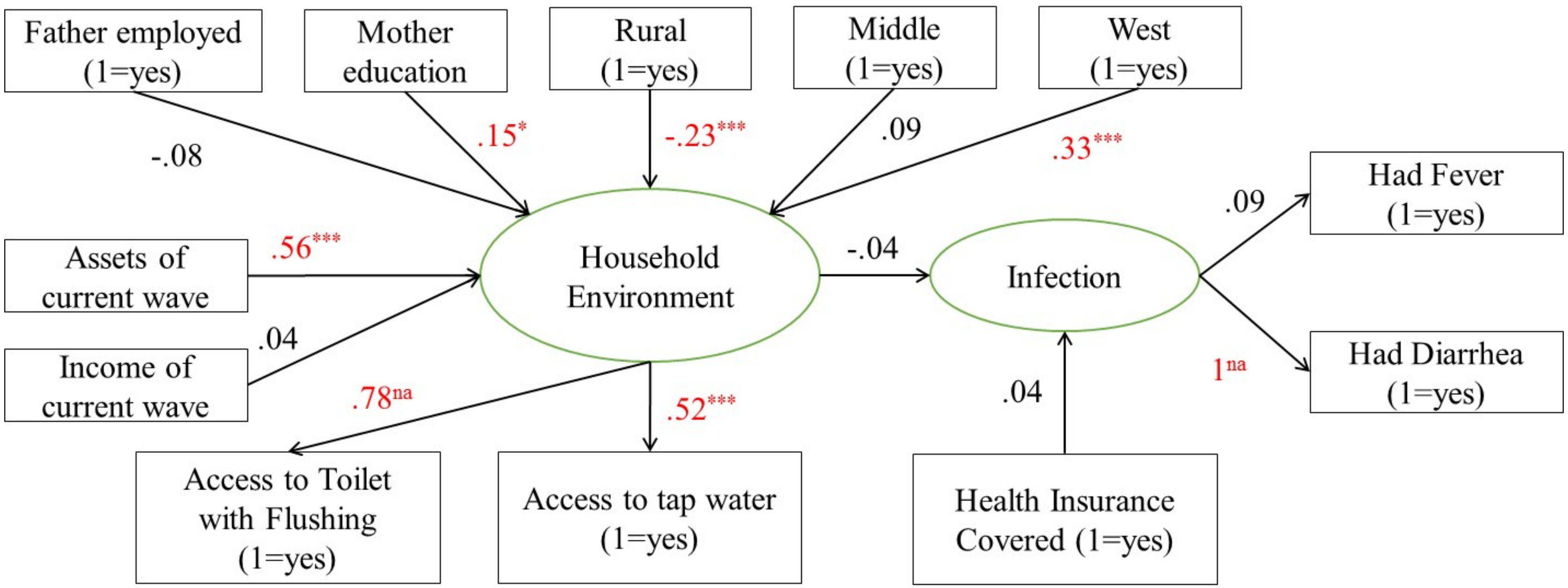
†: <.1; *: <.05; **: <.01; ***: <.001; o: omitted.

Table 4.15: Summary of SEM model diagnosis for the pathway
"Asset holdings – household environment & access to health services – infections"

| Models with the economic status of current wave as main predictor | | $\chi^2$ | CFI | TLI | SRMR | RMSEA |
|---|---|---|---|---|---|---|
| Access to Healthcare | Household Environment | df; value | | | | (90% CI) |
| Both indicators | All indicators | 55; 69.26 | .882 | .850 | .067 | .049 (.000, .082) |
| Both indicators | Water and toilet | 43; 64.09 | .804 | .741 | .068 | .068 (.028, .101) |
| Both indicators | Water and excreta | 44; 56.66 | .795 | .735 | .069 | .052 (.000, .088) |
| Both indicators | Toilet and excreta | 43; 42.75 | 1.000 | 1.001 | .059 | .000 (.000, .065) |
| Insurance covered | All indicators | 36; 83.76 | .861 | .807 | .048 | .062 (.045, .079) |
| Insurance covered | Water and toilet | 25; 40.81 | .941 | .911 | .036 | .043 (.016, .066) |
| Insurance covered | Water and excreta | 25; 85.29 | .593 | .381 | .052 | .083 (.064, .103) |
| Insurance covered | Toilet and excreta | 25; 48.15 | .907 | .859 | .037 | .052 (.029, .073) |
| Time to healthcare facility | All indicators | 36; 53.51 | .859 | .805 | .061 | .067 (.022, .103) |
| Time to healthcare facility | Water and toilet | 25; 46.74 | .805 | .703 | .059 | .090 (.048, .130) |
| Time to healthcare facility | Water and excreta | 26; 50.09 | .651 | .490 | .065 | .093 (.053, .132) |
| Time to healthcare facility | Toilet and excreta | 25; 29.06 | .949 | .922 | .050 | .039 (.000, .090) |
| **Models with the economic status of current wave as main predictor** | | **$\chi^2$** | **CFI** | **TLI** | **SRMR** | **RMSEA** |
| **Access to Healthcare** | **Household Environment** | **df; value** | | | | **(90% CI)** |
| Both indicators | All indicators | 58; 119.20 | .275 | .125 | .094 | .114 (.085, .143) |
| Both indicators | Water and toilet | 42; 43.69 | .955 | .938 | .069 | .052 (.000, .095) |
| Both indicators | Water and excreta | 42; 43.69 | .955 | .938 | .070 | .022 (.000, .080) |
| Both indicators | Toilet and excreta | 46; 305.00 | .000 | −5.346 | .135 | .264 (.236, .292) |
| Insurance covered | All indicators | 36; 69.91 | .871 | .821 | .050 | .059 (.038, .079) |
| Insurance covered | Water and toilet | 25;38.63 | .934 | .900 | .044 | .045 (.010, .071) |
| Insurance covered | Water and excreta | 27; 265.92 | .000 | −1.956 | .099 | .180 (.161, .200) |
| Insurance covered | Toilet and excreta | 25; 43.41 | .905 | .856 | .042 | .052 (.024, .077) |
| Time to healthcare facility | All indicators | 38; 88.49 | .410 | .223 | .086 | .127 (.093, .162) |
| Time to healthcare facility | Water and toilet | 25; 34.09 | .877 | .814 | .055 | .067 (.000, .118) |
| Time to healthcare facility | Water and excreta | 25; 35.10 | .852 | .775 | .059 | .055 (.000, .109) |
| Time to healthcare facility | Toilet and excreta | 28; 275.38 | .000 | −5.646 | .128 | .328 (.294, .364) |

Note: The models marked in red are present in the following figures.

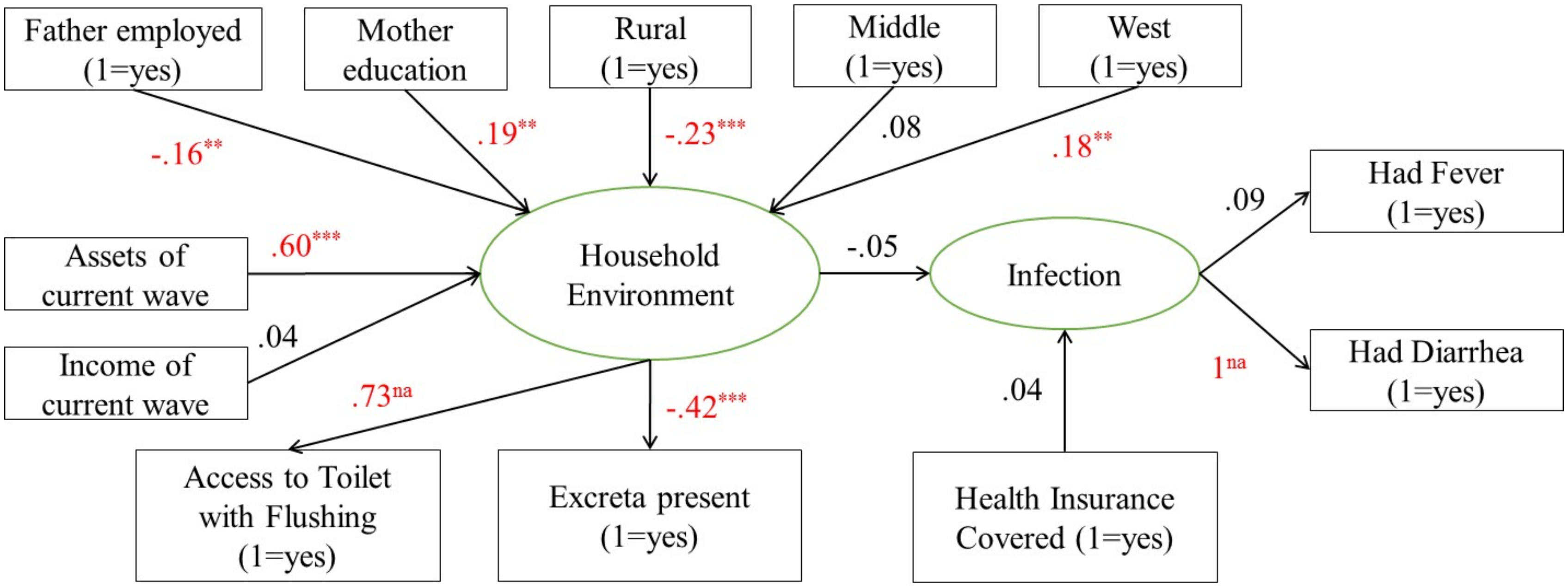
Figure 4.16(a): SEM Model: Assets of current wave – household environment & access to healthcare – infections




| | Coefficient | Std. Error | | Coefficient | Std. Error |
|---|---|---|---|---|---|
| Structural model: Household Environment 66.62% of the variance explained | | | Structural model: Infections .29% of the variance explained | | |
| Assets | .11*** | .01 | Household environment | −.02 | .02 |
| Income | .02 | .02 | Insurance covered (1=yes) | .01 | .02 |
| Rural (1=yes) | −.19*** | .05 | Measurement model: Household Environment | | |
| Middle (1=yes) | .07 | .05 | Access to toilet with flushing (1=yes) | 1 | (constrained) |
| West (1=yes) | .28*** | .05 | Access to tap water (1=yes) | .61*** | .08 |
| Father employed (1=yes) | −.11 | .07 | Measurement model: Infections | | |
| Mother education | .02* | .01 | Fever | .25 | .56 |
| | | | Diarrhea | 1 | (constrained) |

Standardized coefficients present in the figure; unstandardized coefficients present in the table.
†: <.1; *: <.05; **: <.01; ***: <.001.

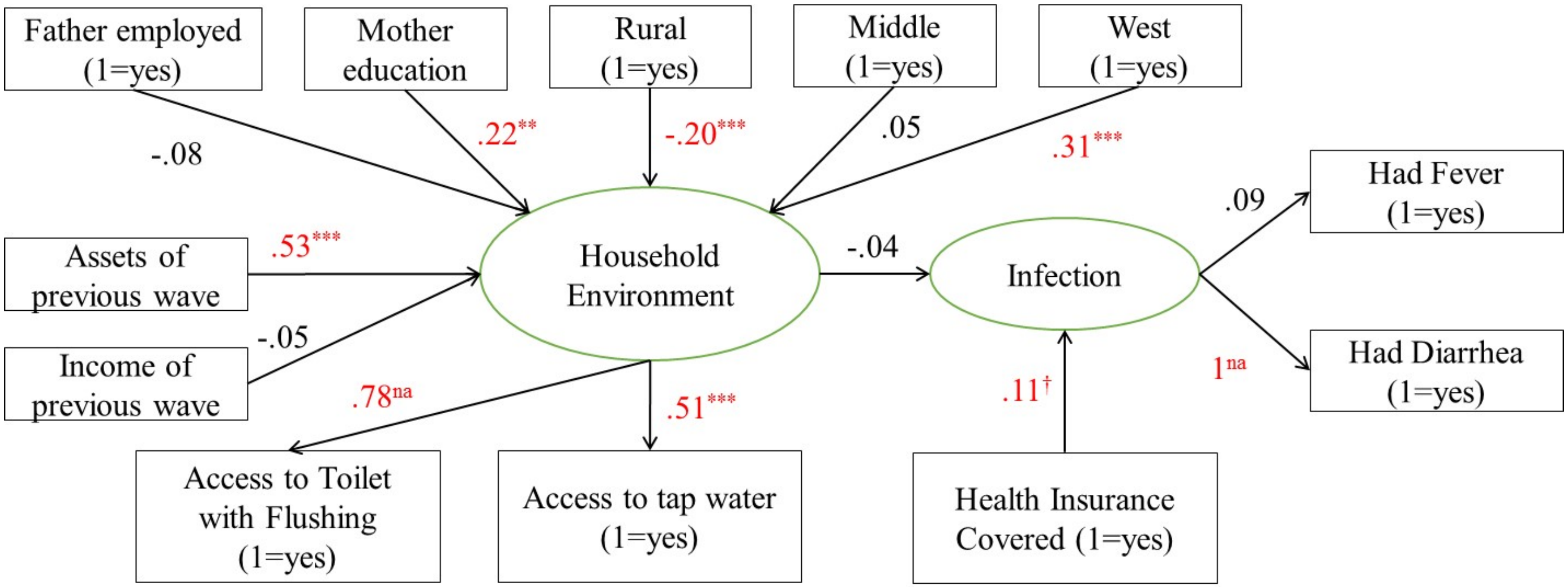
Figure 4.16(b): SEM Model: Assets of current wave – household environment & access to healthcare – infections




| | Coefficient | Std. Error | | Coefficient | Std. Error |
|---|---|---|---|---|---|
| Structural model: Household Environment<br>79.42% of the variance explained | | | Structural model: Infections<br>.57% of the variance explained | | |
| Assets | .11*** | .01 | Household environment | −.02 | .02 |
| Income | .01 | .02 | Insurance covered (1=yes) | .01 | .02 |
| Rural (1=yes) | −.18*** | .05 | Measurement model: Household Environment | | |
| Middle (1=yes) | .06 | .05 | Access to toilet with flushing (1=yes) | 1 | (constrained) |
| West (1=yes) | .14** | .05 | Excreta (1=yes) | −.55*** | .08 |
| Father employed (1=yes) | −.20** | .07 | Measurement model: Infections | | |
| Mother education | .02** | .01 | Fever | .23 | .29 |
| | | | Diarrhea | 1 | (constrained) |

Standardized coefficients present in the figure; unstandardized coefficients present in the table.
†: <.1; *: <.05; **: <.01; ***: <.001.

Figure 4.17(a): SEM Model: Assets of previous wave – household environment & access to healthcare – infections

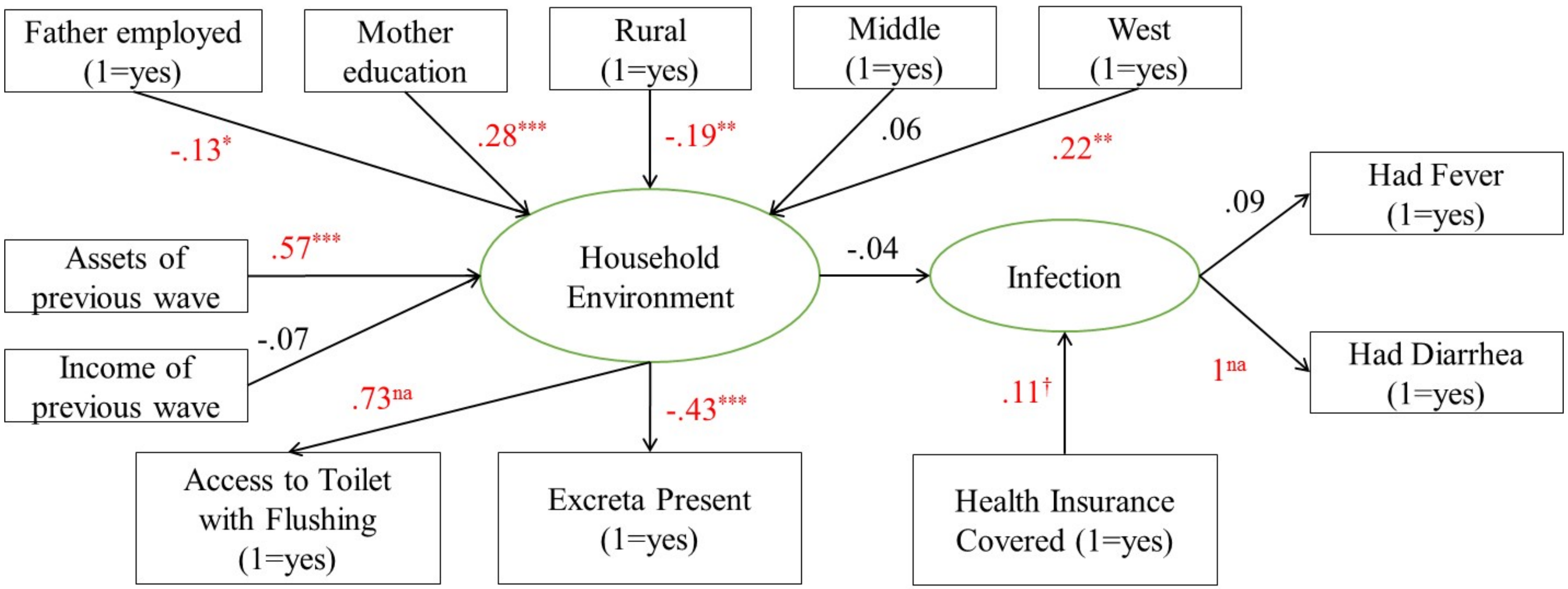



| | Coefficient | Std. Error |
|---|---|---|
| Structural model: Household Environment<br>64.28% of the variance explained | | |
| Assets | .11*** | .01 |
| Income | −.02 | .02 |
| Rural (1=yes) | −.17*** | .05 |
| Middle (1=yes) | .04 | .05 |
| West (1=yes) | .27*** | .06 |
| Father employed (1=yes) | −.10 | .08 |
| Mother education | .02** | .01 |

| | Coefficient | Std. Error |
|---|---|---|
| Structural model: Infections<br>1.44% of the variance explained | | |
| Household environment | −.02 | .03 |
| Insurance covered (1=yes) | .03† | .02 |
| Measurement model: Household Environment | | |
| Access to toilet with flushing (1=yes) | 1 | (constrained) |
| Access to tap water (1=yes) | .62*** | .09 |
| Measurement model: Infections | | |
| Fever | .24 | .43 |
| Diarrhea | 1 | (constrained) |

Standardized coefficients present in the figure; unstandardized coefficients present in the table.
†: <.1; *: <.05; **: <.01; ***: <.001.

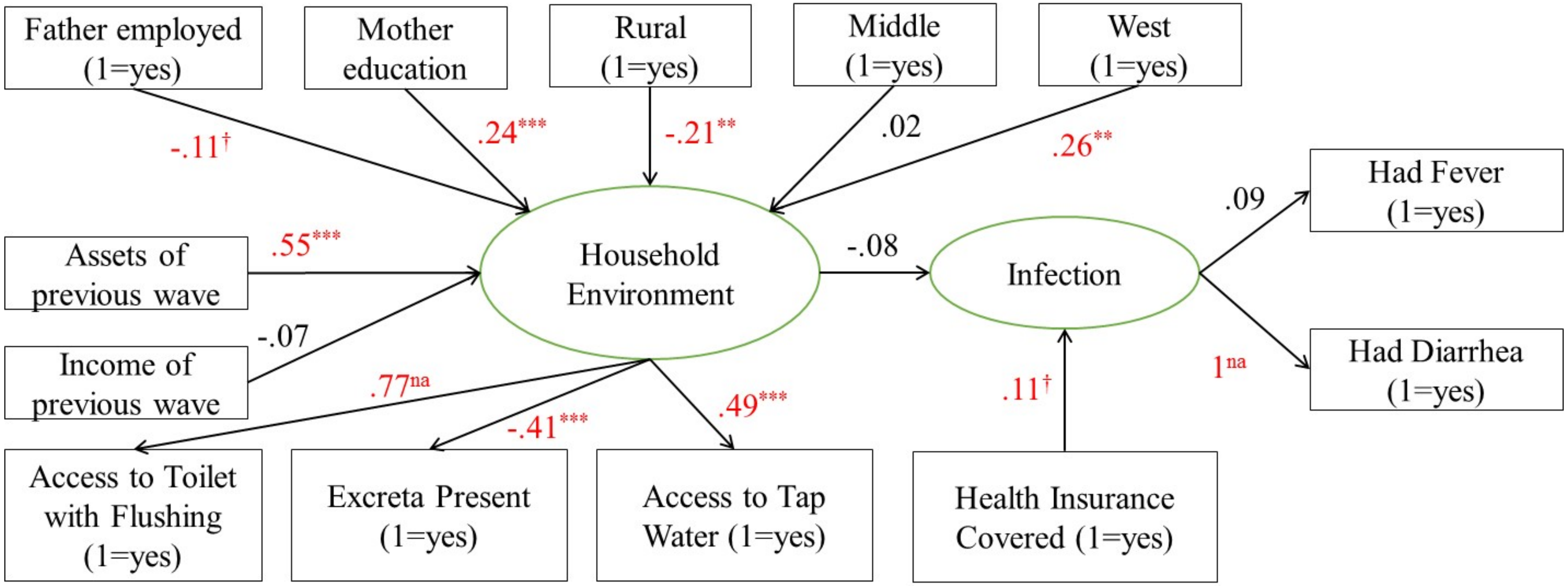
Figure 4.17(b): SEM Model: Assets of previous wave – household environment & access to healthcare – infections




| | Coefficient | Std. Error | | Coefficient | Std. Error |
|---|---|---|---|---|---|
| Structural model: Household Environment<br>74.95% of the variance explained | | | Structural model: Infections<br>1.81% of the variance explained | | |
| Assets | $.11^{***}$ | .01 | Household environment | −.03 | .03 |
| Income | −.02 | .02 | Insurance covered (1=yes) | $.03^{\dagger}$ | .02 |
| Rural (1=yes) | $-.15^{**}$ | .05 | Measurement model: Household Environment | | |
| Middle (1=yes) | .05 | .05 | Access to toilet with flushing (1=yes) | 1 | (constrained) |
| West (1=yes) | $.17^{**}$ | .06 | Excreta present (1=yes) | $-.58^{***}$ | .10 |
| Father employed (1=yes) | $-.16^{*}$ | .06 | Measurement model: Infections | | |
| Mother education | $.03^{***}$ | .01 | Fever | .23 | .31 |
| | | | Diarrhea | 1 | (constrained) |

Standardized coefficients present in the figure; unstandardized coefficients present in the table.
†: <.1; *: <.05; **: <.01; ***: <.001.

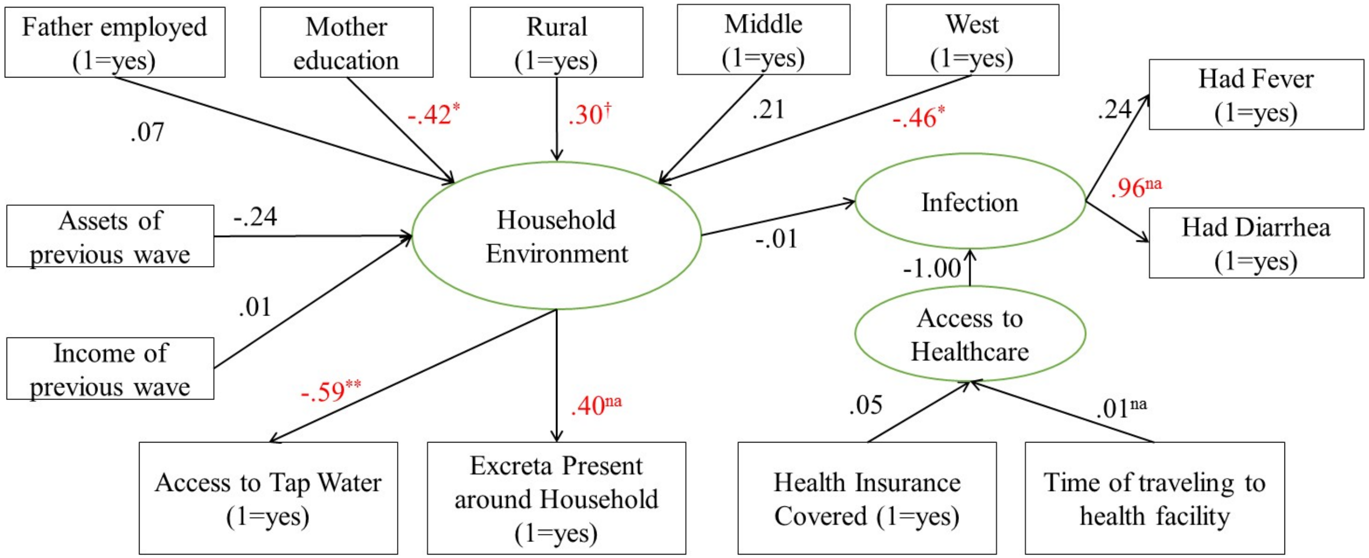
Figure 4.18: SEM Model: Assets of previous wave – household environment & access to healthcare – infections




| | Coefficient | Std. Error | | Coefficient | Std. Error |
|---|---|---|---|---|---|
| Structural model: Household Environment | | | Structural model: Infections | | |
| 68.01% of the variance explained | | | 1.60% of the variance explained | | |
| Assets | .11$^{***}$ | .01 | Household environment | −.03 | .03 |
| Income | −.02 | .02 | Insurance covered (1=yes) | .03$^{†}$ | .02 |
| Rural (1=yes) | −.18$^{**}$ | .05 | Measurement model: Household Environment | | |
| Middle (1=yes) | .01 | .05 | Access to toilet with flushing (1=yes) | 1 | (constrained) |
| West (1=yes) | .22$^{**}$ | .06 | Access to tap water (1=yes) | .60$^{***}$ | .08 |
| Father employed (1=yes) | −.14$^{†}$ | .07 | Excreta present (1=yes) | −.52$^{***}$ | .09 |
| Mother education | .03$^{***}$ | .01 | Measurement model: Infections | | |
| | | | Fever | .24 | .35 |
| | | | Diarrhea | 1 | (constrained) |

Standardized coefficients present in the figure; unstandardized coefficients present in the table.
†: <.1; *: <.05; **: <.01; ***: <.001.

Figure 4.19: SEM Model: Assets of previous wave – household environment & access to healthcare – infections




| | Coefficient | Std. Error |
|---|---|---|
| Structural model: Household Environment<br>95.54% of the variance explained | | |
| Assets | −.03 | .02 |
| Income | .00 | .03 |
| Rural (1=yes) | .11† | .07 |
| Middle (1=yes) | .08 | .07 |
| West (1=yes) | −.19* | .08 |
| Father employed (1=yes) | .04 | .10 |
| Mother education | −.02* | .01 |

| | Coefficient | Std. Error |
|---|---|---|
| Structural model: Infections | | |
| Household environment | −.00 | .10 |
| Access to healthcare | −.56 | 2.49 |
| Measurement model: Household Environment | | |
| Excreta present around house (1=yes) | 1 | (constrained) |
| Access to tap water (1=yes) | −1.53** | .51 |
| Measurement model: Infections | | |
| Fever | .89 | 9.07 |
| Diarrhea | 1 | (constrained) |
| Measurement model: Access to healthcare | | |
| Time of traveling to health facility | 1 | (constrained) |
| Insurance covered (1=yes) | .09 | 1.09 |

Standardized coefficients present in the figure; unstandardized coefficients present in the table.
†: <.1; *: <.05; **: <.01; ***: <.001.

Table 4.20 (to be continued): Full Models predicting child nutrition

| Variable | Height for Age Z Score | | | Weight for Age Z Score | | |
|---|---|---|---|---|---|---|
| Model | I | II | III | IV | V | VI |
| Wealth index | .12* | / | .10 | −.01 | / | −.00 |
| Wealth index (previous wave) | / | .17** | .13† | / | −.06 | −.06 |
| Household income | −.04 | / | −.17 | .01 | / | −.04 |
| Household income (previous wave) | / | .02 | .04 | / | −.05 | −.04 |
| Household size | −.05 | −.11 | −.10 | .03 | .04 | .04 |
| Middle area (1=yes) | −.45* | −.34 | −.37† | −.46** | −.52** | −.52** |
| Western area (1=yes) | −1.24*** | −1.26*** | −1.31*** | −.99*** | −1.11*** | −1.12*** |
| Rural (1=yes) | −.01 | .11 | .19 | −.01 | −.18 | −.17 |
| Mother employed (1=yes) | −.04 | −.01 | .07 | −.26† | −.21 | −.19 |
| Mother education | .02 | .00 | −.02 | .01 | .03 | .03 |
| Mother BMI | −.00 | −.01 | −.01 | .03† | .02 | .02 |
| Father employed (1=yes) | −.33 | −.46 | −.54 | −.04 | .20 | .19 |
| Father education | .00 | .02 | .02 | .03 | .03 | .03 |
| Child age (in years) | −.04 | −.04 | −.03 | −.15* | −.12† | −.12† |
| Child sex (1=girls) | −.34* | −.17 | −.15 | .05 | .23† | .23† |
| Only child (1=yes) | .10 | .07 | .07 | .25† | .27† | .27† |
| Wave 2009 (1=yes) | .45** | .37* | .40* | .13 | .21 | .22 |
| Constant | .69 | .76 | 2.08 | −.59 | −.16 | .13 |
| Model Statistics | $F$(15,257) = 6.65***; $r^2$=27.96% | $F$(15,196) = 6.01***; $r^2$=31.49% | $F$(17,193) = 5.58; $r^2$=32.94% | $F$(15,267) = 6.10***; $r^2$=25.52% | $F$(15,203) = 5.71***; $r^2$=29.67% | $F$(17,200) = 4.92***; $r^2$=29.50% |

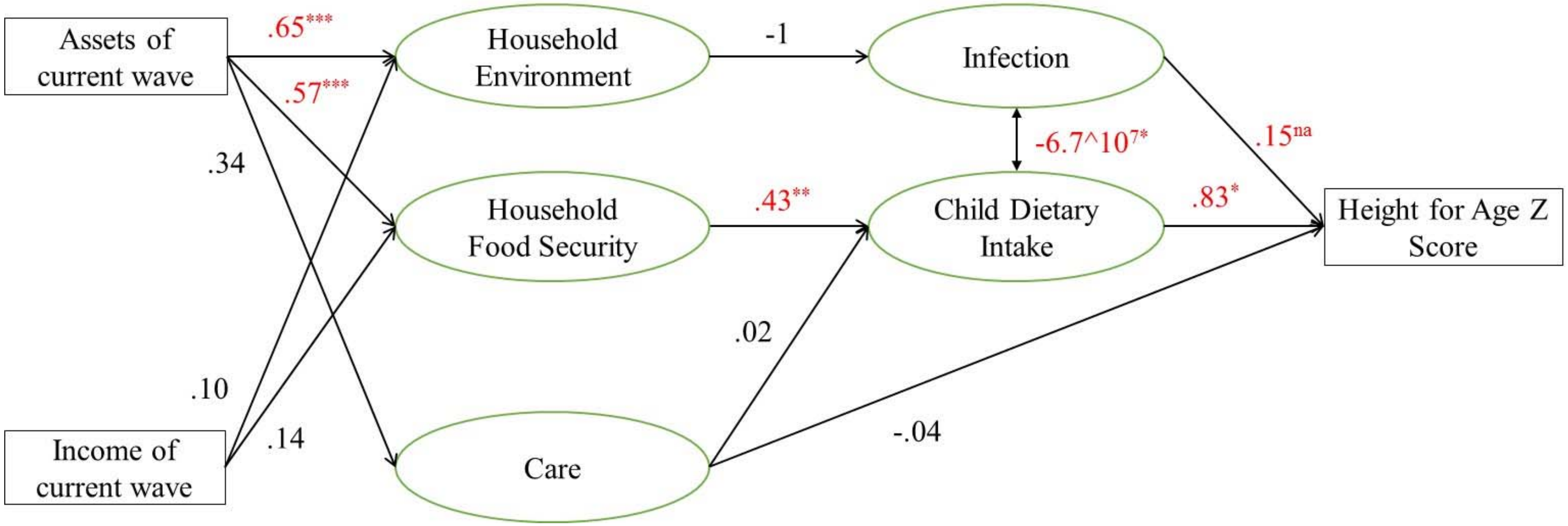
†: <.1; *: <.05; **: <.01; ***: <.001.

Table 4.20 (continued): Full Models predicting child nutrition

| Variable | Weight for Height Z Score | | |
|---|---|---|---|
| Model | VII | VIII | IX |
| Wealth index | −.10$^{†}$ | / | −.09 |
| Wealth index (previous wave) | / | −.18$^{**}$ | −.14$^{†}$ |
| Household income | .05 | / | .09 |
| Household income (previous wave) | / | −.06 | −.08 |
| Household size | .12$^{†}$ | .18$^{*}$ | .17$^{*}$ |
| Middle area (1=yes) | −.29 | −.35 | −.33 |
| Western area (1=yes) | −.28 | −.43$^{†}$ | −.39$^{†}$ |
| Rural (1=yes) | .11 | −.21 | −.26 |
| Mother employed (1=yes) | −.27 | −.21 | −.25 |
| Mother education | .02 | .02 | .04 |
| Mother BMI | .06$^{*}$ | .05 | .05$^{†}$ |
| Father employed (1=yes) | .54$^{†}$ | .73$^{*}$ | .79$^{*}$ |
| Father education | .06$^{*}$ | .04 | .04 |
| Child age (in years) | −.12 | −.06 | −.07 |
| Child sex (1=girls) | .27$^{†}$ | .36$^{*}$ | .35$^{†}$ |
| Only child (1=yes) | .28 | .39$^{†}$ | .39$^{†}$ |
| Wave 2009 (1=yes) | −.19 | −.09 | −.10 |
| Constant | −2.67$^{*}$ | −1.95 | −2.67$^{†}$ |
| Model Statistics | $F(15,252) = 2.51^{**}$; $r^2$=12.99% | $F(15,192) = 2.64^{**}$; $r^2$=17.12% | $F(17,189) = 2.38^{**}$; $r^2$=17.65% |

†: <.1; *: <.05; **: <.01; ***: <.001.

Figure 4.21(a): Full SEM model predicting Height for Age Z Score




†: <.1; *: <.05; **: <.01; ***: <.001.

*Note: For presentation simplicity, only standardized coefficients presented, control variables, measures, and error terms omitted.*

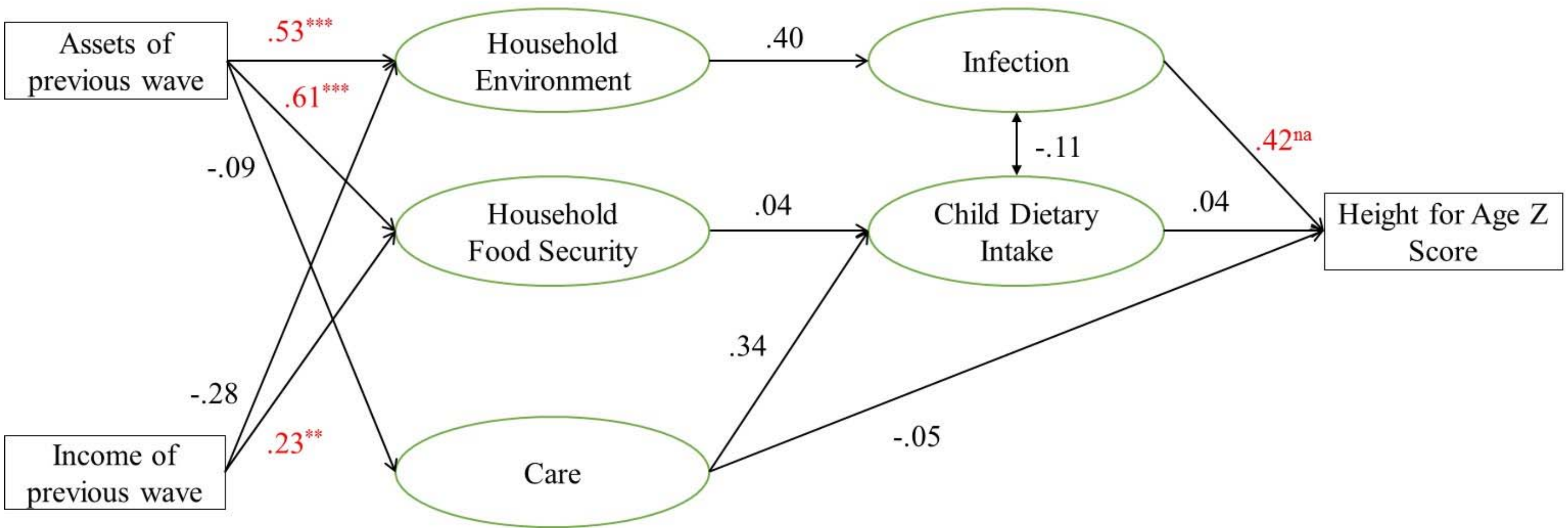
$X^2(174) = 221.22$, $p < .01$; CFI = .870; TLI = .844; SRMR = .068; RMSEA = .051 (90% CI: .027, .070).

| | Coefficient | Std. Error |
|---|---|---|
| Structural model: HAZ | | |
| Child intake | .08$^{*}$ | .04 |
| Infection | 1 | (constrained) |
| Care | −.03 | .14 |
| Child sex (1=girl) | −.52$^{*}$ | .24 |
| Wave (1=2009) | .71$^{**}$ | .26 |
| Structural model: Household food security 47.88% of the variance explained | | |
| Assets of current wave | .33$^{***}$ | .06 |
| Income of current wave | .00 | .00 |
| Household size | .05 | .09 |
| Middle (1=yes) | −.68$^{**}$ | .26 |
| West (1=yes) | −.48$^{\dagger}$ | .29 |
| Structural model: Child dietary intake 35.13% of the variance explained | | |
| Household food security | 5.51$^{**}$ | 1.82 |
| Care | .19 | .90 |
| Rural (1=yes) | −2.89 | 2.55 |
| Mother education | 1.01$^{*}$ | .44 |
| Child age | 2.12 | 1.45 |
| Structural model: Household environment 77.08 % of the variance explained | | |
| Assets of current wave | .13$^{***}$ | .02 |
| Income of current wave | .00 | .00 |
| Father employed (1=yes) | −.48$^{**}$ | .13 |
| Rural (1=yes) | −.24$^{**}$ | .08 |
| Middle (1=yes) | −.07 | .08 |
| West (1=yes) | .04 | .10 |
| Structural model: Infections | | |
| Household environment | −.60 | .72 |

| | Coefficient | Std. Error |
|---|---|---|
| Structural model: Care. 80.29% of the variance explained | | |
| Assets of current wave | .32 | .21 |
| Mother employed (1=yes) | −2.88$^{***}$ | .86 |
| Father employed (1=yes) | 3.25$^{*}$ | 1.36 |
| Father education (1=yes) | −.25$^{*}$ | .12 |
| Only child (1=yes) | −.89 | .79 |
| Measurement model: Household food security | | |
| Food diverse score | 1 | (constrained) |
| ASF amount | 302.59$^{***}$ | 50.00 |
| Measurement model: Child dietary intake | | |
| Fat | 1 | (constrained) |
| Protein | 1.01$^{***}$ | .18 |
| Measurement model: Household environment | | |
| Access to toilet with flushing | 1 | (constrained) |
| Excreta present around houses | −.57$^{***}$ | .13 |
| Measurement model: Infection | | |
| Fever | .03 | .03 |
| Diarrhea | .01 | .01 |
| Measurement model: Care | | |
| Care time by mother | 1 | (constrained) |
| Breastfeeding time | .81$^{*}$ | .41 |
| Covariance: Dietary intake and infections | −12.28$^{*}$ | 5.67 |

Unstandardized coefficients present in the table. †: <.1; *: <.05; **: <.01; ***: <.001.

Figure 4.21(b): Full SEM model predicting Height for Age Z Score




†: <.1; *: <.05; **: <.01; ***: <.001.

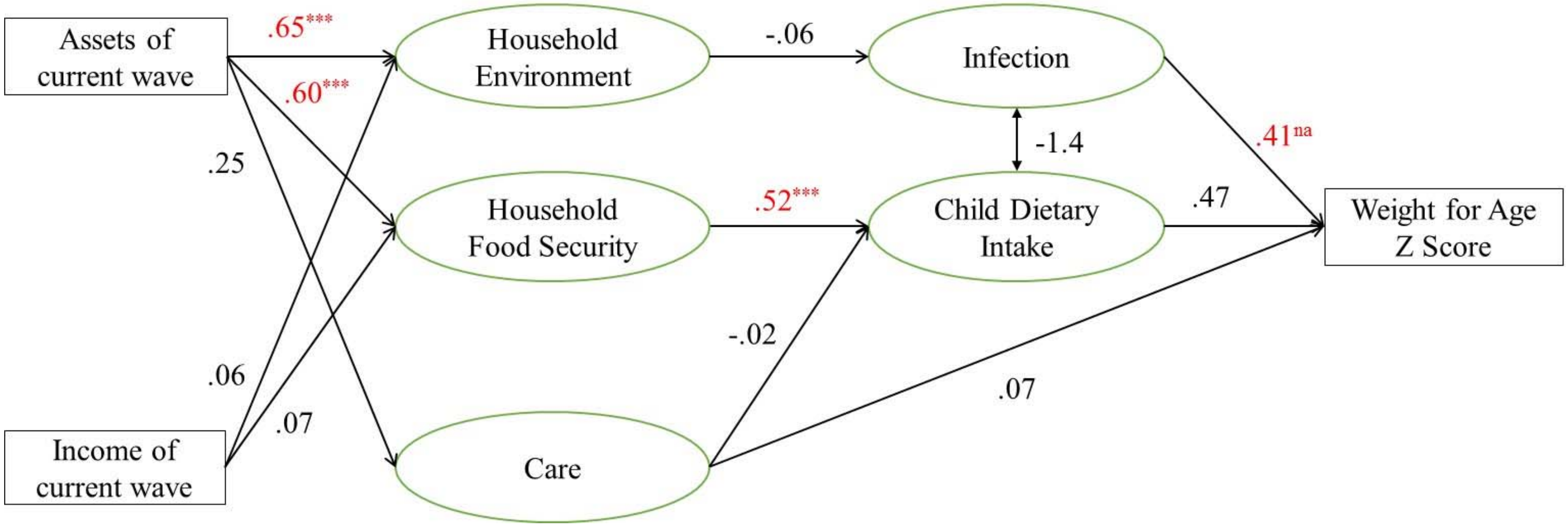
*Note: For presentation simplicity, only standardized coefficients presented, control variables, measures, and error terms omitted.*

$X^2(180) = 401.54$, $p < .001$; CFI = .183; TLI = .051; SRMR = .120; RMSEA = .123 (90% CI: .107, .139).

| | Coefficient | Std. Error | | Coefficient | Std. Error |
|---|---|---|---|---|---|
| Structural model: HAZ | | | Structural model: Care | | |
| Child intake | .00 | .01 | Assets of previous wave | −.07 | .36 |
| Infection | 1 | (constrained) | Mother employed (1=yes) | −2.18$^{**}$ | .76 |
| Care | −.05 | .28 | Father employed (1=yes) | 2.48 | 1.88 |
| Child sex (1=girl) | −.40 | .31 | Father education (1=yes) | −.14 | .19 |
| Wave (1=2009) | 1.16$^{***}$ | .33 | Only child (1=yes) | −.87 | .76 |
| Structural model: Household food security<br>69.85% of the variance explained. | | | Measurement model: Household food security | | |
| Assets of previous wave | .56$^{***}$ | .08 | Food diverse score | 1 | (constrained) |
| Income of previous wave | −.00006$^{**}$ | .00002 | ASF amount | 171.14$^{*}$ | 68.77 |
| Household size | .51$^{***}$ | .13 | Measurement model: Child dietary intake | | |
| Middle (1=yes) | −2.00$^{***}$ | .29 | Fat | 1 | (constrained) |
| West (1=yes) | −1.37$^{***}$ | .32 | Protein | .59$^{***}$ | .15 |
| Structural model: Child dietary intake<br>25.67% of the variance explained. | | | Measurement model: Household environment | | |
| Household food security | 5.54 | 3.24 | Access to toilet with flushing | 1 | (constrained) |
| Care | 4.56 | . | Excreta present around houses | −.41$^{*}$ | .18 |
| Rural (1=yes) | −14.35$^{**}$ | 5.15 | Measurement model: Infection | | |
| Mother education | −.24 | .88 | Fever | −.02 | .14 |
| Child age | 5.78$^{\dagger}$ | 3.18 | Diarrhea | −.01 | .04 |
| Structural model: Household environment<br>51.36% of the variance explained. | | | Measurement model: Care | | |
| Assets of previous wave | .10$^{***}$ | .03 | Care time by mother | 1 | (constrained) |
| Income of previous wave | .000011 | .000007 | Breastfeeding time | .38 | .75 |
| Father employed (1=yes) | −.29$^{\dagger}$ | .17 | Covariance: Dietary intake and infections | −.97 | . |
| Rural (1=yes) | −.05 | .12 | | | |
| Middle (1=yes) | .12 | .12 | | | |
| West (1=yes) | .24$^{\dagger}$ | .13 | | | |
| Structural model: Infections. 16.36% of the variance | | | | | |
| Household environment | .74 | . | | | |

Unstandardized coefficients present in the table. †: <.1; *: <.05; **: <.01; ***: <.001.

Figure 4.22(a): Full SEM model predicting Weight for Age Z Score




†: <.1; *: <.05; **: <.01; ***: <.001.

*Note: For presentation simplicity, only standardized coefficients presented, control variables, measures, and error terms omitted.*

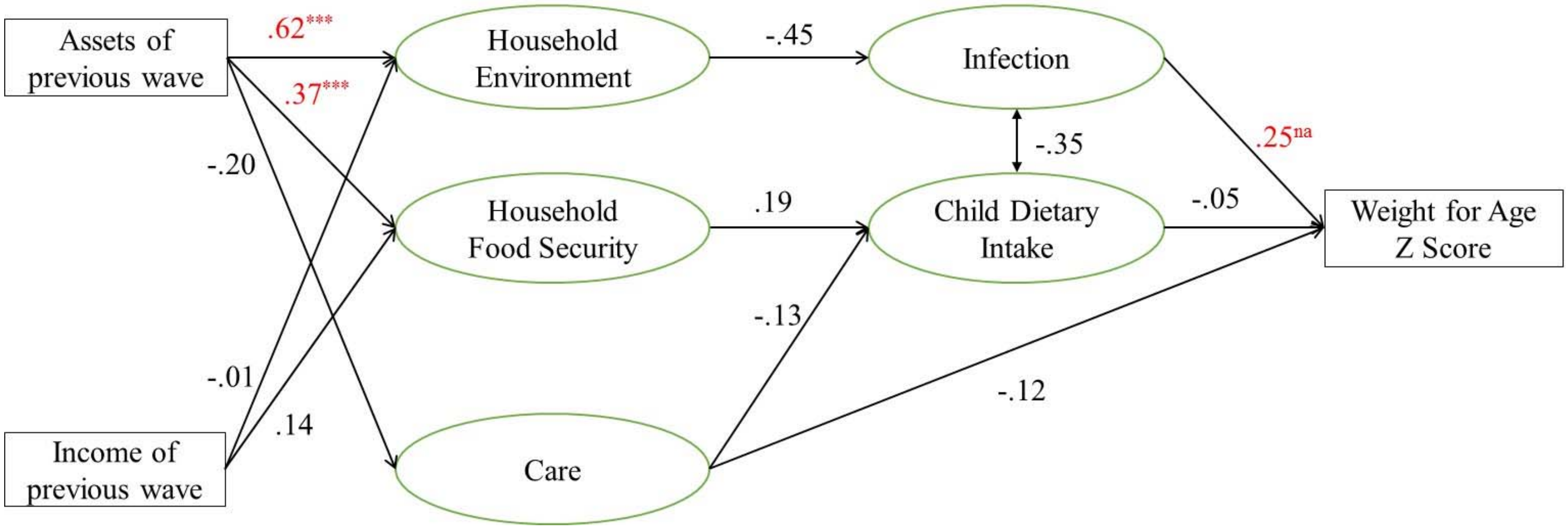
$X^2(174) = 229.46$, $p < .01$; CFI = .843; TLI = .812; SRMR = .068; RMSEA = .054 (90% CI: .032, .072).

| | Coefficient | Std. Error |
|---|---|---|
| Structural model: WAZ | | |
| Child intake | .04 | .02 |
| Infection | 1 | (constrained) |
| Care | .03 | .06 |
| Child sex (1=girl) | −.11 | .19 |
| Wave (1=2009) | .30 | .21 |
| Structural model: Household food security 46.40% of the variance explained | | |
| Assets of current wave | $.32^{***}$ | .06 |
| Income of current wave | .000008 | .00001 |
| Household size | .09 | .09 |
| Middle (1=yes) | $-.56^{*}$ | .25 |
| West (1=yes) | −.33 | .27 |
| Structural model: Child dietary intake 35.98% of the variance explained | | |
| Household food security | $6.70^{***}$ | 2.02 |
| Care | −.13 | .67 |
| Rural (1=yes) | .41 | 2.45 |
| Mother education | .63 | .47 |
| Child age | 1.99 | 1.28 |
| Structural model: Household environment 72.03% of the variance explained | | |
| Assets of current wave | $.12^{***}$ | .02 |
| Income of current wave | .000002 | .000003 |
| Father employed (1=yes) | $-.41^{**}$ | .14 |
| Rural (1=yes) | $-.25^{**}$ | .08 |
| Middle (1=yes) | −.04 | .08 |
| West (1=yes) | .04 | .09 |
| Structural model: Infections. .35% of the variance explain | | |
| Household environment | −.07 | .47 |

| | Coefficient | Std. Error |
|---|---|---|
| Structural model: Care. 65.93% of the variance explained | | |
| Assets of current wave | .28 | .20 |
| Mother employed (1=yes) | $-3.40^{***}$ | .72 |
| Father employed (1=yes) | $3.54^{**}$ | 1.29 |
| Father education (1=yes) | $-.23^{*}$ | .12 |
| Only child (1=yes) | −.65 | .77 |
| Measurement model: Household food security | | |
| Food diverse score | 1 | (constrained) |
| ASF amount | $336.01^{***}$ | 54.96 |
| Measurement model: Child dietary intake | | |
| Fat | 1 | (constrained) |
| Protein | $1.06^{***}$ | .17 |
| Measurement model: Household environment | | |
| Access to toilet with flushing | 1 | (constrained) |
| Excreta present around houses | $-.56^{***}$ | .14 |
| Measurement model: Infection | | |
| Fever | .05 | .07 |
| Diarrhea | .01 | .02 |
| Measurement model: Care | | |
| Care time by mother | 1 | (constrained) |
| Breastfeeding time | $.72^{*}$ | .34 |
| Covariance: Dietary intake and infections | $-6.56^{\dagger}$ | 3.66 |

Unstandardized coefficients present in the table. †: <.1; *: <.05; **: <.01; ***: <.001.

Figure 4.22(b): Full SEM model predicting Weight for Age Z Score




†: <.1; *: <.05; **: <.01; ***: <.001.

*Note: For presentation simplicity, only standardized coefficients presented, control variables, measures, and error terms omitted.*

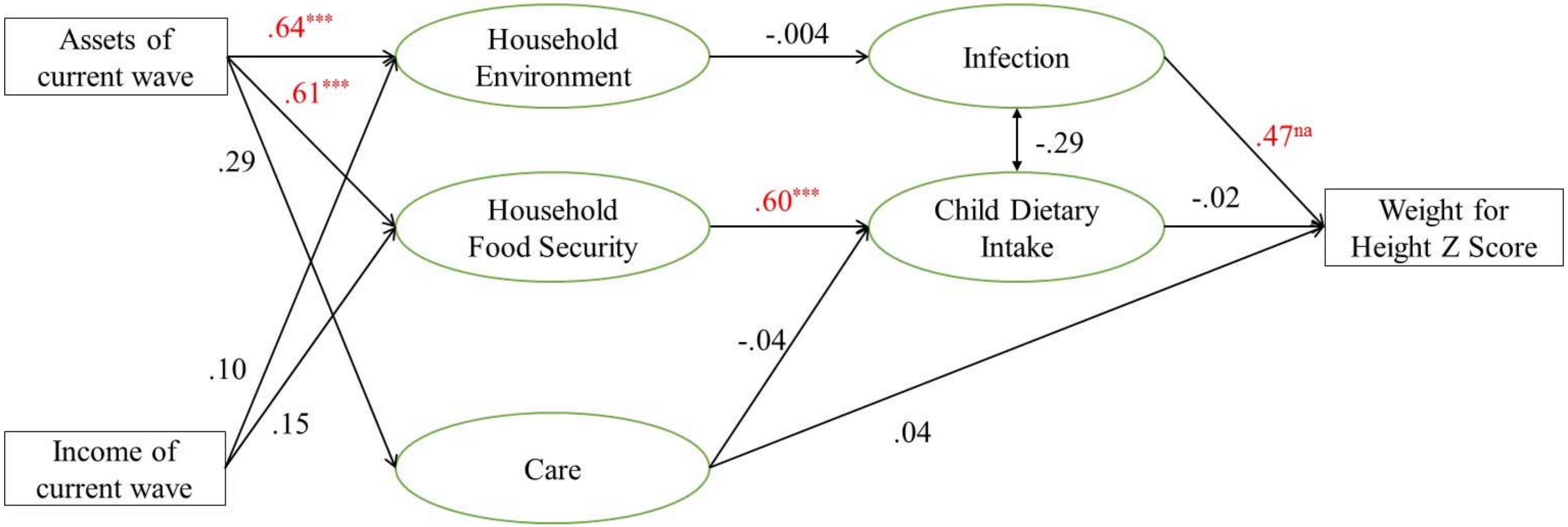
$X^2(176) = 255.00$, $p < .001$; CFI = .679; TLI = .618; SRMR = .086; RMSEA = .073 (90% CI: .052, .092).

| | Coefficient | Std. Error |
|---|---|---|
| Structural model: WAZ | | |
| Child intake | −.00 | .01 |
| Infection | 1 | (constrained) |
| Care | −.09 | .12 |
| Child sex (1=girl) | .01 | .22 |
| Wave (1=2009) | .41$^{\dagger}$ | .23 |
| Structural model: Household food security 35.83% of the variance explained | | |
| Assets of previous wave | .32$^{***}$ | .10 |
| Income of previous wave | .00003 | .00002 |
| Household size | .33$^{*}$ | .15 |
| Middle (1=yes) | −1.41$^{***}$ | .37 |
| West (1=yes) | −.68$^{\dagger}$ | .41 |
| Structural model: Child dietary intake 13.29% of the variance explained | | |
| Household food security | 2.31 | 2.10 |
| Care | −1.70 | 2.04 |
| Rural (1=yes) | −9.23$^{\dagger}$ | 5.09 |
| Mother education | −.02 | .86 |
| Child age | 3.57 | 2.56 |
| Structural model: Household environment 63.34% of the variance explained | | |
| Assets of previous wave | .13$^{***}$ | .03 |
| Income of previous wave | −.0000004 | .000006 |
| Father employed (1=yes) | −.25 | .17 |
| Rural (1=yes) | −.23$^{*}$ | .10 |
| Middle (1=yes) | .06 | .10 |
| West (1=yes) | .20 | .12 |
| Structural model: Infections. 20.04% of the variance | | |
| Household environment | −.31 | .45 |

| | Coefficient | Std. Error |
|---|---|---|
| Structural model: Care | | |
| Assets of previous wave | −.16 | .24 |
| Mother employed (1=yes) | −2.12 | 1.39 |
| Father employed (1=yes) | 3.06$^{*}$ | 1.25 |
| Father education (1=yes) | −.10 | .12 |
| Only child (1=yes) | −.45 | .92 |
| Measurement model: Household food security | | |
| Food diverse score | 1 | (constrained) |
| ASF amount | 187.24$^{***}$ | 50.46 |
| Measurement model: Child dietary intake | | |
| Fat | 1 | (constrained) |
| Protein | .57$^{***}$ | .11 |
| Measurement model: Household environment | | |
| Access to toilet with flushing | 1 | (constrained) |
| Excreta present around houses | −.51$^{**}$ | .17 |
| Measurement model: Infection | | |
| Fever | .17 | .38 |
| Diarrhea | .10 | .12 |
| Measurement model: Care | | |
| Care time by mother | 1 | (constrained) |
| Breastfeeding time | .94 | .85 |
| Covariance: Dietary intake and infections | −1.35 | . |

Unstandardized coefficients present in the table. †: <.1; *: <.05; **: <.01; ***: <.001.

Figure 4.23(a): Full SEM model predicting Weight for Height Z Score



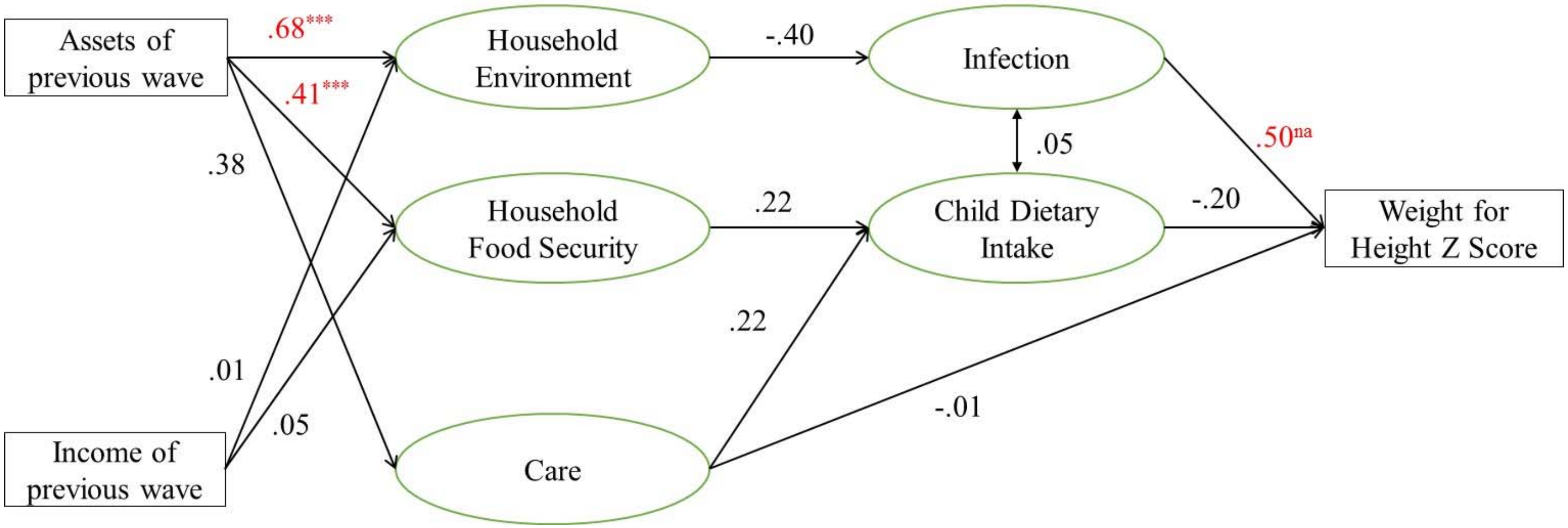

†: <.1; *: <.05; **: <.01; ***: <.001.
*Note: For presentation simplicity, only standardized coefficients presented, control variables, measures, and error terms omitted.*
$X^2(174) = 206.43$, $p < .05$; CFI = .900; TLI = .880; SRMR = .065; RMSEA = .042 (90% CI: .005, .063).

| | Coefficient | Std. Error |
|---|---|---|
| Structural model: WHZ | | |
| Child intake | −.00 | .02 |
| Infection | 1 | (constrained) |
| Care | .02 | .07 |
| Child sex (1=girl) | .13 | .23 |
| Wave (1=2009) | −.28 | .25 |
| Structural model: Household food security 50.49% of the variance explained | | |
| Assets of current wave | .34$^{***}$ | .06 |
| Income of current wave | .00002 | .00001 |
| Household size | .05 | .09 |
| Middle (1=yes) | −.59$^{*}$ | .25 |
| West (1=yes) | −.23 | .26 |
| Structural model: Child dietary intake 40.40% of the variance explained | | |
| Household food security | 7.83$^{***}$ | 2.14 |
| Care | −.25 | .72 |
| Rural (1=yes) | .42 | 3.10 |
| Mother education | .31 | .49 |
| Child age | 2.69 | 1.78 |
| Structural model: Household environment 80.82% of the variance explained | | |
| Assets of current wave | .12$^{***}$ | .02 |
| Income of current wave | .000003 | .000003 |
| Father employed (1=yes) | −.54$^{***}$ | .13 |
| Rural (1=yes) | −.24$^{**}$ | .08 |
| Middle (1=yes) | −.09 | .08 |
| West (1=yes) | −.02 | .09 |
| Structural model: Infections. .00% of the variance explain | | |
| Household environment | −.01 | .36 |

| | Coefficient | Std. Error |
|---|---|---|
| Structural model: Care. 67.07% of the variance explained. | | |
| Assets of current wave | .32 | .22 |
| Mother employed (1=yes) | −3.26$^{***}$ | .77 |
| Father employed (1=yes) | 2.92$^{*}$ | 1.92 |
| Father education (1=yes) | −.27$^{*}$ | .12 |
| Only child (1=yes) | −.69 | .79 |
| Measurement model: Household food security | | |
| Food diverse score | 1 | (constrained) |
| ASF amount | 324.58$^{***}$ | 53.85 |
| Measurement model: Child dietary intake | | |
| Fat | 1 | (constrained) |
| Protein | 1.03$^{***}$ | .19 |
| Measurement model: Household environment | | |
| Access to toilet with flushing | 1 | (constrained) |
| Excreta present around houses | −.59$^{***}$ | .13 |
| Measurement model: Infection | | |
| Fever | −.02 | .16 |
| Diarrhea | .04 | .11 |
| Measurement model: Care | | |
| Care time by mother | 1 | (constrained) |
| Breastfeeding time | .69$^{\dagger}$ | .36 |
| Covariance: Dietary intake and infections | −1.70 | 3.15 |

Unstandardized coefficients present in the table. †: <.1; *: <.05; **: <.01; ***: <.001.

Figure 4.23(b): Full SEM model predicting Weight for Height Z Score




†: <.1; *: <.05; **: <.01; ***: <.001.
*Note: For presentation simplicity, only standardized coefficients presented, control variables, measures, and error terms omitted.*
$X^2(177) = 272.51$, $p < .001$; CFI = .629; TLI = .562; SRMR = .092; RMSEA = .082 (90% CI: .062, .101).

| | Coefficient | Std. Error |
|---|---|---|
| Structural model: WHZ | | |
| Child intake | −.01 | .02 |
| Infection | 1 | (constrained) |
| Care | −.01 | .28 |
| Child sex (1=girl) | .14 | .30 |
| Wave (1=2009) | −.34 | .31 |
| Structural model: Household food security<br>49.15% of the variance explained | | |
| Assets of previous wave | $.35^{***}$ | .09 |
| Income of previous wave | .00001 | .00002 |
| Household size | $.39^{**}$ | .14 |
| Middle (1=yes) | $-1.89^{***}$ | .37 |
| West (1=yes) | $-1.06^{**}$ | .40 |
| Structural model: Child dietary intake<br>29.65% of the variance explained | | |
| Household food security | 3.16 | 2.28 |
| Care | 4.66 | . |
| Rural (1=yes) | $-18.37^{**}$ | 7.03 |
| Mother education | .26 | .74 |
| Child age | $7.76^{\dagger}$ | 3.98 |
| Structural model: Household environment<br>65.03% of the variance explained | | |
| Assets of previous wave | $.14^{***}$ | .03 |
| Income of previous wave | .0000004 | .000007 |
| Father employed (1=yes) | −.25 | .21 |
| Rural (1=yes) | −.17 | .11 |
| Middle (1=yes) | .04 | .12 |
| West (1=yes) | .16 | .15 |
| Structural model: Infections. 15.61% of the variance | | |
| Household environment | −.64 | .80 |

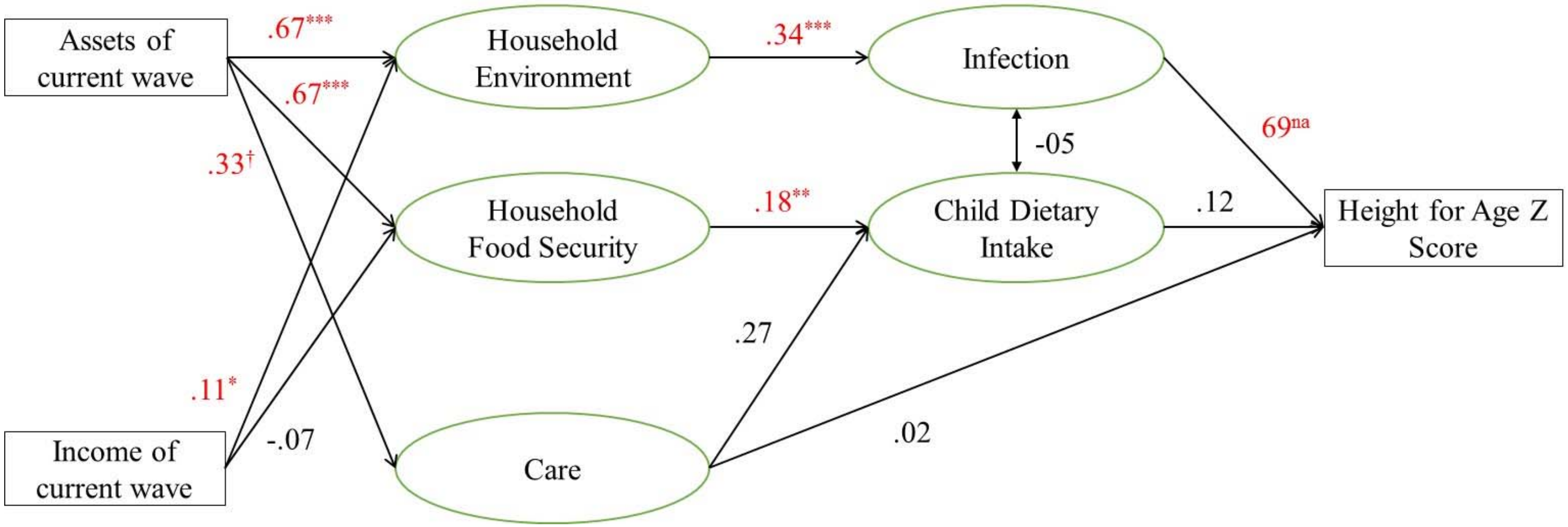
| | Coefficient | Std. Error |
|---|---|---|
| Structural model: Care | | |
| Assets of previous wave | .22 | .29 |
| Mother employed (1=yes) | −1.45 | 1.34 |
| Father employed (1=yes) | 1.46 | 2.78 |
| Father education (1=yes) | −.16 | .14 |
| Only child (1=yes) | −.99 | .98 |
| Measurement model: Household food security | | |
| Food diverse score | 1 | (constrained) |
| ASF amount | $197.41^{***}$ | 45.42 |
| Measurement model: Child dietary intake | | |
| Fat | 1 | (constrained) |
| Protein | $.63^{***}$ | .13 |
| Measurement model: Household environment | | |
| Access to toilet with flushing | 1 | (constrained) |
| Excreta present around houses | $-.55^{**}$ | .20 |
| Measurement model: Infection | | |
| Fever | .12 | .41 |
| Diarrhea | .04 | .18 |
| Measurement model: Care | | |
| Care time by mother | 1 | (constrained) |
| Breastfeeding time | .61 | 2.13 |
| Covariance: Dietary intake and infections | .43 | 7.80 |

Unstandardized coefficients present in the table. †: <.1; *: <.05; **: <.01; ***: <.001.

Table 5.1: Examining the missing pattern (missing group – non−missing group) against the nutritional outcomes by T−tests

| Variables (Missing > 20%) | Missing, % | HAZ | WAZ | WHZ |
|---|---|---|---|---|
| Care | | | | |
| Breastfeeding Time | 66.86 | $t(477)=.86, p=.39$ | $t(478)=1.23, p=.22$ | $t(478)=1.67, p<.1$ |
| Care time by mothers | 22.43 | $t(477)=-.38, p=.70$ | $t(494)=.61, p=.54$ | $t(478)=-.11, p=.91$ |
| Care time by others | 23.02 | $t(477)=-.20, p=.84$ | $t(494)=.66, p=.51$ | $t(478)=-.22, p=.83$ |
| Parents' demographic | | | | |
| Mother's employment status | 28.45 | $t(477)=2.47, p<.05$ | $t(494)=1.25, p=.21$ | $t(478)=-.07, p=.94$ |
| Mother's education | 28.59 | $t(477)=2.39, p<.05$ | $t(494)=1.15, p=.25$ | $t(478)=-.14, p=.89$ |
| Mother's BMI | 32.55 | $t(477)=2.03, p<.05$ | $t(494)=.98, p=.33$ | $t(478)=-.06, p=.96$ |
| Father's employment status | 38.27 | $t(477)=.81, p=.42$ | $t(494)=-.35, p=.73$ | $t(478)=-.25, p=.81$ |
| Father's education | 38.27 | $t(477)=.75, p=.45$ | $t(494)=-.45, p=.65$ | $t(478)=-.34, p=.74$ |
| Previous wave | | | | |
| Assets | 32.26 | $t(477)=3.01, p<.01$ | $t(494)=1.44, p=.15$ | $t(478)=-.75, p=.45$ |
| Income | 31.67 | $t(477)=3.32, p<.01$ | $t(494)=1.44, p=.15$ | $t(478)=-1.01, p=.32$ |

Figure 5.2(a): Sensitivity test: Full model predicting Height for Age Z Score by FIML



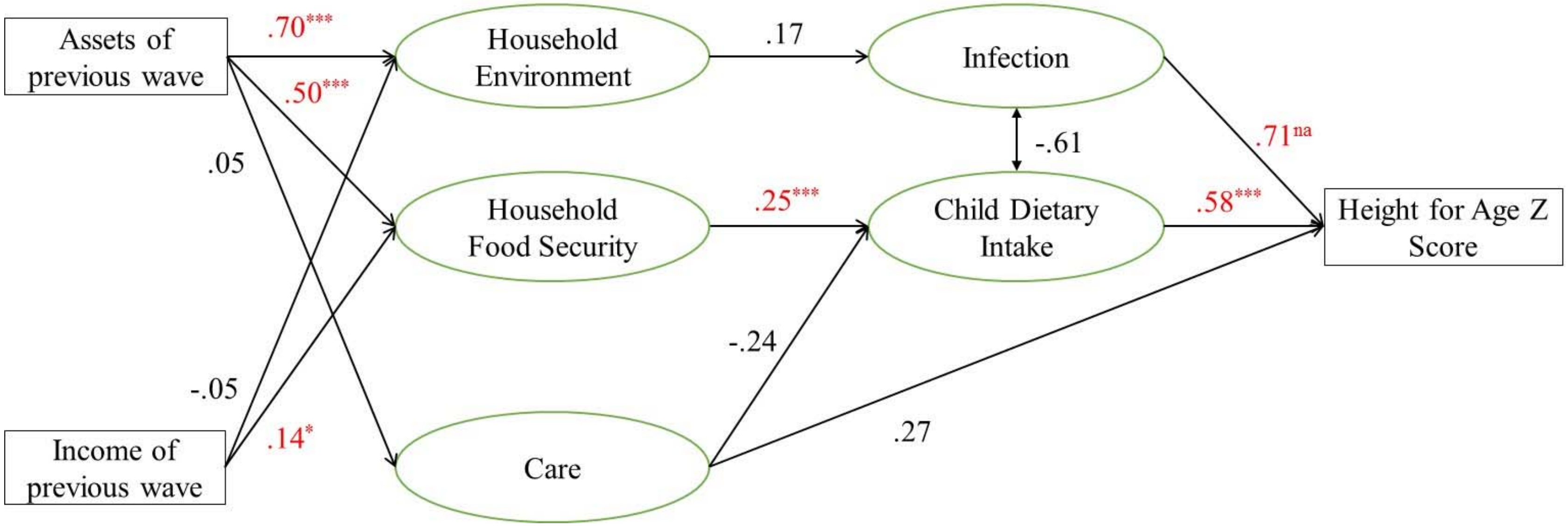

†: <.1; *: <.05; **: <.01; ***: <.001.
*Note: For presentation simplicity, only standardized coefficients presented, control variables, measures, and error terms omitted.*
$X^2(321) = 706.18$, $p < .01$; CFI = .785; TLI = .860; RMSEA = .042 (90% CI: .000, .).

| | Coefficient | Std. Error |
|---|---|---|
| Structural model: HAZ. 54.45% of variance explained | | |
| Child intake | .005 | .003 |
| Infection | 1 | (constrained) |
| Care | .03 | .14 |
| Child sex (1=girl) | −.10 | .12 |
| Wave (1=2009) | .46$^{***}$ | .13 |
| Structural model: Household food security 67.36% of the variance explained | | |
| Assets of current wave | .36$^{***}$ | .03 |
| Income of current wave | −.00001 | .000006 |
| Household size | .21$^{***}$ | .03 |
| Middle (1=yes) | −.92$^{***}$ | .11 |
| West (1=yes) | −.55$^{***}$ | .11 |
| Structural model: Child dietary intake 28.88% of the variance explained | | |
| Household food security | 5.47$^{**}$ | 2.06 |
| Care | 8.97 | . |
| Rural (1=yes) | −24.48$^{***}$ | 2.94 |
| Mother education | −.20 | .68 |
| Child age | 6.92$^{**}$ | 1.70 |
| Structural model: Household environment 69.45% of the variance explained | | |
| Assets of current wave | .12$^{***}$ | .01 |
| Income of current wave | .00005$^{*}$ | .00002 |
| Father employed (1=yes) | −.12$^{\dagger}$ | .07 |
| Rural (1=yes) | −.20$^{***}$ | .04 |
| Middle (1=yes) | .07$^{\dagger}$ | .04 |
| West (1=yes) | .06 | .05 |
| Structural model: Infections. 11.81% of variance explain. | | |
| Household environment | .94$^{***}$ | .29 |

| | Coefficient | Std. Error |
|---|---|---|
| Structural model: Care. | | |
| Assets of current wave | .16$^{\dagger}$ | .09 |
| Mother employed (1=yes) | −1.78$^{***}$ | .29 |
| Father employed (1=yes) | 2.35$^{***}$ | .55 |
| Father education (1=yes) | −.13$^{*}$ | .06 |
| Only child (1=yes) | −.54$^{\dagger}$ | .28 |
| Measurement model: Household food security | | |
| Food diverse score | 1 | (constrained) |
| ASF amount | 246.61$^{***}$ | 23.14 |
| Measurement model: Child dietary intake | | |
| Fat | 1 | (constrained) |
| Protein | .74$^{***}$ | .05 |
| Measurement model: Household environment | | |
| Access to toilet with flushing | 1 | (constrained) |
| Excreta present around houses | −.54$^{***}$ | .07 |
| Measurement model: Infection | | |
| Fever | .04 | .02 |
| Diarrhea | .01 | .01 |
| Measurement model: Care | | |
| Care time by mother | 1 | (constrained) |
| Breastfeeding time | .75 | .50 |
| Covariance: Dietary intake and infections | −1.28 | . |

Unstandardized coefficients present in the table. †: <.1; *: <.05; **: <.01; ***: <.001.

Figure 5.2(b): Sensitivity test: Full model predicting Height for Age Z Score by FIML



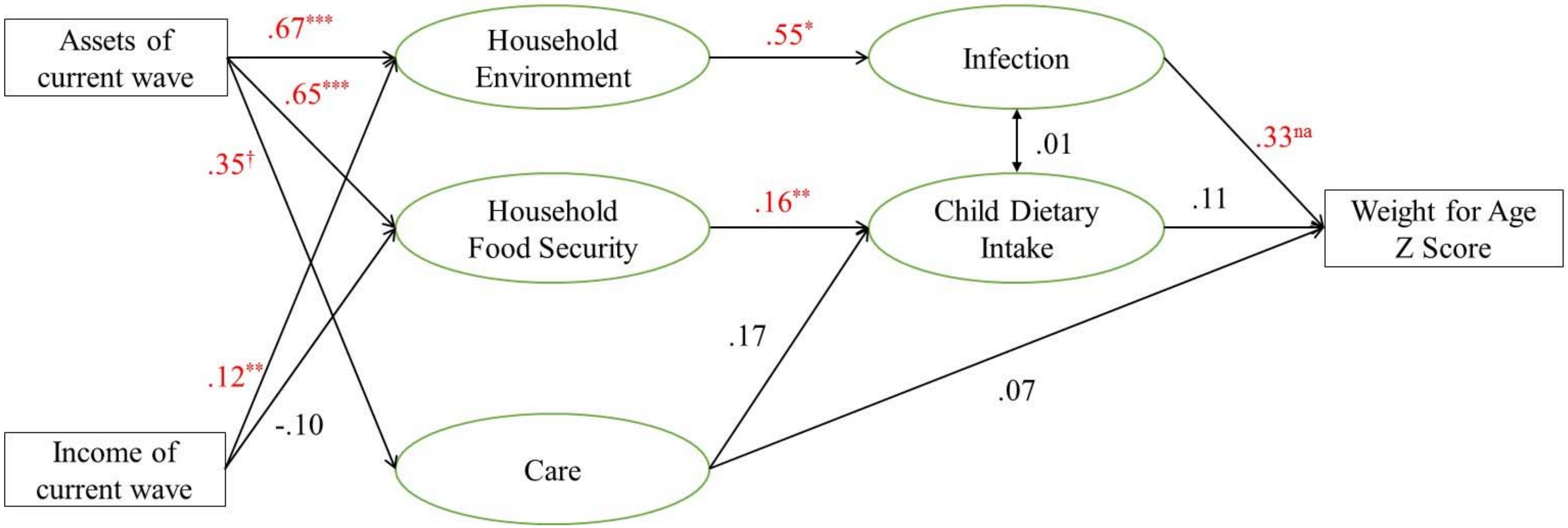

†: <.1; *: <.05; **: <.01; ***: <.001.
*Note: For presentation simplicity, only standardized coefficients presented, control variables, measures, and error terms omitted.*
$X^2(309) = 509.61$, $p < .001$; CFI = .887; TLI = .924; RMSEA = .031 (90% CI: .000, .).

| | Coefficient | Std. Error |
|---|---|---|
| **Structural model: HAZ. 49.26% of the variance explained** | | |
| Child intake | .03$^{***}$ | .01 |
| Infection | 1 | (constrained) |
| Care | .13 | .10 |
| Child sex (1=girl) | −.16 | .12 |
| Wave (1=2009) | .35$^{**}$ | .12 |
| **Structural model: Household food security 46.34% of the variance explained** | | |
| Assets of previous wave | .30$^{***}$ | .03 |
| Income of previous wave | .00003$^{*}$ | .00001 |
| Household size | .11$^{***}$ | .03 |
| Middle (1=yes) | −.72$^{***}$ | .13 |
| West (1=yes) | −.58$^{***}$ | .14 |
| **Structural model: Child dietary intake 26.50% of the variance explained** | | |
| Household food security | 6.19$^{***}$ | 1.26 |
| Care | −2.18 | 1.58 |
| Rural (1=yes) | −13.28$^{***}$ | 2.43 |
| Mother education | 1.09$^{**}$ | .41 |
| Child age | 2.51$^{*}$ | 1.24 |
| **Structural model: Household environment 82.13% of the variance explained** | | |
| Assets of previous wave | .12$^{***}$ | .01 |
| Income of previous wave | −.000004 | .000004 |
| Father employed (1=yes) | −.25$^{***}$ | .06 |
| Rural (1=yes) | −.23$^{***}$ | .04 |
| Middle (1=yes) | −.03 | .04 |
| West (1=yes) | −.04 | .05 |
| **Structural model: Infections. 3.05% of variance explained** | | |
| Household environment | .52 | .32 |

| | Coefficient | Std. Error |
|---|---|---|
| **Structural model: Care. 13.44% of the variance explained** | | |
| Assets of previous wave | .08 | .13 |
| Mother employed (1=yes) | −2.37$^{***}$ | .44 |
| Father employed (1=yes) | 1.59$^{*}$ | .79 |
| Father education (1=yes) | −.07 | .08 |
| Only child (1=yes) | −.56 | .41 |
| **Measurement model: Household food security** | | |
| Food diverse score | 1 | (constrained) |
| ASF amount | 254.97$^{***}$ | 30.33 |
| **Measurement model: Child dietary intake** | | |
| Fat | 1 | (constrained) |
| Protein | .91$^{***}$ | .06 |
| **Measurement model: Household environment** | | |
| Access to toilet with flushing | 1 | (constrained) |
| Excreta present around houses | −.62$^{***}$ | .07 |
| **Measurement model: Infection** | | |
| Fever | .04$^{\dagger}$ | .02 |
| Diarrhea | −.00 | .01 |
| **Measurement model: Care** | | |
| Care time by mother | 1 | (constrained) |
| Breastfeeding time | .08 | .20 |
| **Covariance: Dietary intake and infections** | −13.93 | . |

Unstandardized coefficients present in the table. †: <.1; *: <.05; **: <.01; ***: <.001.

Figure 5.3(a): Sensitivity test: Full model predicting Weight for Age Z Score by FIML



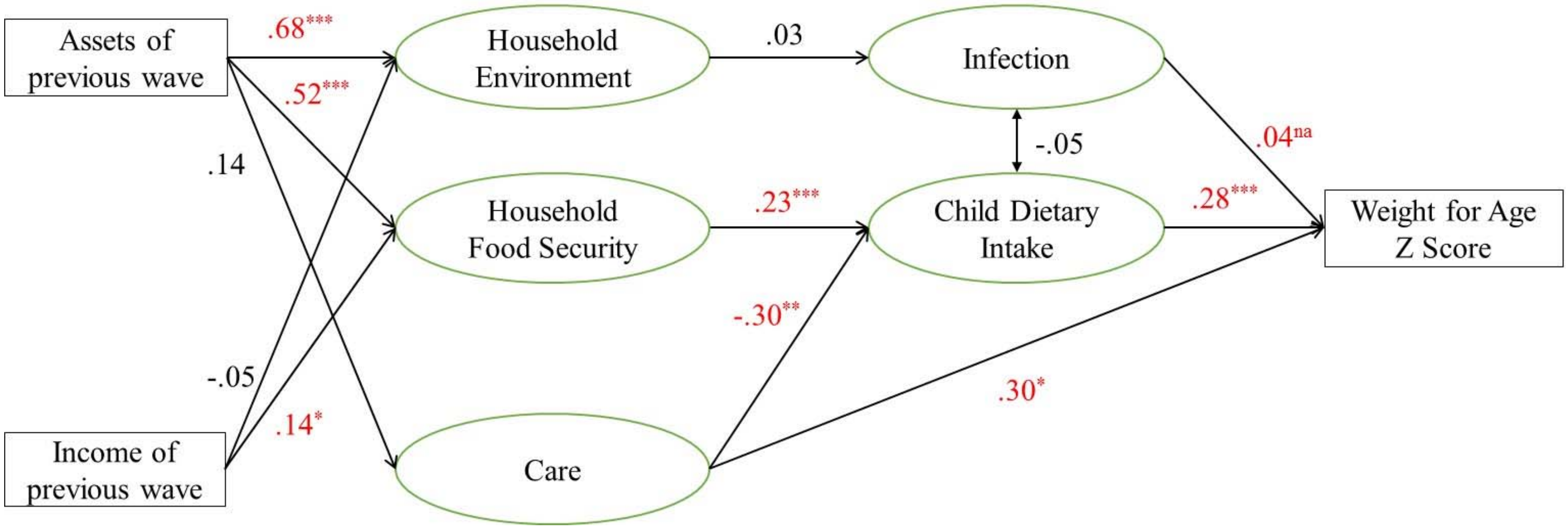

†: <.1; *: <.05; **: <.01; ***: <.001.
*Note: For presentation simplicity, only standardized coefficients presented, control variables, measures, and error terms omitted.*
$X^2(321) = 670.48$, $p < .001$; CFI = .803; TLI = .870; RMSEA = .040 (90% CI: .000, .).

| | Coefficient | Std. Error |
|---|---|---|
| Structural model: WAZ. 14.89% of variance explained | | |
| Child intake | .004 | .003 |
| Infection | 1 | (constrained) |
| Care | .08 | .12 |
| Child sex (1=girl) | −.03 | .10 |
| Wave (1=2009) | .14 | .11 |
| Structural model: Household food security 65.18% of the variance explained | | |
| Assets of current wave | .34*** | .03 |
| Income of current wave | −.00001 | .000006 |
| Household size | .19*** | .03 |
| Middle (1=yes) | −.96*** | .11 |
| West (1=yes) | −.69*** | .12 |
| Structural model: Child dietary intake 25.37% of the variance explained | | |
| Household food security | 4.99** | 1.78 |
| Care | 5.63 | . |
| Rural (1=yes) | −.25.45*** | 2.89 |
| Mother education | −.25 | .62 |
| Child age | 6.70*** | 1.70 |
| Structural model: Household environment 68.45% of the variance explained | | |
| Assets of current wave | .12*** | .01 |
| Income of current wave | .000006** | .000002 |
| Father employed (1=yes) | −.10 | .07 |
| Rural (1=yes) | −.19*** | .04 |
| Middle (1=yes) | .08† | .04 |
| West (1=yes) | .08 | .05 |
| Structural model: Infections. 30.45% of variance explain | | |
| Household environment | .60* | .25 |

| | Coefficient | Std. Error |
|---|---|---|
| Structural model: Care | | |
| Assets of current wave | .17† | .10 |
| Mother employed (1=yes) | −1.79*** | .40 |
| Father employed (1=yes) | 2.34*** | .55 |
| Father education (1=yes) | −.13† | .08 |
| Only child (1=yes) | −.49 | .36 |
| Measurement model: Household food security | | |
| Food diverse score | 1 | (constrained) |
| ASF amount | 256.38*** | 25.98 |
| Measurement model: Child dietary intake | | |
| Fat | 1 | (constrained) |
| Protein | .74*** | .05 |
| Measurement model: Household environment | | |
| Access to toilet with flushing | 1 | (constrained) |
| Excreta present around houses | −.54*** | .07 |
| Measurement model: Infection | | |
| Fever | .09 | .10 |
| Diarrhea | .02 | .03 |
| Measurement model: Care | | |
| Care time by mother | 1 | (constrained) |
| Breastfeeding time | .87 | .60 |
| Covariance: Dietary intake and infections | .11 | . |

Unstandardized coefficients present in the table. †: <.1; *: <.05; **: <.01; ***: <.001.

Figure 5.3(b): Sensitivity test: Full model predicting Weight for Age Z Score by FIML




†: <.1; *: <.05; **: <.01; ***: <.001.

*Note: For presentation simplicity, only standardized coefficients presented, control variables, measures, and error terms omitted.*

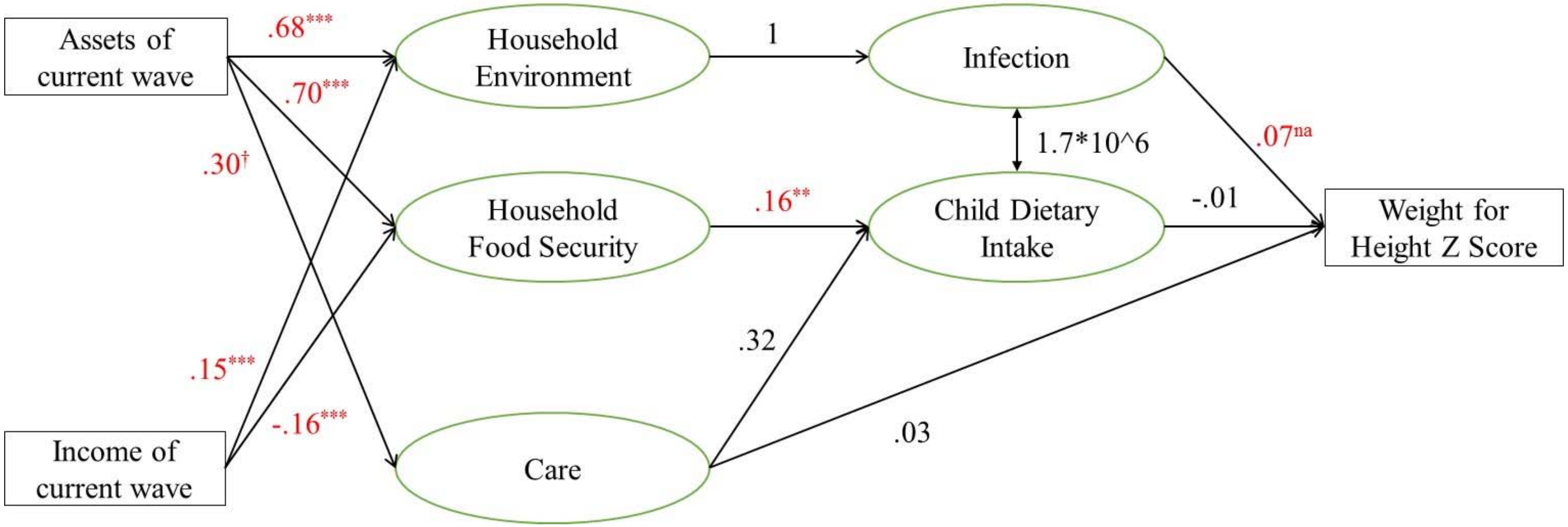
$X^2(309) = 524.90$, $p < .001$; CFI = .877; TLI = .917; RMSEA = .032 (90% CI: .000, .).

| | Coefficient | Std. Error |
|---|---|---|
| Structural model: WAZ. 12.33% of variance explained | | |
| Child intake | $.01^{***}$ | .002 |
| Infection | 1 | (constrained) |
| Care | $.16^{*}$ | .07 |
| Child sex (1=girl) | −.06 | .10 |
| Wave (1=2009) | .11 | .10 |
| Structural model: Household food security 47.22% of the variance explained | | |
| Assets of previous wave | $.30^{***}$ | .03 |
| Income of previous wave | $.00003^{*}$ | .00001 |
| Household size | $.11^{***}$ | .03 |
| Middle (1=yes) | $-.70^{***}$ | .13 |
| West (1=yes) | $-.51^{***}$ | .14 |
| Structural model: Child dietary intake 30.59% of the variance explained | | |
| Household food security | $5.82^{***}$ | 1.41 |
| Care | $-3.86^{**}$ | 1.38 |
| Rural (1=yes) | $-15.85^{***}$ | 2.55 |
| Mother education | $.98^{*}$ | .45 |
| Child age | $3.96^{**}$ | 1.43 |
| Structural model: Household environment 76.82% of the variance explained | | |
| Assets of previous wave | $.12^{***}$ | .01 |
| Income of previous wave | −.000004 | .000004 |
| Father employed (1=yes) | $-.25^{***}$ | .06 |
| Rural (1=yes) | $-.25^{***}$ | .04 |
| Middle (1=yes) | −.01 | .04 |
| West (1=yes) | .00 | .02 |
| Structural model: Infections. .10% of variance explained | | |
| Household environment | .00 | .01 |

| | Coefficient | Std. Error |
|---|---|---|
| Structural model: Care. 25.03% of the variance explained | | |
| Assets of previous wave | .16 | .11 |
| Mother employed (1=yes) | $-2.29^{***}$ | .48 |
| Father employed (1=yes) | $1.52^{*}$ | .73 |
| Father education (1=yes) | −.07 | .08 |
| Only child (1=yes) | −.50 | .37 |
| Measurement model: Household food security | | |
| Food diverse score | 1 | (constrained) |
| ASF amount | $266.54^{***}$ | 32.52 |
| Measurement model: Child dietary intake | | |
| Fat | 1 | (constrained) |
| Protein | $.89^{***}$ | .06 |
| Measurement model: Household environment | | |
| Access to toilet with flushing | 1 | (constrained) |
| Excreta present around houses | $-.59^{***}$ | .07 |
| Measurement model: Infection | | |
| Fever | 8.38 | 13.11 |
| Diarrhea | .47 | .53 |
| Measurement model: Care | | |
| Care time by mother | 1 | (constrained) |
| Breastfeeding time | .14 | .28 |
| Covariance: Dietary intake and infections | −.05 | .08 |

Unstandardized coefficients present in the table. †: <.1; *: <.05; **: <.01; ***: <.001.

Figure 5.4(a): Sensitivity test: Full model predicting Weight for Height Z Score by FIML




†: <.1; *: <.05; **: <.01; ***: <.001.

*Note: For presentation simplicity, only standardized coefficients presented, control variables, measures, and error terms omitted.*

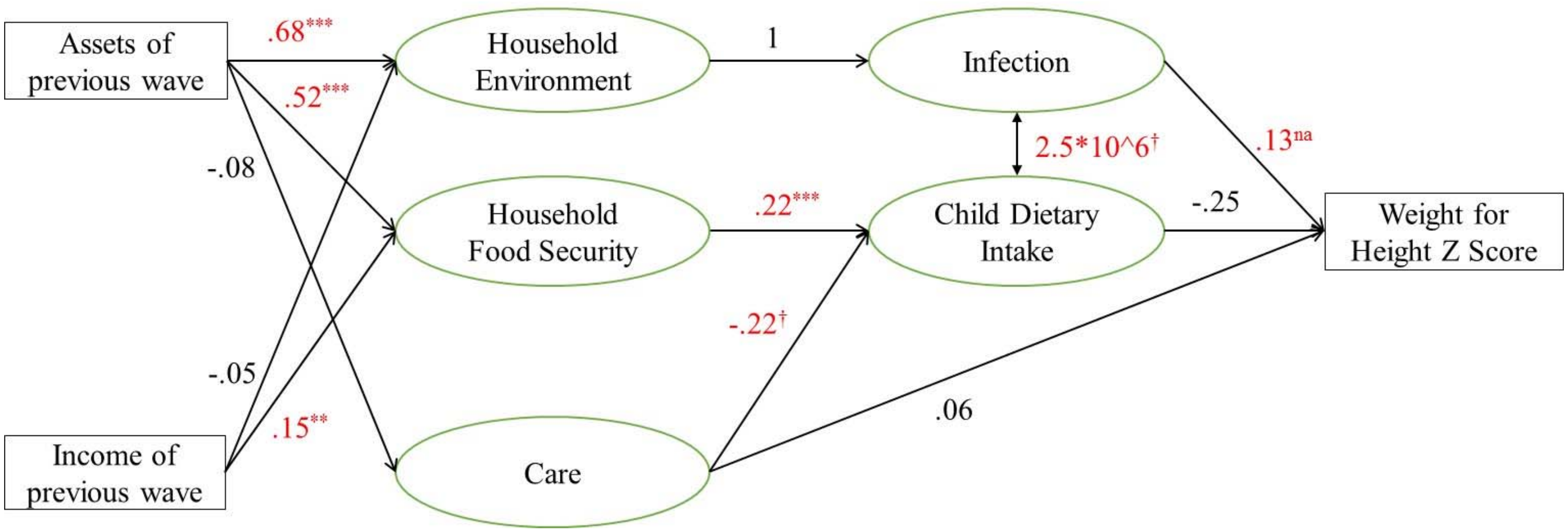
$X^2(320) = 816.15$, $p < .001$; CFI = .705; TLI = .808; RMSEA = .048 (90% CI: .000, .).

| | Coefficient | Std. Error |
|---|---|---|
| Structural model: WHZ. 1.40% of the variance explained | | |
| Child intake | −.00 | .02 |
| Infection | 1 | (constrained) |
| Care | .04 | .08 |
| Child sex (1=girl) | .06 | .11 |
| Wave (1=2009) | −.27* | .11 |
| Structural model: Household food security 76.05% of the variance explained | | |
| Assets of current wave | .35*** | .02 |
| Income of current wave | −.00002*** | .000006 |
| Household size | .20*** | .02 |
| Middle (1=yes) | −1.05*** | .10 |
| West (1=yes) | −.69*** | .11 |
| Structural model: Child dietary intake 34.27% of the variance explained | | |
| Household food security | 5.30** | 2.03 |
| Care | 9.78 | . |
| Rural (1=yes) | −26.86*** | 3.01 |
| Mother education | −.30 | .68 |
| Child age | 6.82*** | 1.58 |
| Structural model: Household environment 71.22% of the variance explained | | |
| Assets of current wave | .12*** | .01 |
| Income of current wave | .000007*** | .000002 |
| Father employed (1=yes) | −.10 | .07 |
| Rural (1=yes) | −.18*** | .03 |
| Middle (1=yes) | .09* | .04 |
| West (1=yes) | .11** | .04 |
| Structural model: Infections. | | |
| Household environment | .24 | .20 |

| | Coefficient | Std. Error |
|---|---|---|
| Structural model: Care. 90.50% of the variance explained | | |
| Assets of current wave | .15† | .08 |
| Mother employed (1=yes) | −1.76*** | .27 |
| Father employed (1=yes) | 2.43*** | .44 |
| Father education (1=yes) | −.13** | .05 |
| Only child (1=yes) | −.60* | .26 |
| Measurement model: Household food security | | |
| Food diverse score | 1 | (constrained) |
| ASF amount | 246.61*** | 24.40 |
| Measurement model: Child dietary intake | | |
| Fat | 1 | (constrained) |
| Protein | .73*** | .05 |
| Measurement model: Household environment | | |
| Access to toilet with flushing | 1 | (constrained) |
| Excreta present around houses | −.54*** | .07 |
| Measurement model: Infection | | |
| Fever | .05 | . |
| Diarrhea | .03 | .11 |
| Measurement model: Care | | |
| Care time by mother | 1 | (constrained) |
| Breastfeeding time | .66 | .28 |
| Covariance: Dietary intake and infections | .83 | . |

Unstandardized coefficients present in the table. †: <.1; *: <.05; **: <.01; ***: <.001.

Figure 5.4(b): Sensitivity test: Full model predicting Weight for Height Z Score by FIML




†: <.1; *: <.05; **: <.01; ***: <.001.
*Note: For presentation simplicity, only standardized coefficients presented, control variables, measures, and error terms omitted.*
$X^2(311) = 485.34$, $p < .001$; CFI = .896; TLI = .930; RMSEA = .029 (90% CI: .000, .).

| | Coefficient | Std. Error |
|---|---|---|
| Structural model: WHZ. | | |
| Child intake | −.01 | .01 |
| Infection | 1 | (constrained) |
| Care | .05 | .18 |
| Child sex (1=girl) | .07 | .11 |
| Wave (1=2009) | $-.27^{\dagger}$ | .12 |
| Structural model: Household food security 47.62% of the variance explained | | |
| Assets of previous wave | $.30^{***}$ | .03 |
| Income of previous wave | $.00004^{**}$ | .00001 |
| Household size | $.13^{***}$ | .03 |
| Middle (1=yes) | $-.68^{***}$ | .13 |
| West (1=yes) | $-.49^{**}$ | .14 |
| Structural model: Child dietary intake 26.06% of the variance explained | | |
| Household food security | $5.82^{***}$ | 1.51 |
| Care | $-4.39^{\dagger}$ | 2.34 |
| Rural (1=yes) | $-18.82^{***}$ | 2.63 |
| Mother education | −.22 | .57 |
| Child age | $4.97^{***}$ | 1.84 |
| Structural model: Household environment 73.06% of the variance explained | | |
| Assets of previous wave | $.12^{***}$ | .01 |
| Income of previous wave | −.000004 | .000004 |
| Father employed (1=yes) | $-.14^{*}$ | .07 |
| Rural (1=yes) | $-.25^{***}$ | .04 |
| Middle (1=yes) | .01 | .04 |
| West (1=yes) | .01 | .04 |
| Structural model: Infections | | |
| Household environment | .47 | .41 |

| | Coefficient | Std. Error |
|---|---|---|
| Structural model: Care. 55.32% of the variance explained | | |
| Assets of previous wave | −.06 | .22 |
| Mother employed (1=yes) | $-2.08^{**}$ | .76 |
| Father employed (1=yes) | $2.49^{**}$ | .93 |
| Father education (1=yes) | −.04 | .14 |
| Only child (1=yes) | −.66 | .41 |
| Measurement model: Household food security | | |
| Food diverse score | 1 | (constrained) |
| ASF amount | $270.35^{***}$ | 32.79 |
| Measurement model: Child dietary intake | | |
| Fat | 1 | (constrained) |
| Protein | $.85^{***}$ | .06 |
| Measurement model: Household environment | | |
| Access to toilet with flushing | 1 | (constrained) |
| Excreta present around houses | $-.57^{***}$ | .07 |
| Measurement model: Infection | | |
| Fever | −.03 | .05 |
| Diarrhea | .02 | .02 |
| Measurement model: Care | | |
| Care time by mother | 1 | (constrained) |
| Breastfeeding time | .95 | 1.25 |
| Covariance: Dietary intake and infections | $8.78^{\dagger}$ | 4.75 |

Unstandardized coefficients present in the table. †: <.1; *: <.05; **: <.01; ***: <.001