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Three essays on food insecurity and child welfare

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DEDICATION

This dissertation is dedicated to my personal Lord and Savior JESUS CHRIST who began a good work in me and was faithful to complete it. Thank you.

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ABSTRACT

Three major issues affecting the welfare of children are investigated in three papers in this dissertation. These issues are the intra-household allocation of resources, food insecurity and obesity. The first two papers are focused on the issue of intra-household allocation of food resources and food insecurity in a developing country setting, namely Zimbabwe, while the relationship between food insecurity and obesity is investigated n the United States.

In the first paper, a 2004 household survey of children in Zimbabwe is utilized to investigate differences in self-reports of food insecurity. A bivariate ordered probit regression is utilized to investigate any differences in reports of food insecurity between boys and girls. Findings reveal that all categories of children report roughly the same level of food security with the exception of orphan girls, who are significantly more likely to report food insecurity.

The second paper is also focused on the intra-household allocation of food, this time between adults and children. Bivariate comparisons are utilized to highlight the magnitude of differences in the perception of food inadequacy and food insecurity, while bivariate probit regressions provide more insight into sources of these differences. Children are more likely than adults to report food security, although the differences are not uniform across households. A substantial number of households have children who are food inadequate or food insecure while the adult is not. In addition, there is evidence of a tendency to protect younger children and discriminate against female orphans in food distribution.

The third paper utilizes nonparametric approaches and two nationally representative data sets to investigate the relationship between food insecurity and obesity in the United States. Nonparametric approaches are utilized to portray possible subtleties in the relationship between food insecurity and obesity over the full range of body mass index

(BMI)-based percentiles of children in different racial and socioeconomic categories. The relationship between food insecurity and childhood obesity is revealed to be nonlinear and complex. More specifically, there is a strong positive association between food insecurity and age-gender based BMI percentiles for children who are low food secure or very low food secure. This positive association is consistent across a range of racial and socio-economic subgroups, and also across both data sets.

CHAPTER ONE

INTRODUCTION

1.1 Introduction

According to article three of the universal declaration of human rights, “Everyone has the right to life, liberty and security of person” (UN, 1948). According to this declaration, all individuals have the right to live a rich, productive and abundant life, achieving all their potential. This is particularly true for children because of the promise of the future that they carry within themselves. The welfare of children is of paramount importance in every society, not only because of the future they represent, but also because of the associated costs faced by societies that ignore these welfare issues.

In this dissertation, three major issues that affect the welfare of children will be investigated. These issues are the intra-household allocation of resources, food insecurity and obesity. The question of the relationship between the allocation of food in the household and food insecurity is investigated in a developing country setting, Zimbabwe. Conversely, the relationship between food insecurity and obesity is investigated in the United States.

1.2 Food insecurity in developing countries

The concept

Food insecurity is a multidimensional/flexible concept that has evolved over time and location. The concept of food insecurity originated in the mid-1970s due to the international food problems that emerged as part of a larger global economic crisis. The initial food insecurity focus was macroeconomic in nature and was mainly concerned with assuring the availability and price stability of foodstuffs at the international and national levels.

Traditionally, food insecurity was measured through aggregate food supplies, and food availability, accessibility and adequacy (Busch & Lacy, 1984; FAO, 2003a; FAO, 2003b). In addition to economic factors, the preponderance of drought and famine in some developing regions of the world led to further rethinking and refinement of the concept. Amartya Sen (1981), in a seminal publication, helped redefine the food security discussion in the development literature. His contribution did not focus on the availability of food in the macro sense as was the prevailing thought at the time, but on constraints on individual access to food (Webb, et al. 2006).

Definitions of food insecurity have evolved as thinking about the problem has changed over time. At the 1974 world food summit, food security was defined as:
"availability at all times of adequate world food supplies of basic foodstuff to sustain a steady expansion of food consumption and to offset fluctuations in production and prices" (UN, 1975). By 2001, the definition of food security evolved to:
" Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2002). This definition implies that food insecurity reflects uncertain access to enough and appropriate foods (Barrett, 2002).

However food insecurity is defined, it is generally agreed that three distinct variables are central to the attainment of food security – namely food availability, access and utilization.

Food availability: Food insecurity research before Sen (1981) focused on food availability in a macro sense. The goal was to ensure that sufficient quantities of appropriate kinds of food were available from domestic sources, imports, or donor sources (FAO, 2003b; Webb et al. 2006). The focus of both domestic and international policy was on removing

constraints to food availability by concentrating on agricultural policy, trade policy, marketing and transportation systems, the role of natural disasters, and the price effects of economic policies. Eventually, the realization grew that availability was necessary, but not sufficient to promote food security. The concept of food security was expanded to include access.

Food access: The debate on food insecurity shifted from macro supply issues to focus on the ability of households to obtain food in the market place or from other sources (Webb et al. 2006). Having access to food includes having physical access to a place where food is available and economic access – a socially legitimate claim to food (Staatz, Boughton & Donovan, forthcoming).

It is important to note that in many developing countries, the availability and access dimensions of food insecurity are strongly linked. While availability reflects the supply side of food insecurity, access reflects effective demand. The two concepts are linked by food prices (Staatz, Boughton & Donovan, forthcoming).

Food utilization/consumption: This third aspect of food security speaks to the proper usage of food and includes processing, storage, consumption and digestion. How the food is prepared (which affects nutritional value) and the health of the individuals consuming the food (which affects the ability to absorb and use nutrients) affects food security (Staatz, Boughton & Donovan, forthcoming). Providing nutrition education and family management skills is thus another aspect of the process of ensuring food security.

The problem

Food insecurity in the developing world is different compared to developed countries. Household food insecurity in developing countries is commonly measured through consumption and anthropometric measures, and is often used interchangeably with similar

concepts such as poverty, malnutrition, and hunger (Coates et al. 2006). This is evidenced in several definitions of food insecurity. "A person is considered food insecure, or hungry, if average food availability or access to food falls below the Food and Agriculture Organization's recommended average calorie intake levels of approximately 2,100 calories per day, with some differences among regions" (Meade, Rosen & Shapouri, 2007). "Food insecurity as a concept concerns the risk of macronutrient or micronutrient deficiency, which may threaten the physical wellbeing of the individual" (Barrett, 2002). Malnutrition[1], hunger[2], and at the most extreme, starvation[3] are extreme forms of food insecurity. However, there are also households that are food insecure and are not immediately experiencing malnutrition, hunger or starvation.

It is difficult to deny that these extreme forms of food insecurity exist in the developing world. Of the estimated 953 million undernourished people in the world, about 820 million live in developing countries, with about 200 million of them in Sub-Saharan Africa. The situation has been worsened by the rise in food prices, which has restricted economic access to food for many in developing countries where it is currently estimated that about one in three people are deprived of access to sufficient food (FAO, 2008).

There are many factors that have exacerbated the food insecurity issue in developing countries. One factor is the HIV crisis that is ravaging many countries in Sub-Saharan Africa (UNAIDS, 2004b). Food insecurity and HIV have an unhealthy two-way relationship that

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[1] Malnutrition is a broad term commonly used as an alternative to undernutrition but technically also refers to overnutrition. People are malnourished if their diet does not provide adequate calories and protein for growth and maintenance or they are unable to fully utilize the food they eat due to illness (undernutrition). They are also malnourished if they consume too many calories (overnutrition). (Unicef, 2009)

[2] Hunger is a physiological sensation associated with insufficient food intake (American Dietetic Association, 1990).

[3] Starvation is an extreme form of malnutrition where nutrition intake is so far below what the body needs that the individual's life is threatened (FAO, 2002).

works through malnourished individuals engaging in risky behavior (e.g., traveling for food and additional income, migrating, engaging in hazardous work, and exchanging sex for money or food, among others) in order to survive. The result is the cycling of poverty, as individuals weakened by HIV find it harder to access food because they are not healthy enough to work (Oxfam, 2002). This tragedy has severe implications for children in this region. The massive explosion in the number of AIDS orphans has led to increased poverty and poor nourishment among other negative conditions faced by these children (Oxfam, 2002). Other factors such as conflicts, persistent droughts, increased grain prices and spiraling energy costs have compounded the food insecurity issues in Sub-Saharan Africa (FAO, 2006; Meade, Rosen & Shapouri, 2007).

Food insecurity in Zimbabwe

The country of Zimbabwe is located in Southern Africa. Zimbabwe obtained its independence from Britain in 1980 and has been governed by Robert Mugabe ever since. The two major tribes are the Shona who account for about 71 % of the population, and the Ndebele who make up around 16 % of the population. Zimbabwe is currently undergoing an economic crisis. In 2007, the real Gross Domestic Product (GDP) growth rate was -12 % and GDP per capita was about $500. The country also has had the highest rate of inflation in the world for the last several years (CIA, 2009). In addition, the country has faced persistent drought and political crises, as well as international isolation.

Zimbabwe is particularly susceptible to food insecurity not only because of its economic and political issues, but also because it is facing a major HIV crisis. While Zimbabwe's population is currently estimated to be about 13 million (WHO, 2009), the annual population growth rate between 1997-2007 was estimated at only 0.9 %, due mostly to deaths

from the HIV crisis and emigration due to the economic crisis. About 1.3 million individuals were estimated to be HIV infected in Zimbabwe in 2007 (UNAIDS, 2008); the prevalence rate of the disease among adults is estimated at about 15 % (WHO, 2009). It is estimated that 20-30 % of all children are now orphans, about three quarters of whom were orphaned by HIV/AIDS (Catholic Relief Services, 2004; UNAIDS, 2004a).

Other health statistics are also very troubling. Between 2003 and 2005, about 40 % (over 5 million people) of the country's population was estimated to be undernourished (FAO, 2008). Among malnourished children, about 17 % were underweight and 29 % suffered from stunting. The life expectancy at birth for men in 2007 was estimated to be 45, while that for females was 44 (WHO, 2009; FAO, 2008). From these statistics, it is obvious that extreme food insecurity is pervasive in Zimbabwe.

Consequences of food insecurity

Food insecurity in developing countries has extremely serious consequences. It leads to individuals who are "vulnerable", meaning that they are more exposed to and sensitive to livelihood shocks (Ellis, 2003). This has profound implications for health, economic and social aspects of life, and even for the environments within which these individuals are located. Food insecurity often results in hunger and malnutrition, which in turn lead to reduced school attendance and learning capacity for children, less education and employment for women and girls, weakened immune systems, rising child mortality, impaired maternal and infant health, risky survival strategies, spread of HIV/AIDS, malaria and other diseases, unsustainable use of natural resources and reduced capacity to access markets and resources (Bindraban et. al, 2003; FAO, 2005).

1.3 Food insecurity and intra-household allocation of food resources

Food insecurity in the developing world often manifests itself in extreme forms such as hunger and severe malnutrition due to a paucity of sufficient resources to live above subsistence levels. This situation leads households to have to make difficult distributional decisions that include trading one member's consumption for another's. Households may have to allocate food resources among members based on productivity, age or gender among other factors revealing the relative importance of individuals within the household based on economic, social and cultural norms. It is therefore important to examine intra-household food allocations in order to promote efficient targeting for interventions.

There is a very wide literature on the intra-household allocation of resources showing that household members get differential access to household resources based on differences in gender and age, among other factors. For example, the disadvantage faced by women and girls in the allocation of food resources in Asia is well documented. Differences were found in the Philippines (Senauer et al. 1988), India (Behrman 1988a), Nepal (Gittelsohn et al. 1997), Northern India and Bangladesh (Haddad et. al, 1996). However, no consistent evidence of a gender bias in food allocation has been found in Africa (Strauss, 1990; Haddad and Reardon, 1993).

The evidence is more mixed in terms of an age bias. Some studies have found that adults are favored over children in the allocation of resources in Asia and Africa (Sauerborn, Berman & Nougtara, 1996; Abdullah & Wheeler, 1985; Engle & Nieves, 1993); some find no bias at all (Bouis & Peña 1997; Kennedy, 1983); while others find a pro-child bias (McIntyre et. al, 2003; Leonard, 1991).

1.4 Food insecurity in the United States

The United States is a very wealthy country, with a current per capita GDP of about $46,000 (IMF, 2009). For this reason, food insecurity and approaches to it are very different from developing countries. In the United States, issues of availability and utilization are not as pressing as in developing countries. Instead, the primary focus of definition and measurement has been on household-level access (Coates et al., 2006). While food insecurity in the United States is not as severe as in the more underdeveloped countries, it is still a problem as 11 % of the U.S. population was found to be food insecure in 2007. In addition, one third of that number (4 % of total U.S. population) had very low food security —"meaning that the food intake of one or more adults was reduced and their eating patterns were disrupted at times during the year because the household lacked money and other resources for food" (Nord, Andrews & Carlson, 2008).

History of measuring food insecurity

Measuring food insecurity in the U.S. began in the 1980s when policymakers asked for better measurement of poverty-related hunger. Research showed that income based measures did not fully capture the twin issues of food insecurity and hunger. The need for more research in this area led to the addition of a food security supplement to the Current Population Survey (CPS) in 1995, which marked the beginning of the official measurement of food insecurity in the United States. Fine-tuning of this questionnaire over the years has led to the development of the Core Food Security Module (CFSM). The CFSM has 18 questions for families with children, and 10 questions for families without. These questions are found on a variety of nationally representative data sets, including the National Health and Nutrition Examination

Survey (NHANES) and the Panel Study of Income Dynamics (PSID) (see Gundersen, 2008 for a more comprehensive history). All 18 questions are listed in Appendix 1.

Consequences of food insecurity

Children in food insecure settings are more likely to have poor health (Casey, et al., 2001). More specifically, food insecure children have higher incidences of infection, stomachaches, headaches, colds, ear infections and iron deficiency (Alaimo, Olson & Frongillo, 2001a; Casey et. al, 2001). In addition, they are more likely to exhibit emotional and behavioral problems as well as experience more fatigue and irritability (Kleinman et. al 1998; Murphy et. al, 1998). Not surprisingly, they are also found to perform more poorly in school (Glewwe, Jacoby & King, 1999; Alaimo, Olson & Frongillo, 2001b). They are more likely to exhibit aggressive, destructive and suicidal behaviors (Reid, 2000; Alaimo, Olson & Frongillo, 2002) and also need more mental health and special education services (Alaimo, Olson & Frongillo, 2001b).

1.5 Obesity in the United States

Obesity has become a serious problem for both adults and children in the United States. Between 2003 and 2006, almost 32 % of all children (aged 2-19) were overweight or obese (Ogden et al., 2008). Childhood obesity has negative physical, psychological and social consequences for children that extend into their adult lives (Gunnell, Frankel, Nanchahal, Peters, & Davey Smith, 1998; Mahoney et al., 1996; Nieto, Szklo, & Comstock, 1992; Power, Lake, & Cole, 1997; Schwimmer, Burwinkle, & Varni, 2003; Serdula et al., 1993; Smoak et al., 1987; Williams et al., 1992). There is an economic cost as well, as obesity related health care costs accounted for over 9 % of national health care expenditures for all adults (Finkelstein,

Fiebelkorn, & Wang, 2003). Children with obesity have health care cost that are on average three times as much that of a non-obese child, are more likely to be hospitalized (Marder & Chang, 2006), and tend to stay in the hospital longer with diseases related to obesity (Wang & Dietz, 2002).

1.6 Obesity and food insecurity

Previous studies reveal mixed results regarding the relationship between food insecurity and obesity in children, with some studies finding either no relationship (Alaimo, Olson, & Frongillo, 2001c; Gundersen, Lohman, Garasky, Stewart, & Eisenmann, 2008; Kaiser et al., 2002; Martin & Ferris, 2007), an inverse relationship (Jimenez-Cruz et al., 2003; Matheson et al., 2002; Rose & Bodor, 2006), or a positive relationship (Casey et al., 2001; Casey et al. 2006; Dubois et al., 2006; Jyoti et al., 2005).

1.7 Dissertation plan

The rest of this dissertation is devoted to answering the following questions in three different papers:

Paper 1: *Are there differences in the allocation of food resources between boys and girls within households in Zimbabwe?*

This paper is aimed at ascertaining whether or not the differences in the intra-household allocation of food resources that exist between boys and girls in some Asian countries also exist in Zimbabwe. Using data from a 2004 household-based survey of children, differences between boys and girls in self-reports of food insecurity in Zimbabwe are examined. A bivariate ordered probit regression provides insight into sources of any differences that may exist.

Paper 2: *Are there differences in the allocation of food resources between children and adults within households in Zimbabwe?*

This paper is also focused on the intra-household allocation of food, this time between adults and children. The 2004 household-based survey conducted in Zimbabwe is also used in this study. Bivariate comparisons are utilized to highlight the magnitudes of differences in perception of food insecurity, while bivariate probit regressions provide more insight into sources of these differences.

Papers 3 *What is the relationship between food insecurity and obesity among children in the United States?*

This paper utilizes nonparametric regression approaches and two nationally representative data sets (the 1999-2002 National Health and Nutritional Examination Survey (NHANES) and the Child Development Supplement (CDS) of the Panel Study of Income Dynamics (PSID)) to answer this question. Nonparametric methods are utilized to portray possible subtleties in the relationship between food insecurity and obesity over the full range of body mass index (BMI) based percentiles of children in different racial and socio-economic categories. Food insecurity is measured via the 18 question Core Food Security Module (CFSM) derived by the USDA.

The remainder of the dissertation is organized as follows: The second chapter contains the literature and theoretical frameworks utilized in each of the three papers. The third through fifth chapters contain each of the papers in this dissertation. The sixth chapter presents conclusions and recommendations.

CHAPTER TWO

LITERATURE AND THEORETICAL FRAMEWORK

2.1 Introduction

This chapter presents the literature and theoretical background for the three papers included in this dissertation. The chapter begins with a section on intra-household allocation and food insecurity (section 2.2). Literature relating food insecurity to gender preference is presented in section 2.2.1.1, while similar literature on age preference is presented in 2.2.1.2. The theoretical framework for both gender and age preference is contained in section 2.2.2. The emphasis subsequently shifts to the issue of food insecurity and obesity (section 2.3), with literature relating the two variables of interest included in section 2.3.1. Finally, the theoretical framework is contained in section 2.3.2.

2. 2. Intra-household allocation and food insecurity

2.2.1. Literature

Intra-household allocation of resources

The fundamental economic problem faced by all individuals and governments is that of scarcity of sufficient resources to meet human wants (Lipsey, Courant & Ragan, 1998). Studying the intra-household allocation of resources, this problem has been further reduced to identifying resources to meet needs in many low-income societies. When resources for life's necessities are scarce, households must make distributional decisions. This section is devoted to investigating the rules that guide households in making decisions with regard to food distribution within the household.

Studying the intra-household allocation of resources is important for many reasons, four of which were identified by Behrman (1994):

a) Households have critical roles in determining human capital investments and time use.

b) The nature of human capital allocations have important implications for the analysis of other outcomes such as the impact of nutrition on the productivity of individuals in school or in the labor market.

c) There may be concerns regarding the distribution of household resources – particularly in terms of nutrition regarding females and children.

d) The nature of intra-household allocations may affect the effectiveness of policies that target households such as transfer programs.

2.2.1.1 Gender preference

In many developing countries, differences have been found in the allocation of household resources based on power or position within the household. In many of these settings, women are found to be disadvantaged mostly because their cultures value them less than men (Derose et al., 2000). Females have greater life expectancies than males. Because of this pattern, observations in several developing countries, particularly in Asia, of an imbalance in the sex ratio in adult age groups favoring males have led researchers to hypothesize that environmental factors have counteracted the expected female superiority in life expectancy (Coale, 1991). The idea of "missing women" was most famously crystallized by Sen (1989) who identified a deficit of females in the 1980s in Asia, North Africa, and to a lesser extent, Latin America, using sex ratios. He claimed that 100 million women of all ages were "missing" as a result of excess female mortality. He attributed these excess female deaths to

discrimination against females in areas such as medical attention, sex-based abortion, and most importantly, nutrition. Gbenyon and Locoh (1992) carried out a comprehensive review of child mortality in Sub-Saharan Africa. While they reported variation by regions (for example excess post-infantile female mortality in countries with predominantly Muslim populations), they found that death rates for children between ages one and four were approximately equal. This might suggest – though inconclusively - a hidden excess mortality of girls because the biologically "normal" situation is that of excess male mortality, particularly in the first few years of birth.

The evidence for gender preference

There is some evidence of boy preference in intra-household resource allocation in many part of the developing world. For instance, Hill and Upchurch, (1995) found a pattern of disadvantage for girls in terms of under-5 mortality. Their study, which examined the issue in 35 developing countries, including Zimbabwe, found a pervasive disadvantage for females in over 90 % of the countries surveyed.

Gender preference in Asia

Many countries in Asia pervasively and unambiguously practice boy preference. For instance, in India, son preference has been found to be practiced in many different facets of life including healthcare, where boys are more likely than girls to be taken to a health care facility when sick; immunization, with boys having higher immunization rates; and malnourshment, with girls more likely to be malnourished (Pande, 2003). Son preference reflected in fertility behavior has also been found in Vietnam (Haughton & Haughton, 1995); and in Bangladesh as reflected in parental care, feeding patterns, intra-family food distribution and treatment of illness (D'Souza & Chen, 1980). Boys were found to have an advantage in the allocation of

nutrients in the Philippines (Senauer et al. 1988) and in the distribution of food resources in India (Behrman, 1988a) and Nepal (Gittelsohn et al. 1997). However, Chaudhury's (1988) findings in Bangladesh were mixed for different outcomes. While boys were found to be preferred in non-food areas such as the quality of food, mother's child-care time and quality, and expenditure on health care, girls were found to have a higher caloric adequacy ratio than boys based on their nutritional needs.

Gender Preference in Africa

Boy preference?

The evidence for gender preference in intra-household allocations in Africa seems to differ by region and also in terms of the resource in question. In North Africa, son preference was found in Morocco and Tunisia by Obermeyer and Cardenas (1997). Their analyses of gender preference were based on information about breastfeeding, immunization and the treatment of diarrhea for the sample population of children. They found no differences between boys and girls in the duration and intensity of breastfeeding, but found that boys were favored in immunization coverage and treatment of diarrhea. Also, parents were found to take boys more often than girls to preferred private sources of health care in Egypt (Yount, 2004).

Culturally in many countries in Sub-Saharan Africa there is anecdotal evidence of boy preference in fertility decisions. For instance, men and women indicated a preference for having male children rather then females among the Ekiti of the Yoruba tribe in southwestern Nigeria (Renne, 1993), and slight boy preference was also revealed by a review of Demographic and Health Surveys (DHS) questionnaires in Zimbabwe, Kenya and Burundi (Arnold, 1992).

Several studies have also documented evidence of differential allocations of resources other than food. For example, boys were found to be advantaged in school enrollment, attendance and educational attainment in South Africa (Townsend, Madhavan, Tollman, Garenne, & Kahn, 2002) and Botswana (Chernichovsky 1985). In addition, Filmer (1999) reported a large female disadvantage in education in countries in Western and Central Africa, North Africa and South Asia. Thomas (1994), using data from the United States, Brazil and Ghana found gender differences in the allocation of household resources as mothers were likely to favor daughters and fathers to favor sons.

Girl preference?

Many other studies, however, have found that if a gender preference exists at all, females are likely to hold the nutritional advantage. Where anthropometric measures are utlized to proxy for nutritional practices, boys have been usually found to fare worse than girls in terms of anthropometric indicators in many developing countries (Marcoux, 2002). These anthropometric indicators include wasting (weight for height), stunting (height for age) and underweight (weight for age). Marcoux (2002) reviewed surveys that examined differences in nutrition by gender for many developing countries and found that while boys in general seemed to be at a disadvantage when surveys involving children were examined, women were at a huge disadvantage when surveys involving adults were examined. A study, also on anthropometric measures, examining the nutritional status of children aged 1-35 months in six Sub-Saharan African countries including Zimbabwe using data from Demographic and Health Surveys for the period between 1990 and 1994 also found that female children appeared to be better nourished than male children in all six study countries (Madise, Matthews, & Margetts, 1999). In fact, results from the study prompted the authors to speculate about sex discrimination in

favor of girls, especially in Malawi. Hardenbergh (1997) also reported an advantage in calorie intake for young females in Madagascar.

No preference?

Other studies show no differences in terms of nutritional distribution between male and female children. For example, in Côte d'Ivoire, Strauss (1990) found no significant difference between boys and girls in preschool children's nutrition. In Burkina Faso, Haddad and Reardon (1993) carried out a disaggregated outlay equivalent analysis to test for gender differentials in household resource allocation, but were unable to find any evidence in favor of boys. In Ethiopia, Kimhi (2004) reported little evidence of gender bias in the allocation of calories in households. These studies are consistent with the work of DeRose et al. (2000) who carried out a comprehensive global review of the literature on differences in food intake by gender and concluded that there was no conclusive evidence of gender bias in the allocation of nutrients in any studies outside of South Asia. While they found it true that women were disadvantaged in many cultures in most developing countries, this disadvantage did not seem to manifest itself in allocation of nutrients, but more in access to health and educational facilities.

Why might there be a gender preference?

The most widely utilized theoretical explanations of gender preference in developing countries have been found in the economic literature. One explanation is the profit maximization behavior of parents (Rosenzweig & Schultz, 1982, Pitt et al. 1990; Berhman 1997). When the market values the human capital of boys more than girls, then it is more rational for parents to invest in boys. Market forces tend to work hand in hand with cultural norms to create a higher valuation of boys over girls. In many developing societies, boys may be preferred because sons are considered essential for maximizing the economic and non-

economic utilities of households. They contribute to family resources and do not move away to get married as daughters do (Chaudhury, 1988). Consequently, the full return to investing in sons is more likely to be reaped by parents than the return to investments in daughters. This was found to be the logic behind boy preference in Ghana, and the pattern is the same in many developing countries (Garg & Morduch, 1998). Yamauchi (2006), in a study of parental nutrition and schooling investments in South Africa, however found that while parents were more likely to invest in the better endowed child (the healthier child in this case). Although, wealthier households were more likely to invest more in less well endowed children in an attempt to reduce sibling inequality.

Another explanation is that parents may prefer a certain gender of child regardless of returns. This idea is rooted in the parental utility function (i.e parents derive more utility from the human capital of boys than girls) (Berhman, et al 1982, Berhman 1988, 1997). This idea will be explored in more detail in the theory section.

Gender preference in fertility behavior can also be rooted in the evolutionary biology literature, based on the ideas of natural selection (Trivers & Willard, 1973). If the condition of mothers during parental investment (i.e nursing or feeding) correlates with the probable reproductive success of their offspring, parents will adjust their investments to favor the sex with the best reproductive propects. In many species, male reproductive success is more variable than that of females. Therefore, males may benefit more than females from good maternal conditions and suffer more than females from poor maternal conditions. Cronk (1989) expanded this idea to the human species, using the Mukogodo group in Kenya. This perspective predicts and finds that parents at the higher end of the socioeconomic hierachy will invest more

in sons than in daughters, while parents at the lower end will favor daughters. This conclusion was also reached by Miller (1997) in a summary of findings of studies from throughout Asia.

2.2.1.2 Age preference

In addition to gender preference, another possibility affecting the household allocation of resources is age preference, where an individual is prioritized in the allocation of resources (e.g., food) because of their age. The evidence as to whether or not age preference holds is mixed and seems to depend on cultural and socioeconomic contexts. In general, parents are expected to display altruism towards their children (Eswaran & Ashok, 2004) and there is some evidence that they do. However, in many developing country settings, whether parents are altruistic or not can depend on the individual family arrangements (e.g. expected stability of marriage, number of wives, whether children are biological or stepchildren, duration of marriage), as well as on institutional structures which may determine what is appropriate in terms of allocation. Although parents care about their children, their level of altruism varies across different types of families and seems to depend on culturally acceptable practices (Desai, 1992).

Some evidence suggests that low-income adults in developing countries give up their rights to food resources so that their children may be adequately nourished. For instance, in Peru, male adults within households were more likely to face seasonal caloric stress than children (Leonard, 1991). In Nepal, evidence suggests preferential treatment of young children over adults in food allocation (Gittlesohn, 1991); a finding corroborated by a separate study by Panter-Brick (1993). Two studies in Peru (Leonard, 1989; Graham, 1997) found that children were shown preference over adults in times of food scarcity; and Bouis and Pena (1997) found that preschoolers were favored in the intra-household distribution of food in the Philippines.

However, there are also situations in which adults may be prioritized over children. Sometimes it is due to ignorance as to the importance of certain foods for children. In a study of the provision of animal source foods to children in Ghana, it was found that some adults were ignorant of the benefits of some animal source foods to children and thus household consumption was restricted to adults (Colecraft, et al., 2006). The differential in resource allocation between adults and children may also be due to differences in perceived productivity. If households are concerned with maintaining their capacity to produce, they are likely to prioritize the most productive members of the family in terms of resource allocation, a result found in Burkina Faso where adults were given priority in the intra-household allocation of health resources (Sauerborn, Berman, & Nougtara, 1996). This preference may extend to the allocation of food as well. Evidence from rural Bangladesh suggested a pro-adult bias in food allocation at the expense of children within the household (Abdullah & Wheeler, 1985). Gomna and Rana (2007) investigated the consumption of meat and fish in two fishing communities in two states in Nigeria. They found that the consumption of fish was influenced by the social structure within households. Fish consumption within households on a unit body weight basis was skewed towards heads of households who consumed 59 % more fish than their wives or children – probably due to the greater energy demands of men who engage in manual labour. Men usually got the main body of the fish, wives got the tail, and the children the head. The situation was similar in Guatemala, as heads of households were more likely to have adequate diets when compared to other household members, particularly adolescents (Engle & Nieves, 1993). Also, children were found to be disfavored for nonstaple foods in Mali (Dettwyler, 1986; 1987).

There is also the Cinderella hypothesis, which states that parents are less willing to invest in children who are not biologically theirs (Case, Lin & Mclanahan, 1999). First hinted at by Hamilton (1964) in the field of evolutionary biology, the basic idea is that investments in children by caregivers are most strongly motivated by biological relatedness. More recently, it has been found that the presence of a child's biological mother appears to increase food expenditures in the U.S. and South Africa (Case, Lin, & Mclanahan, 2000). In a South African study where food spending could be disaggregated by items purchased, households were found to spend less on milk, fruit and vegetables, and more on tobacco and alcohol, in the absence of a child's birth mother (Case, Lin, & Mclanahan, 2000).

Foster parenting is very common in Africa (Desai, 1992) and has increased exponentially with the HIV epidemic that has hit many countries in Southern Africa especially hard. Of the roughly two million deaths due to AIDS in 2007, 38 % occurred in Southern Africa. In addition, the subregion was also burdened with 35 % of the roughly 2.7 million new HIV infections in the same year. There were an estimated one million AIDS orphans in Zimbabwe alone (UNAIDS, 2008). Some evidence suggests discrimination against orphans in Zimbabwe. Gundersen, Kelly and Jemison (2006) investigated the demand for schooling among orphans in Zimbabwe. They found strong evidence of discrimination as orphans were significantly less likely to go to school than non-orphans. They also found that the effect of being an orphan was especially large for older children.

No discrimination?

Most studies of the intra-household allocation of food resources utilize either anthropometric measures (weight for age, height for age) or measurements of diet adequacy which assess the degree to which the nutrient intakes of individuals meet established

requirements (Marcoux, 2002; Madise, Matthews, & Margetts, 1999; Hardenbergh, 1997). However, it has been argued that this approach may overstate the incidence of differences in food allocation, if any differences exist at all. The anthropometry measures approach assumes that low weights and heights are primarily the result of low nutrition, and this may not be true. Low weights and heights can also be attributed to unsanitary living conditions and inadequate health care (Bouis & Pena, 1997). In addition, it is important to control for differences in energy requirements - for instance, those occasioned by different activity patterns - between individuals when determining adequacy of intakes. This is a difficult task because determining which factors influence daily needs and which can be ignored is controversial. Determining what is "fair" in terms of intra-household allocations is consequently not a trivial issue (Bouis & Pena, 1997).

Also Pitt, Rosenzweig and Hassan (1990) suggest in their study in Bangladesh that there may be no differences in the allocation of nutrients for younger children (younger than 12 years). This is because they are not on the labor market and work activities are gender neutral at younger ages. Male preference only starts to emerge for older children and adults because the male child tends to engage in more energy intensive activity (Berhman, 1988).

2.2.2 Theoretical framework

The unitary model, also called the common preferences approach, the altruism model or the benevolent dictator model, is widely utilized to explain intra-household allocations. The defining characteristic of these parental preferences models is the assumption that parents act as if they are maximizing a single utility function subject to appropriate constraints. The unitary model in its original form (Becker & Tomes, 1976) is a model of constrained utility

maximization of a single representative household. A single household objective function is maximized subject to several household level constraints to derive the optimal allocation of resources, investments and transfers for the creation of offspring wealth. Basic elements of the model, as well as those of its successor (the Behrman, Pollack and Taubman (BPT) model) are outlined below and are borrowed liberally from Behrman, Pollak and Taubman (1982), Behrman (1988a, 1997), Becker and Tomes (1976), and Strauss and Beegle (1996).

The model assumes that

a) Parents are concerned with their children's total level of future wealth.

b) Parents exhibit equal concern for each child, equal concern meaning that equal outcomes across individuals or groups are not weighted differently in the household's utility function.

c) Parents allocate resources to their children until the marginal rate of return on a human capital investment in each child equals the return available on financial investments (i.e. to the point of the wealth maximizing level of human capital).

Human capital investments are made in the children best placed to generate a higher rate of return on these investments (i.e. parents invest in their children in such a way as to reinforce differences in child endowments). Transfers (of resources from parents to children) are made to the more poorly endowed offspring in order to equalize children's wealth – this is the "wealth model".

Based on the preceding assumptions, the model of Becker and Tomes concludes that:

a) Parents allocate human resource investments to reinforce endowment differentials among their children.

b) Human resource investments are socially efficient (pareto optimal) and privately efficient (wealth maximizing).

c) Parents obtain equality in children's wealth by distributing transfers among their children so as to offset earnings differences.

At its core, this model only allows for discrimination or bias in household resource allocations as a function of market returns given individual endowments. It makes no allowances for decision-making regarding allocations to be motivated by preferences toward specific household members.

Behrman, Pollak & Taubman (1982) developed a more robust model, the BPT model, which retained some of the assumptions of the original Becker and Tomes (1976) model, while addressing some of its shortcomings. Some of the flaws they identified included the overambitious assumption of social efficiency (which requires perfect capital markets), as well as the fact that the model fails when parents do not have enough resources to invest in their children at the socially efficient, wealth maximizing levels of human resources – as is the case in many developing countries. Also important, the BPT model is a model of utility maximization where both preferences and market opportunities operate to affect allocations. The BPT model is adapted here to fit a model of nutrient inputs and health outcomes for children in developing countries.

The BPT model disentangles the nature of preferences that underlie the distribution of resources in the household (Strauss & Beegle, 1996). The household is assumed to have a utility function (U*) defined over a separable subutility function (U) and other outcomes of interest. The separable subutility function is defined over I expected health-related outcomes for each of the J individuals in the household (H_{ij}; i=1,…..I; j = 1,……..,J).

$$U = U(H_{11},\ldots\ldots,H_{ij}). \quad (2.1)$$

Household preferences for various outcomes – in this case food distribution -- are comprised of two components: the degree of inequality aversion and the welfare weights (equal concern) attached to the individuals.

Degree of inequality aversion

The degree of inequality aversion is also called the equity/productivity tradeoff. It describes the degree of concern by households regarding disparities in the distribution of outcomes across household members. When graphed in the space of outcomes over two members of the household, inequality aversion is characterized by the slope of the indifference curve that describes preferences in the utility function. There are three possibilities:

L shaped indifference curve: Households are perfectly averse to inequality and may only care about the outcome of the worst off members. This preference is reflected in U_1 in figure 2.1, and refers to the extreme case where households are concerned exclusively with equity.

Linear household indifference curve: Households have no inequality aversion and equity in outcomes does not matter. In this case, only market opportunities matter, as in the wealth model. In other words, there is no concern with the distribution of food, but only with the total sum available in the household. This is shown by U_2 in figure 2.1.

Convex indifference curve: U_3 portrays the intermediate case, where equity is traded against productivity.

Inequality aversion has no bearing on ***preferences*** regarding which specific individuals in a household should get preferential treatment. If preferential treatment does occur (boys over

girls or adults over children), it occurs in response to other forces (e.g., market forces), not due to the inequality aversion aspect of preferences.

Equal concern

While different individuals or groups of individuals within a household may receive different weights in household preferences, equal concern means that all individuals receive equal weight in the household's utility function so that the utility function is symmetric in the space of on outcome for individuals such as health. At points of equal outcomes, indifference curves are symmetric around the 45^{o} line for any two members for whom the household has equal concern. Where unequal concern exists, indifference curves will be asymmetric, or slanted toward outcomes for a particular member or group – for example the male child, or the adult member of the household. Equal concern is illustrated in figure 2.2, where U_1 represents equal concern between persons 1 and 2, while U_2 represents unequal concern favoring person 2.

Constraints

There are two sets of constraints in this model. The first constraint is the partial nominal budget constraint that applies to household resources devoted to individuals within the family. In this case, we can distinguish between investments in k observed nutrients (N_{kj}, k = 1,….,K; J = 1,….J) and other health-related investments. Households are also assumed to face fixed prices (P_{nk}, P_x) for both observed nutrients and other health related investments, and these are identical for all household members.

$$\sum_{j=1}^{J}(\sum_{k=1}^{K} P_{Nk} N_{kj} + P_x X_j) \leq R \qquad (2.2)$$

The second set of constraints is the i expected health-related outcome generating relations (or health production functions) for each of the J individuals in the household. For the j^{th} individual, each of these I relations depends on the observed nutrients (N_{kj}) and other purchased inputs (X_j) and endowments (E_j).

$$H_{ij} = H\ (N_{1j},\ldots\ldots,N_{kj},\ X_j,\ E_j);\ \ I = 1,\ldots.I;\ \ j = 1,\ldots\ldots,J. \qquad (2.3)$$

The endowments are Beckerian in the sense that they include both genetic (gender and age in this case) and environmental factors that affect the health related outcomes of the individual in question. The budget constraint and the health related generating relations, with the given endowments and investments, imply a health related outcome possibility frontier (HOPF) across different individuals within the household.

Choosing the equilibrium allocation of household resources

The optimal allocation of resources is determined via the usual tangency condition for the maximum: where the slope of the household welfare function equals the slope of the HOPF for the j^{th} vs. the q^{th} individual in the household. Because the HOPF is dependent on the endowments of different individuals/groups, it may not be symmetric around the 45^o line. Households maximize utility when they obtain the highest indifference curve given their HOPF. However, it is important to note that even if households exhibit equal concern and some inequality aversion, outcomes across different individuals may not be equal if their HOPFs are asymmetric. These scenarios are presented for households A and B in figure 2.3.

Inadequate household resources

In addition to the fact that outcomes may not be equal, they may also not be outcome (e.g., health) maximizing. This may occur because a household may not have access to an optimal level of resources that can lead to desired outcomes. This is illustrated in figure 2.4, where the

outcome maximizing level of resources is W*, but equilibrium exists below this level because household resources are inadequate.

Hypotheses

Based on this model and on the literature, I hypothesize the following:

1) There will be differences in reports of food insecurity between boys and girls.

The equilibrium for boy-girl differences in reports of food insecurity in Zimbabwe involves inadequate household resources, unequal concern in favor of boys – evidenced by e* below the 45^{o} line; parental preferences that trade equity against productivity, and an asymmetric production function skewed in favor of the male child (Figure 2.5).

2) There will be differences in reports of food insecurity between adults and children.

The equilibrium for adult – child differences in reports of food insecurity in Zimbabwe will differ by orphan status.

a) Non-orphans. When the child is not an orphan, the parents will show altruism. Thus, the final equilibrium will reflect inadequate household resources, equal concern, and a health production function that is neutral (figure 2.6a).

b) Orphans. When the child involved is an orphan, the final equilibrium will reflect inadequate household resources, unequal concern in favor of the adults, and a health production function skewed in favor of the adult (figure 2.6b).

Concerns

While there are several concerns with the unitary model, it remains the best framework within which to analyze household interactions when children are involved (Ayalew, 2005; Behrman, 1997). Most of the concerns about the model are linked to the assumption of a unified preference function defined over outcomes for each of the individual household

members. This assumption may not be completely implausible if the bonds among household members are strong enough, whether for sociobiological, altruistic or economic reasons (Behrman, 1988b). It can be argued that the relationship between parents and children in terms of the allocation of household resources can be defined as that of economic dependency of the children on the parents.

An alternative to the unitary model often advocated in the literature is the collective model which focuses on the individuality of household members. Also called a bargaining model, the collective model explicitly addresses how individual preferences lead to a collective choice (Alderman, Chiappori, Haddad, Hoddinott, & Kanbur, 1995). However, the collective model is mainly focused on relationships between husbands and wives, rather than allocations among children. Otherwise, it may attribute bargaining powers to children that they may not realistically possess (Behrman, 1997).

2.3 Obesity and food insecurity

2.3.1 Literature

Childhood obesity

There has been a dramatic increase in the incidence of childhood obesity over the past few decades. Ogden et al. (2002, 2006, 2008) comprehensively studied the prevalence of obesity among children in the United States between 1963 and 2004 using The National Health and Nutrition Examination Surveys (NHANES). Their findings revealed a marked upward trend in the incidence of obesity in the U.S. from the 1960s to mid 2000s. The trend has since leveled off in the past four years. For children aged 6-11, obesity prevalence increased from about 4 % between 1963 and 1974, to 15.3 % by 1999-2000. The trend was very similar for

children aged 12-19, increasing from 6.1 % in the early 1970s, to 15.5 % in 1999-2000.

There have been significant differences by racial groups. For example, African American and Hispanic children and adolescents have significantly higher rates of obesity prevalence than white children. In 1999-2000, about 26 % of white children aged 6-11 were overweight or obese (i.e., had BMIs over the 85th percentile for age and gender). Comparable figures for African American and Hispanic children were 35.9 and 39.3 %, respectively. Between 2003 and 2006, almost 32 % of all children (aged 2-19) were overweight or obese. Prevalence rates for children aged 6-11 increased to 33.3 %, while the comparable figure among adolescents aged 12-19 was 34.1 %. Prevalence rates among white children increased to 30.7 % for children aged 6-11 between 2003 and 2006, compared to 34.9 % of black children, and 38 % of Hispanic children. These figures for black and Hispanic children indicate a slight reduction in the rates of obesity or overweight between 2003 and 2006.

Overweight has been attributed to a variety of causes, including environmental and genetic factors. Among environmental factors, overweight has been linked to a sedentary lifestyle (Robinson, 2001). Several studies have found that overweight children spend less time in physical activities than children in lower BMI percentiles (Trost, Sirard, Dowda, Pfeiffer, & Pate, 2003; Andersen, Crespo, Bartlett, Cheskin, & Pratt, 1998: Johnson et al. 2000). More specifically, excessive viewing of television and playing of video games have been blamed for decreased participation in physical activities by children (Robinson, 2001) and several studies have found a strong link between TV watching and increased BMI in children (Andersen et. al, 1998; Gortmaker, et al. 1996; Marshall, Biddle, Gorely, Cameron, & Murdey 2004). Watching more than two hours of television or videos has been associated with being overweight or at risk for overweight (Mendoza, Zimmerman & Christakis, 2007). Among

children from Mexico City, the risk of obesity increased by 12 % for each hour per day spent watching television (Hernández et al. 1999).

Genetic factors have also been found to influence childhood obesity (Strauss &Knight, 1999; Maffeis, 1999; Farooq, 2005; Marti, Moreno-Aliaga, Hebebrand, & Martinez, 2004). There is some evidence that obese parents are more likely to have obese children (Strauss & Knight, 1999; Lake, Power & Cole, 1997), although there are questions as to whether this correlation is due to nature or nurture. Stunkard et al., (1986) in their study of Danish adoptees found a strong relationship between the weight class of adoptees and the BMI of their biological parents, but no correlation between weights of adoptees and their adoptive parents. They concluded that genetics play an important role in determining BMI. In addition to the strong association between the BMI of offspring and parental BMI, high BMI gain in childhood for parents was associated with a higher BMI and an increased risk of overweight/ obesity in the offspring (Li, Law, Lo Conte, & Power, 2009). The inheritability of weight has been estimated to be 78% based on a study of twins (Stunkard, Foch & Hruse, 1986). This means that 78 % of the variability in weight across a population is explained by shared intrafamilial genetic factors. More recent studies in Finland and the United Kingdom have also found the inheritability of BMI to be very high, estimating it to be between 60 and 80 % (Koeppen-Schomerus, Wardle & Plomin, 2001; Pietilainen et. al, 1999).

Overweight and obesity in children have immediate and long-term health consequences (Daniels, 2006; Ebbeling, Pawlak & Ludwig, 2002). Overweight has been associated with metabolic disorders in children (Daniels, 2006). These categories of diseases were long associated with adult obesity, but now are showing up in children at an alarming rate. These diseases include insulin resistance, the metabolic syndrome, dyslipidemia (abnormal levels of

fat in the blood), and type 2 diabetes mellitus (Daniels, 2006; Ebbeling, Pawlak & Ludwig, 2002; Fagot-Campagna et al., 2000; Ludwig & Ebbeling, 2001; Klein et al., 2004). Overweight or obesity is also associated with dyslipidaemia, chronic inflammation, hypertension, increased blood clotting tendency, hyperinsulinaemia and endothelial dysfunction. These symptoms combined are called the insulin resistance syndrome, and put the individual at risk for cardiovascular disease (Ebbeling, Pawlak & Ludwig, 2002; Freedman, Dietz, Srinivasan, & Berenson, 1999; Greenhalgh, 1997; Srinivasan, Myers, & Berenson, 2002). Overweight or obesity has also been known to lead to pulmonary complications and skeletal abnormalities in children. Most common among pulmonary complications are sleep apnea (Patel, 2005, Redline et. al, 1999, Rhodes et al. 1995), and asthma (Figueroa-Munoz, Chinn & Rona, 2001; Luder, Melnik, & DiMaio, 1988). Skeletal abnormalities of note include Blount disease, a mechanical deficiency in the medial tibial growth plate in adolescents that results in bowing of the tibia, a bowed appearance of the lower leg, and an abnormal gait (Daniels, 2006; Dietz, Gross & Kirpatrick, 1982), and capital femoral epiphysis, a disorder of the femur which is rotated externally from under the growth plate, causing pain, creating difficulty in walking, and often requiring surgical repair (Daniels, 2006; Loder, Richards, Shapiro, Reznick, & Aronson (1993).

Besides the physical consequences of disease, obese children also often suffer emotionally and psychologically. Many obese children have been found to develop a negative self-image (Davison & Birch, 2001), have trouble making friends (Strauss & Pollack, 2003), and be more likely to develop depressive symptoms (Strauss, 2000; Ebbeling, Pawlak & Ludwig, 2002). In summary, the physical and psychological conditions associated with

overweight and obesity lead obese children to live a decreased quality of life, and very often results in reduced life expectancy among these children.

Food insecurity

Food insecurity is defined as the uncertainty of having, or the inability to acquire, enough food for all household members to sustain active, healthy living because of insufficient money or other resources (Nord, Andrews & Carlson, 2008). In 2007, 11.1 % of the U.S. population was found to be food insecure (Nord, Andrews & Carlson, 2008). Households with incomes below the poverty line had a food insecurity rate of 37.7 % which was substantially higher than the national average. Other groups with higher than average food insecurity rates included households with children headed by single women (30.2 %) or single men (18.0 %); households headed by a black person (22.2 %) and households headed by a Hispanic person (20.1 %). Overall, households with children reported food insecurity at about double the rate for households without children (15.8 vs. 8.7 %).

These characteristics reveal that food insecurity is closely associated with insufficiency of resources. Food insecurity has been found to be strongly correlated with many other measures of deprivation including low and fluctuating incomes (Alaimo et al. 2001, Rose 1999; Gundersen & Gruber, 2001; Ribar & Hamrick, 2003), homelessness (Gundersen, Weinreb, Wehler, & Hosmer, 2003; Meyers et. al, 2005; Whitbeck, Chen & Johnson, 2005), lack of savings (Olson, Rauschenbach, Frongillo & Kendall, 1997; Rose, 1999), past and present unemployment and unstable employment (Sarlio-La¨hteenkorva & Lahelma, 2001), and lower levels of social capital (Martin, Rogers, Cook, & Joseph, 2004). Poor health, including physical disabilities, has a negative association with an individual's ability to acquire food, and thus increases the level of food insecurity, especially with the elderly (Klesges, et al. 2001).

Depression among mothers is also associated with loss or reduction of welfare support, which leads to an increase in food insecurity (Casey et. al, 2004). Family structure is also an important factor – as children in cohabiting families experience lower levels of food insecurity than children in single parent families, but significantly higher levels of food insecurity than children in married two biological parent families (Acs & Nelson, 2002).

As with obesity, food insecurity has been shown to lead to a range of medical problems for children, including diminished psychosocial functioning (Kleinman et al., 1998), frequent stomachaches and headaches (Alaimo et al., 2001a), worse health outcomes (Cook, Frank, Berkowitz, Cook, Frank, Berkowitz, et al., 2004), increased odds of being hospitalized (Cook et al., 2004), higher levels of hyperactivity (Murphy et al., 1998), greater propensities to have seen a psychologist (Alaimo, Olson, & Frongillo, 2001b), behavior problems (Slack & Yoo, 2005; Whitaker, Phillips, & Orzol, 2006), and higher levels of iron deficiency with anemia (Skalicky, Meyers, Adams, Yang, Cook, & Frank, 2006).

Connections between childhood obesity and food insecurity

On the surface, one might imagine that childhood obesity and food insecurity would be inversely related insofar as reductions in food intakes would be expected to lead to reductions in weight. Clearly, in the extreme, low food intakes will lead to declines in weight as is seen in developing countries. Dietz (1995), however, initiated a line of research that challenged this expected assumption and pondered on a positive relationship. Having noticed the paradox of hunger and obesity coexisting in the same individual, Dietz suggested that cyclical food restriction and binge eating may lead to this phenomenon, however leaving the proof of his hypothesis to succeeding researchers.

The paradoxical and counter intuitive positive relationship between childhood obesity and food insecurity has since been extensively investigated in the literature. Two major pathways, as suggested by Dietz (1995), have been confirmed by larger studies (Casey et. al, 2006). The first is binge eating based on a variable food availability cycle (Townsend, 2001), which has been linked to an increase in body fat and a decrease in lean muscle mass (Dinour, Bergen, & Yeh, 2007; Dietz, 1995). Individuals tend to overeat when food is available, and thus gain weight despite the fact that they face instances when they cannot eat due to a limited availability of food. (Polivy, 1996; Wilde & Ranney, 2000; Polivy & Herman, 1985; Polivy, Zeitlin, Herman, & Beal 1994).

The second, better known, pathway is the consumption of lower cost energy dense foods (Drewnowski & Specter, 2004; Dietz, 1995). Low-income individuals who find fresh healthy food unaffordable tend to eat cheaper, but less healthy, foods that are high in calories and lead to obesity. In addition, these dense, cheap and convenient foods are of lower dietary quality and variety, and tend to contain fewer fruits, vegetables or healthy sources of dairy (Bronte-Tinkew, Zaslwo, Capps, & Horowitz, 2007; Kaiser & Melgar-Quiñonez, 2003; Casey et al. 2001).

More recent evidence confirms these findings. The binge-eating cycle has been more recently associated with the food stamp cycle (Dinour, et al. 2007), which refers to a 3 week period of overeating followed by a week of food restrictions, followed by more overeating when the monthly food stamp allotment is once again available. This cycle of feast and famine has been found to lead to increased rates of obesity among individuals who can be described as food insecure (Dinour et al. 2007; Townsend et al. 2001; Wilde & Ranney, 2000). In addition, increased consumption of more energy dense foods (Cavadini, SigaRiz, & Popkin, 2000;

Kant, 2000; Putnam, Allhouse & Kantor, 2002; Basiotis & Lino, 2003; Adams, Grummer-Strawn & Chavez, 2003; Parker, 2007), high rates of consumption of caloric beverages with high sugar content, and increased snacking between meals (Zizza, Siega-Riz & Popkin, 2001; Ludwig, Petersen & Gortmaker, 2001) have all been found to contribute tremendously to the obesity epidemic.

Overall, the evidence about the relationship between childhood obesity and food insecurity is mixed. Consistent across this research is the use of parametric frameworks to examine this relationship. Parameteric frameworks assume that the data utilized were drawn from a particular distribution (e.g. normal, logistic). Parametric methods used to examine the relationship between childhood obesity and food insecurity have included fixed effects models (Jyoti, Frongillo & Jones, 2005) and multivariate logistic regression (Rose & Bodor , 2006) among several others. This study advances understanding of this relationship by using a methodology, nonparametric regression, while avoiding being restricted to a particular distributional assumption.

2.3.2 Theoretical framework

To understand the interrelationships between food insecurity and obesity, I employ a household production framework (Mincer 1963; Becker 1965; Bryant & Zick, 2005). In this framework, parents allocate resources to produce healthy (e.g., healthy BMI and food secure) children. They do this by encouraging lifestyle choices and enviroments that are amenable to the production of healthy children.

The household production can be defined as follows:

$$HW = g(FI, Y, Z) \qquad (2.4)$$

Where HW denotes “healthy weight,” FI denotes food insecurity, Y denotes environmental (economic) factors at the household level, namely income relative to the poverty line, and Z denotes environmental factors that are constant over time (e.g., race, gender).

Given the negative effects of food insecurity on well-being, the following is expected to hold:

$$\frac{\partial HW}{\partial FI} < 0 \qquad (2.5)$$

However, it is important to note that the literature is ambigious as to the direction of the relationship between food insecurity and obesity. It is hoped that this dissertation can contribute significantly to this body of knowledge.

Figure 2.1 Degree of Inequality Aversion

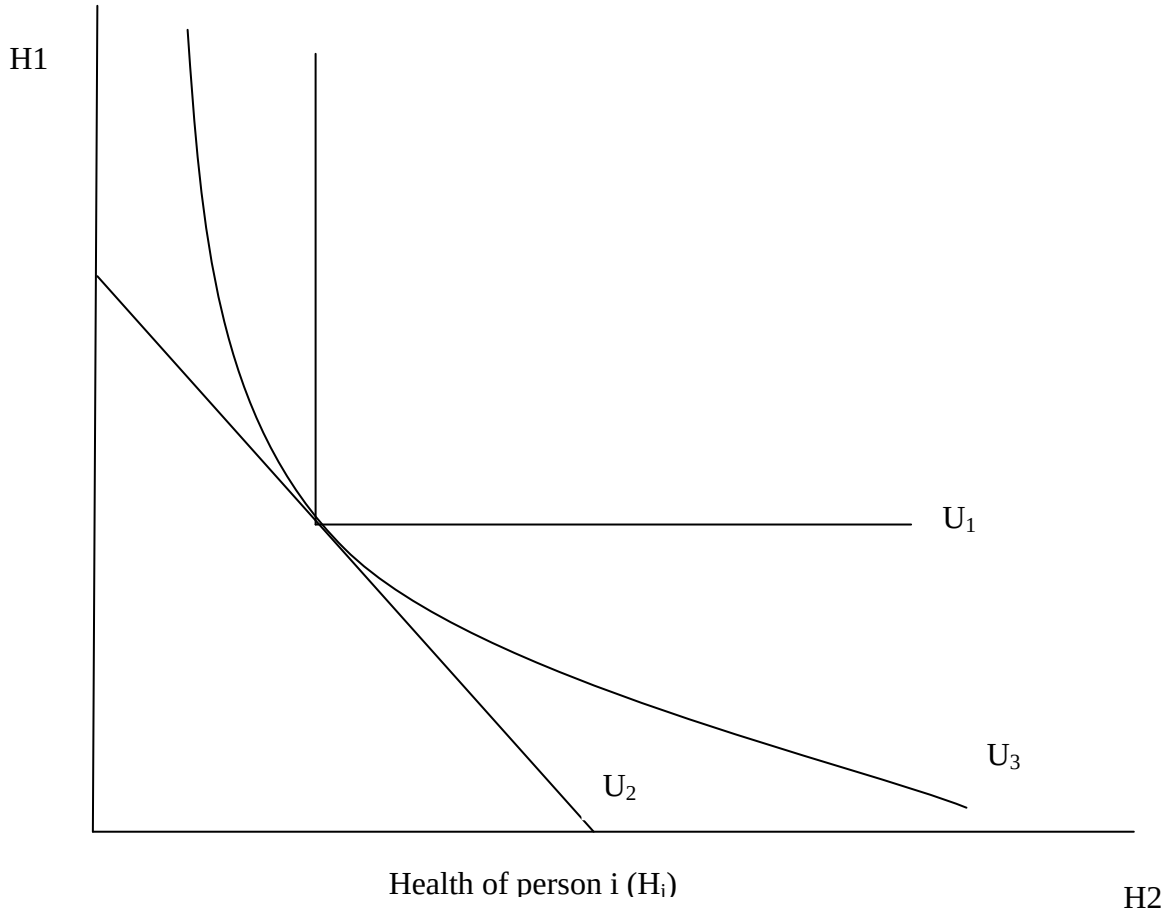


Figure 2.2 Equal Concern

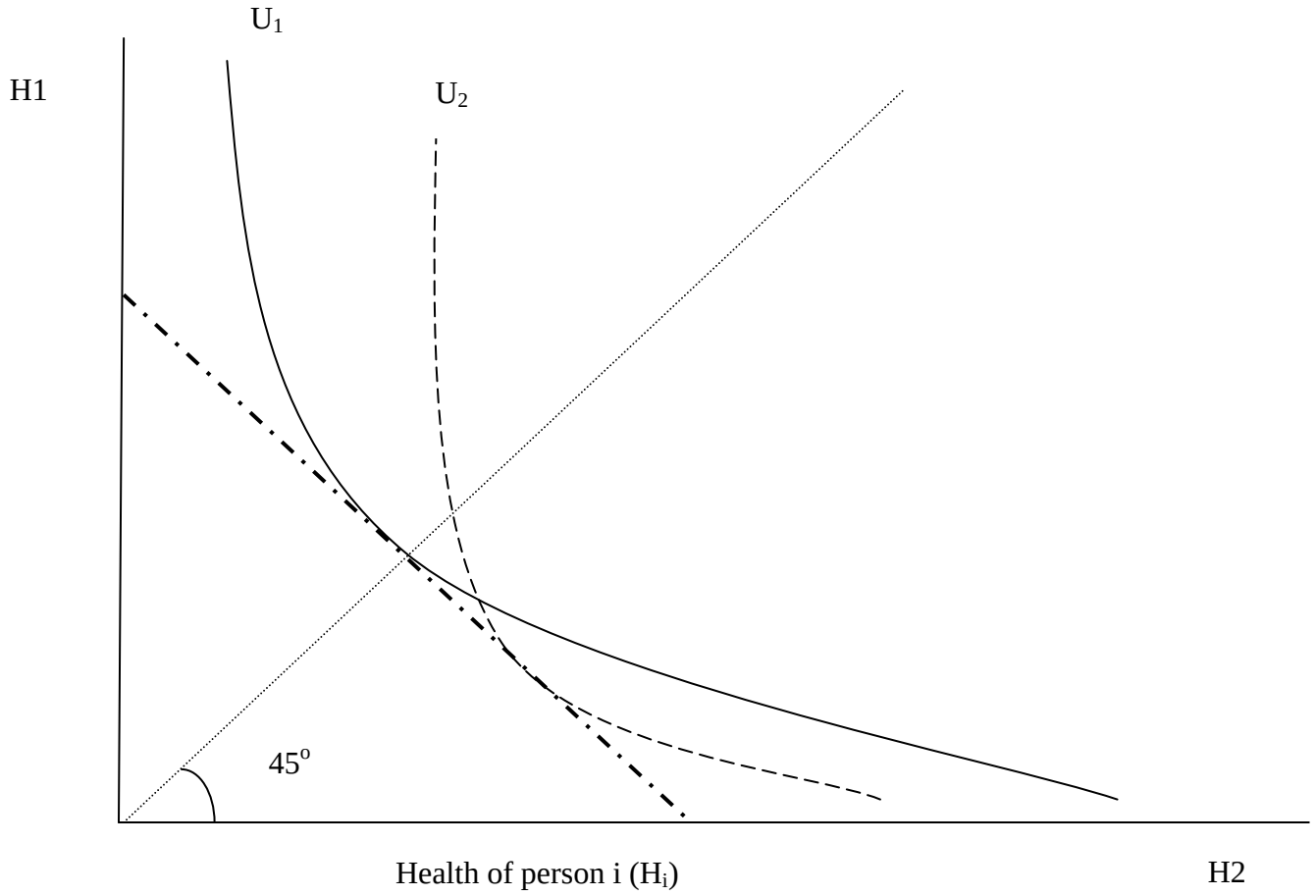


Figure 2.3 Equilibrium allocation of household resources, households with asymmetric health related outcome possibility frontiers (HOPFs)

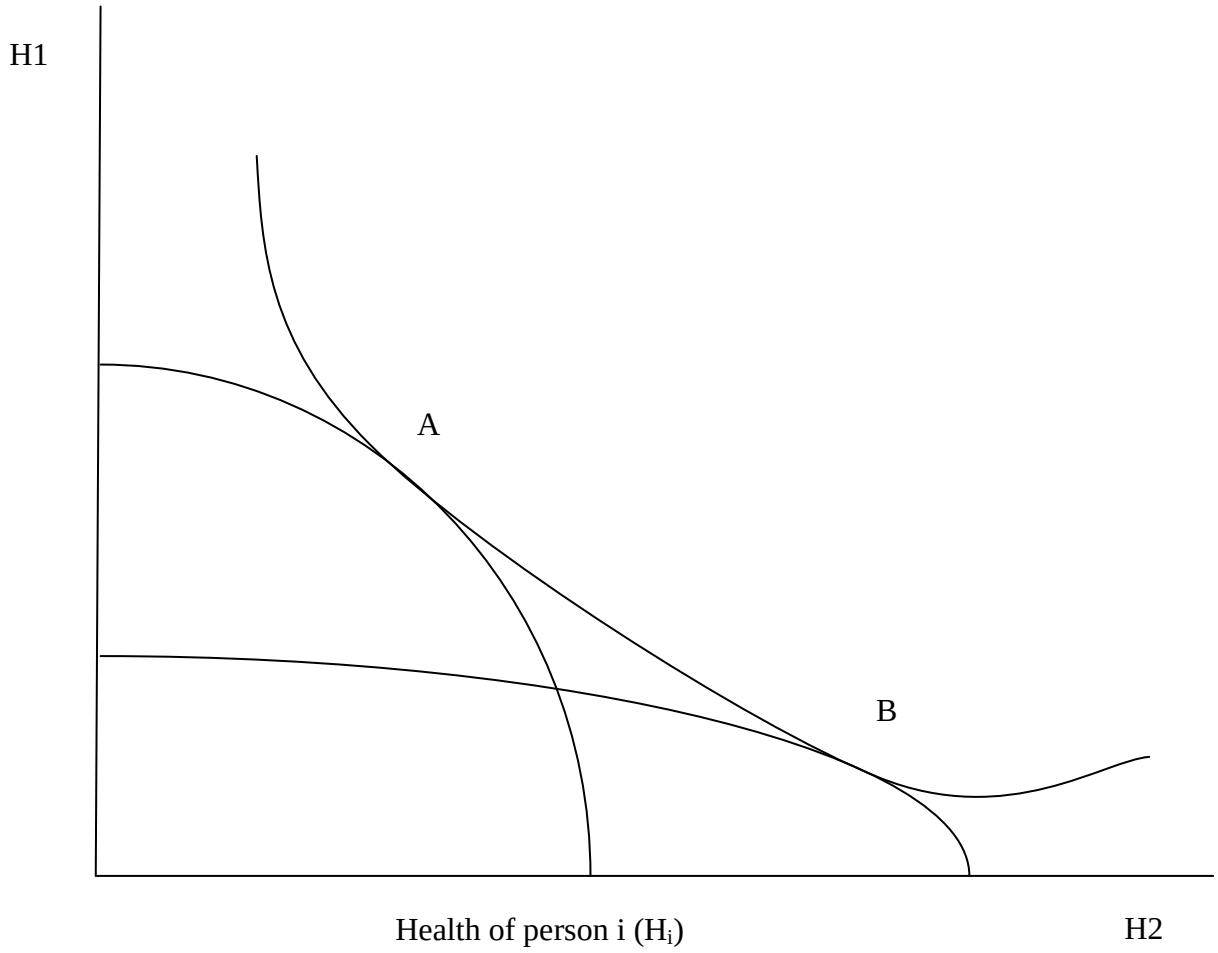


Figure 2.4 Equilibrium at a point lower than the outcome maximizing level of investment.

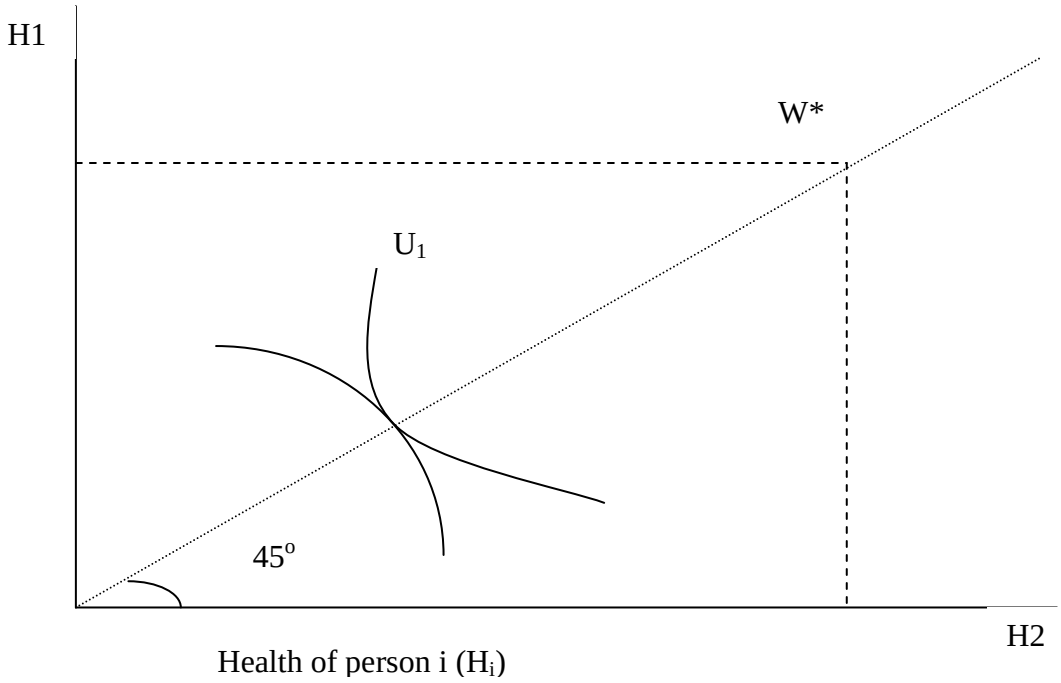


Figure 2.5 Hypothesized equilibrium for boy-girl differences in reports for allocation of nutrients

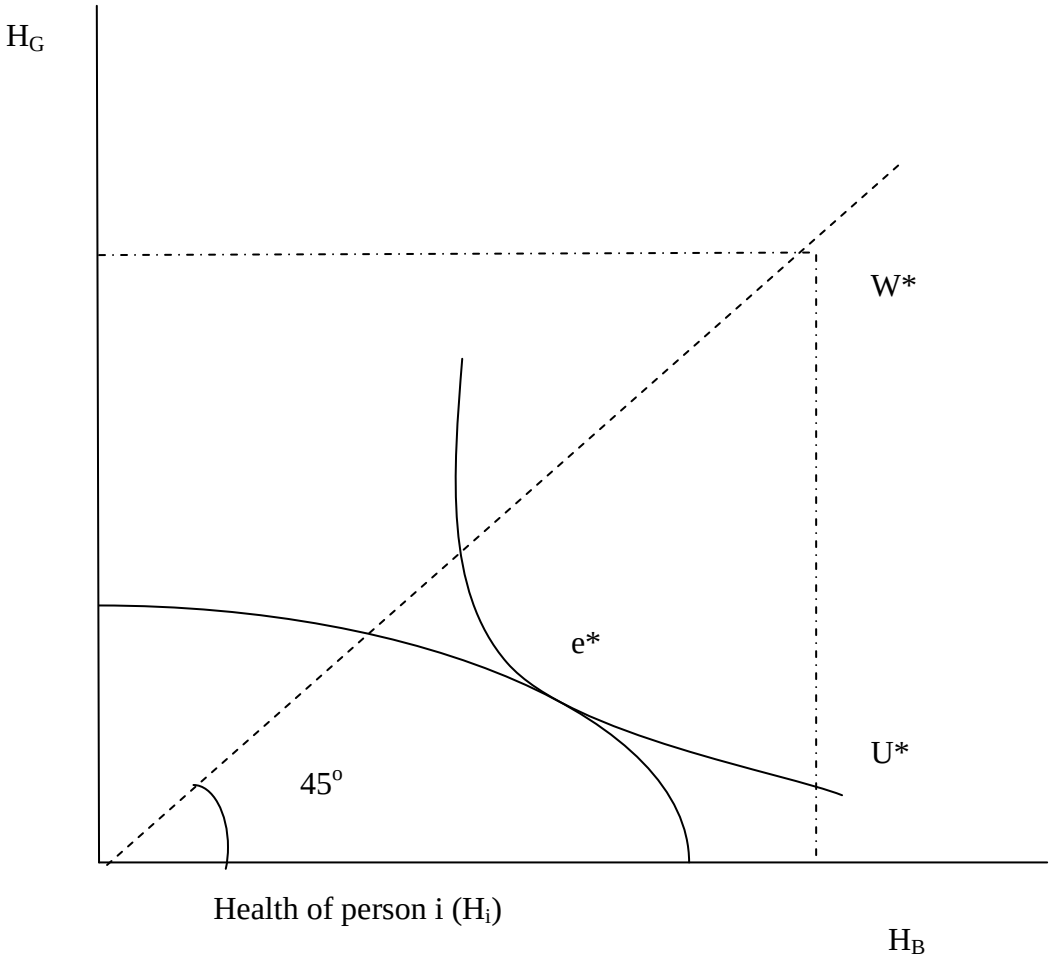


Figure 2.6a Hypothesized equilibrium for adult - child differences in reports of allocation of nutrients: Child is not an orphan.

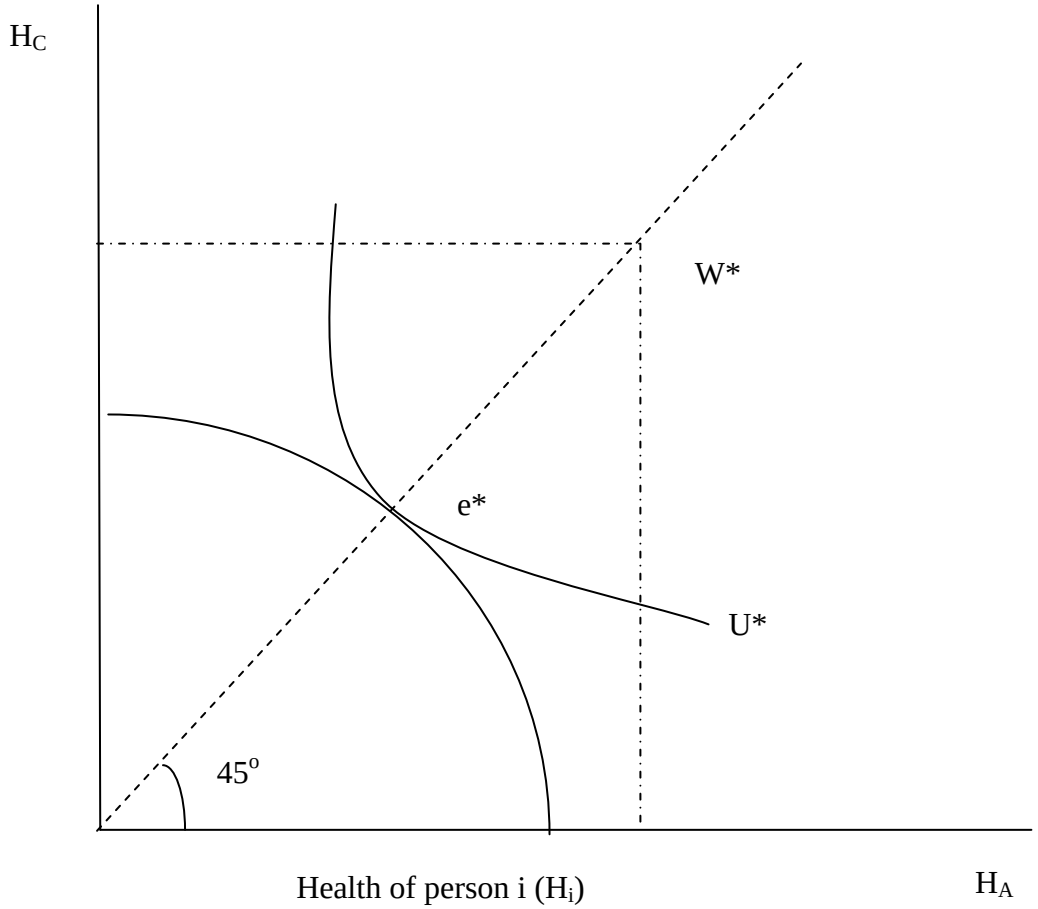
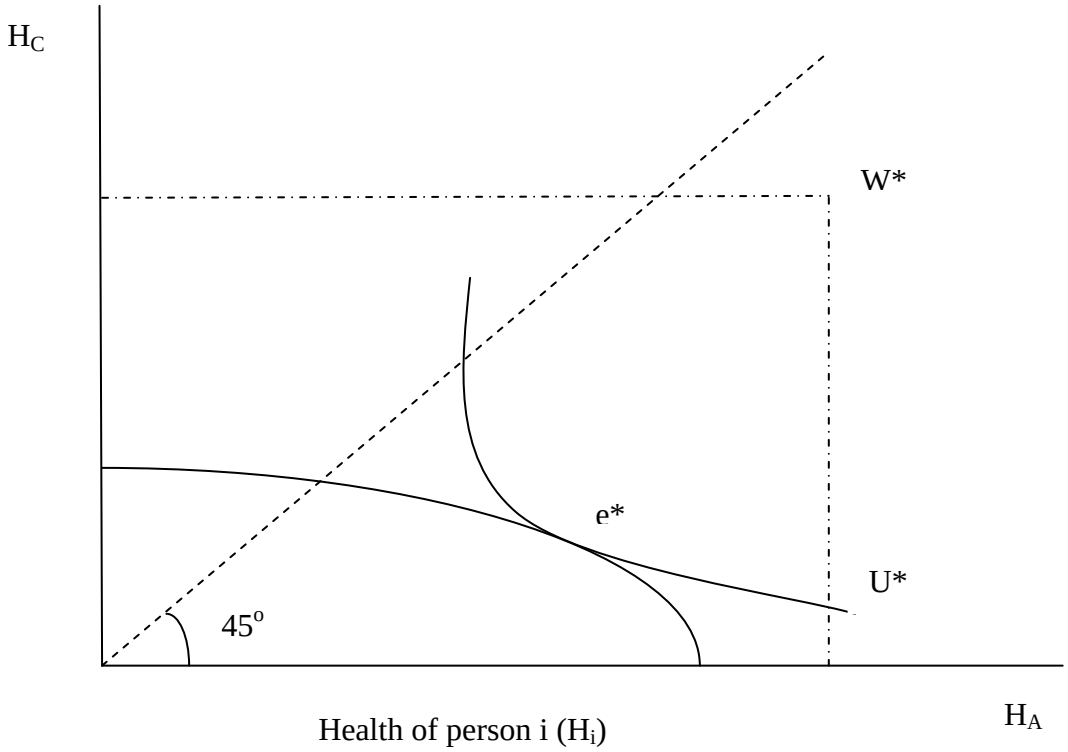


Figure 2.6b: Hypothesized equilibrium for adult - child differences in reports of allocation of nutrients: Child is an orphan.



CHAPTER THREE

DIFFERENCES IN FOOD INSECURITY BETWEEN GIRLS AND BOYS: EVIDENCE FROM ZIMBABWE

3.1 Introduction

Household-based measures have become the standard tool for measuring food security (Nord, Satpathy, Raj, Webb, & Houser, 2002). In almost all cases, however, only the head of the household is surveyed regarding his or her impression of whether the household is meeting its food needs. This response is then used to establish the entire household's food security status. In the process, the impressions of other household members – notably those of the children – are not considered. Neglecting other household members' assessments of their food intake may well skew estimates of overall food security, food security within different groups, and the determinants of food security. Of particular relevance for this paper, neglecting the assessments of children may obscure differences in food intake by the gender of the child. Given the evidence that, in some contexts, girls are disadvantaged in terms of nutrient intakes (e.g., Dréze & Sen, 1989; Harriss, 1990; Dasgupta, 1993; Strauss & Thomas, 1995), disadvantages may carry over to food insecurity, a measure correlated with food intakes. To date, however, due to limited information regarding food insecurity for individual children within a household, intra-household differences in food insecurity among children have not been examined. In this paper, I address this research lacuna by answering the following questions using data from a survey of over 6,000 households across Zimbabwe in 2004.

How do reports of food insecurity differ between boys and girls? In principle, since the children in the survey were chosen at random, the incidences of food insecurity between

girls and boys in this study should be the same. Thus, the reports by children established here will indicate whether food intake by girls and boys differs.

How do the determinants of food insecurity differ by gender and orphan status? Even if reports of food insecurity differ by gender, it is still an open question as to whether the gender of the child matters after controlling for other factors. Therefore, models which allow for the control for additional determinants of child food insecurity are estimated. The orphan reference is particularly relevant in Zimbabwe where the best estimates are that 20 to 30 % of children are orphans (UNAIDS, 2004a). Previous work has demonstrated that orphan status in some instances does matter for food insecurity (Gundersen & Kelly, 2006).

I begin this paper with background on household resource allocation differences by gender. This review is followed by a description of the data and methods. Results and a discussion complete the text. In general, I find some evidence of differences in food insecurity by gender and orphan status in Zimbabwe, mainly that orphan girls are more likely to be food insecure than other children.

3.2 Literature

In many developing countries, differences have been found in the allocation of household resources based on power or position within the household. In many of these settings, women are found to be disadvantaged mostly because their cultures value them less than men (DeRose, Das, & Millman, 2000). Because females have greater life expectancies than males, observations in several developing countries, particularly in Asia, of an imbalance in the sex ratio in adult age groups favoring males have led researchers to hypothesize that environmental factors have counteracted the expected female superiority in

life expectancy (Coale, 1991). The idea of "missing women" was most famously crystallized by Sen (1989) who used sex ratios to identify a deficit of females in the 1980s in Asia, North Africa, and to a lesser extent, Latin America. He claimed that 100 million women of all ages were "missing" as a result of excess female mortality. He attributed these excess female deaths to discrimination against females in areas such as medical attention, sex based abortion, and most importantly, nutrition. Gbenyon and Locoh (1992) carried out a comprehensive review of child mortality in Sub-Saharan Africa. While they reported variation by regions (e.g., excess post-infantile female mortality in countries with predominantly Muslim populations), they found that death rates for children between ages one and four were approximately equal. This might suggest – though inconclusively – a hidden excess mortality of girls because the biologically "normal" situation is that of excess male mortality, particularly in the first few years of birth.

The evidence for gender preference

There is some evidence of boy preference in intra-household resource allocation in many parts of the developing world. For instance, Hill and Upchurch (1995) found a pattern of disadvantage for girls in terms of under-5 mortality. Their study, which examined the issue in 35 developing countries including Zimbabwe, found a pervasive disadvantage for females in over 90% of the countries surveyed.

Gender preference in Asia

Many countries in Asia pervasively and unambiguously practice boy preference. For instance, in India son preference has been found to be practiced in many different facets of life including healthcare, where boys are more likely than girls to be taken to a health care facility when sick; immunization, with boys having higher immunization rates; and

malnourshment, with girls more likely to be malnourished (Pande, 2003). Son preference reflected in fertility behavior has also been found in Vietnam (Haughton & Haughton, 1995); and in Bangladesh as reflected in parental care, feeding patterns, intra-family food distribution and treatment of illness (D'Souza & Chen, 1980). Boys were found to have an advantage in the allocation of nutrients in the Philippines (Senauer, Garcia, & Jacinto, 1988) and in the distribution of food resources in India (Behrman, 1988a) and Nepal (Gittelsohn, Meera, & Landman, 1997). However, Chaudhury's (1988) findings in Bangladesh were mixed for different outcomes. While boys were found to be preferred in non-food areas such as the quality of food, mother's child-care time and quality, and expenditure on health care, girls were found to have a higher caloric adequacy ratio than boys based on their nutritional needs.

Gender Preference in Africa

Boy preference?

The evidence for gender preference in intra-household allocations of resources in Africa differs by region and also in terms of the resource in question. In North Africa, son preference was found in Morocco and Tunisia by Obermeyer and Cardenas (1997). Their analyses of gender preference were based on information about breastfeeding, immunization and the treatment of diarrhea for a sample population of children. They found no differences between boys and girls in the duration and intensity of breastfeeding, but found that boys were favored in immunization coverage and treatment of diarrhea. In Egypt, parents were found to take boys more often than girls to preferred private sources of health care (Yount, 2004).

Culturally, in many countries in Sub-Saharan Africa there is anecdotal evidence of boy preference in fertility decisions. For instance, men and women indicated a preference for having male children rather then females among the Ekiti of the Yoruba tribe in southwestern Nigeria (Renne, 1993). A slight boy preference was also revealed by a review of Demographic and Health Surveys (DHS) questionnaires in Zimbabwe, Kenya and Burundi (Arnold, 1992).

Several studies have documented evidence of differential allocations of resources other than food. For example, boys were found to be advantaged in school enrollment, attendance and educational attainment in South Africa (Townsend et al. 2002) and Botswana (Chernichovsky, 1985). In addition, Filmer (1999) reported a large female disadvantage in education in countries in Western and Central Africa, North Africa and South Asia. Thomas (1994), using data from the United States, Brazil and Ghana, found gender differences in the allocation of household resources as mothers were likely to favor daughters and fathers to favor sons.

Girl preference?

Many other studies have found that if a gender preference exists at all, females are likely to hold a nutritional advantage. Where anthropometric measures are utlized to proxy for nutritional practices, boys usually have been found to fare worse than girls in many developing countries (Marcoux, 2002). These anthropometric indicators include wasting (weight for height), stunting (height for age) and underweight (weight for age). Marcoux (2002) reviewed surveys that examined differences in nutrition by gender for many developing countries and found that while boys in general seemed to be at a disadvantage when surveys involving children were examined, women were at a huge disadvantage when

surveys involving adults were examined. A study, also on anthropometric measures, examining the nutritional status of children aged 1-35 months in six Sub-Saharan African countries including Zimbabwe using DHS data for the period between 1990 and 1994 also found that female children appeared to be better nourished than male children in all six study countries (Madise, Matthews, & Margetts, 1999). In fact, results from the study prompted the authors to speculate about sex discrimination in favor of girls, especially in Malawi. Hardenbergh (1997) also reported an advantage in caloric intake for young females in Madagascar.

No preference?

Other studies show no differences in terms of nutritional distribution between male and female children. For example, in Côte d'Ivoire, Strauss (1990) found no significant difference between boys and girls in preschool children's nutrition. In Burkina Faso, Haddad and Reardon (1993) carried out a disaggregated outlay equivalent analysis to test for gender differentials in household resource allocation. They were unable to find any evidence in favor of boys. In Ethiopia, Kimhi (2004) reported little evidence of gender bias in the allocation of calories in households. These studies are consistent with the work of DeRose, Das, & Millman, (2000) who carried out a comprehensive global review of the literature on differences in food intake by gender. They concluded that there was no conclusive evidence of gender bias in the allocation of nutrients in any studies outside of South Asia. While they found it true that women were disadvantaged in many cultures in most developing countries, this disadvantage did not seem to manifest itself in the allocation of nutrients, but more in access to health and educational facilities.

Why might there be a gender preference?

The most widely utilized theoretical explanations of gender preference in developing countries have been found in the economic literature. One explanation is the profit maximization behavior of parents (Rosenzweig & Schultz, 1982: Pitt, Rosenzweig, & Hassan, 1990; Berhman 1997). From this perspective, it is more rational for parents to invest in boys when the labor market values the human capital of boys more than girls. Market forces tend to work hand in hand with cultural norms to create a higher valuation of boys over girls. In many developing societies, boys may be preferred because sons are considered essential for maximizing the economic and non-economic well-being of households. They contribute to family resources and do not move away to get married as daughters do (Chaudhury, 1988). Consequently, the full return to investing in sons is more likely to be reaped by parents than the return to investments in daughters. This was found to be the logic behind boy preference in Ghana, and the pattern is the same in many developing countries (Garg & Morduch, 1998). Yamauchi (2006) in a study of parental nutrition and schooling investments in South Africa, however, found that parents were more likely to invest in the better endowed child (the healthier child in this case). Although, wealthier households were more likely to invest more in less well-endowed children in an attempt to reduce sibling inequality.

Another explanation of gender preference is that parents may prefer a certain gender of child regardless of returns. This idea is rooted in a parental utility function indicating that parents derive more utility from the human capital of boys than girls (Behrman, Pollack, & Taubman, 1982; Berhman 1988, 1997).

Gender preference in fertility behavior can also be rooted in the evolutionary biology literature, based on the concepts of natural selection (Trivers & Willard, 1973). If the condition of mothers during parental investment (i.e., nursing or feeding) correlates with the probable reproductive success of their offspring, parents will adjust their investments to favor the sex with the best reproductive propects. In many species, male reproductive success is more variable than that of females. Therefore, males may benefit more than females from good maternal conditions and suffer more than females from poor maternal conditions. Cronk (1989) expanded this idea to the human species using the Mukogodo group in Kenya. This perspective predicts and finds that parents at the higher end of the socioeconomic hierachy will invest more in sons than in daughters, while parents at the lower end will favor daughters. This conclusion was also reached by Miller (1997) in a summary of findings of studies from throughout Asia.

3.3 Data and methods

3.3.1 Data description

The data being used in this study are taken from a survey of over 6,000 households across Zimbabwe in 2004. The survey was conducted by Catholic Relief Services (CRS) with funding from the U.S. Agency for International Development (USAID). The sample comprised five districts that were selected to represent the five basic areas of community life in Zimbabwe: urban, peri-urban, rural, commercial farm, and resettlement. The sample frame was derived from the 2002 national census. In each district a sample of households was selected by taking a sample of wards within these districts; a sample of villages within each ward; a sample of Enumeration Areas (EAs) within each village; and a sample of

households in each selected EA. Finally, a household was retained in the sample if it contained a child between 6 and 18 years of age.

For each household, an adult was asked demographic and economic questions pertaining to the household. In addition, within each household a child between the ages of 6 and 18 was randomly selected from those children present in the household to answer several questions. For this paper, information from the adult regarding the economic and demographic characteristics of the household is utilized.

Central to this analysis are the questions posed to the child in the household regarding his or her food insecurity status. Two food insecurity questions were asked. How often do you have enough food? (Responses are never, rarely, sometimes, always). This question constitutes the food inadequacy measure of food insecurity. How many meals did you eat yesterday? (Responses are 0,1,2,3,>3). This question constitutes the number of meals measure. Both measures reflect individual intakes of food within the household.

The use of multiple measures of food insecurity in this study is consistent with the recommendations of Maxwell et al. (1999). The first measure, in the language of Barrett (2002), is a characterization of the physiological aspects of food insecurity, even if it is a more "subjective" measure. The second measure can be characterized as one aspect of households' rationing strategies in response to limited food supplies, and can be considered a more "objective"[4] measure of food insecurity.

[4] Although the number of meals measure counts as a more "objective measure" of food insecurity, it is still not perfect because a) there is no real information as to how representative the previous day was in terms of meals consumed, and b) there is no information as to the content, quality and size of the meals in question.

3.3.2 Model description

Differences by gender in food insecurity reports are presented in tables 3.1 and 3.2, where raw counts and percentages of the two measures of food insecurity are presented by gender. For the food inadequacy measure, about half of the respondents of both genders report having enough food sometimes, with roughly one third reporting having enough food rarely or never. In terms of the number of meals measure, a majority of the children (roughly 60 %) reported consuming 2 meals the previous day and almost 30 % had three meals or more. These trends were consistent across genders. The two measures are also strongly associated with each other, with a simple Pearson correlation coefficient of 0.32 for the female sample and 0.28 for the male sample.

To answer the research questions, a bivariate ordered probit model is estimated that includes interactions of gender by orphan status. The bivariate ordered probit, as laid out by Sajaia (forthcoming), is derived from an underlying latent variable model which consists of two equations relating the latent food inadequacy (FI_1^*) and number of meals (FI_2^*) measures of food insecurity to individual and household characteristics of the children in the sample.

$$FI_{1i}^* = \beta_1 X_{1i} + \varepsilon_{1i}$$

$$FI_{2i}^* = \beta_2 X_{2i} + \varepsilon_{2i}$$

Where β_1 and β_2 are vectors of unknown parameters, ε_1 and ε_2 are error terms and the subscript i denotes an individual observation. The observed variables for the individual's reported food insecurity status captured by the two survey-derived measures are related to the corresponding latent variables as:

$$FI_{1i} = \begin{cases} 1 \text{ - never} & \text{if } FI_{1i}^* \leq c_{11} \\ 2 \text{ - rarely} & \text{if } c_{11} < FI_{1i}^* \leq c_{12} \\ 3 \text{ - sometimes} & \text{if } c_{12} < FI_{1i}^* \leq c_{13} \\ 4 \text{ - always} & \text{if } c_{13} < FI_{1i}^* \end{cases}$$

$$FI_{2i} = \begin{cases} 0 & \text{if } FI_{2i}^* \leq c_{21} \\ 1 & \text{if } c_{21} < FI_{2i}^* \leq c_{22} \\ 2 & \text{if } c_{22} < FI_{2i}^* \leq c_{23} \\ 3 & \text{if } c_{23} < FI_{2i}^* \leq c_{24} \\ >3 & \text{if } c_{24} < FI_{2i}^* \end{cases}$$

The unknown cutoffs satisfy the conditions that $c_{11} < c_{12} < c_{13}$ and $c_{21} < c_{22} < c_{23} < c_{24}$. Assuming that ε_1 and ε_2 are distributed normally $N(0,\Sigma)$, the system can be estimated via maximum likelihood. Accordingly, the following bivariate ordered probit model is analyzed:

$$FI_1 = \Phi (\boldsymbol{\beta}'\mathbf{X}_{1i} + \boldsymbol{\gamma}'\mathbf{AGE}_{1i} + \boldsymbol{\varphi}'GIRL_{1i} * ORPHAN_{1i} + u_{1i}) \qquad (3.1a)$$

$$FI_2 = \Phi (\boldsymbol{\beta}'\mathbf{X}_{2i} + \boldsymbol{\gamma}'\mathbf{AGE}_{2i} + \boldsymbol{\varphi}'GIRL_{2i} * ORPHAN_{2i} + u_{2i}) \qquad (3.1b)$$

The joint estimation of the model yields measures of the correlations between u_{ci} and u_{ai}. The correlation coefficient, denoted as ρ, estimates how unobserved factors jointly affect the outcomes of interest. A negative value of ρ means that after controlling for observed factors, unobserved factors positively affecting the food inadequacy measure are negatively related to the number of meals measure and vice versa. The converse holds for positive values of ρ, as

a positive value indicates that unobserved factors positively affecting the food inadequacy measure are positively related to the number of meals measure and vice versa. If $\rho=0$, this indicates that there is no correlation between the unobserved factors affecting the food inadequacy measure and the unobserved factors affecting the number of meals measure (Garasky, Stewart, Gundersen & Lohman, forthcoming).

The independent variables identified in equation (3.1a) and (3.1b) are defined as follows: i denotes a household, **AGE** is a vector reflecting the age of a child (categories of 6-9, 10-12 and 13-15, with 16-18 omitted); GIRL=1 if a child is a girl and 0 if a boy; **X** is a vector of covariates reflecting a household's economic and non-economic conditions; and u is an error term. The vector **X** includes the following variables – household size (continuous measure), the sector of employment of household members (indicator variables for the formal sector, agricultural sector and trading sector; the omitted group is casual labor or piecework sector); whether the interviewer considers the housing unit to be of good or fair quality (indicator variable = 1) or poor quality (variable = 0); and the location of the interview (indicator variables for at school, at home and in the street, with at an institution as the excluded location). It should be noted that household income was not obtained in this survey. As such, employment sector and housing quality to some extent proxy for this omitted variable. In addition, ORPHAN=1 if a child is an orphan, 0 otherwise. While I am interested in the coefficients on each of the variables, my primary concern is with **φ'**, the coefficients related to the gender by orphan interaction terms for which there are four categories, namely female orphans, male orphans, female non-orphans and male non-orphans (the omitted category).

Regarding orphan status, an orphan is defined as a child (a) who does not live with either of his or her parents and (b) for whom no evidence of a mother being alive is available. This method of identifying orphan status is based on the structure of the survey. Out of concern for the interviewed child, the surveyors did not ask about the status of a child's mother or father. Through other questions on the survey, however, it was possible to ascertain whether or not the mother is alive. Unfortunately, same could not be done for the father. Using definitions employed in other studies (e.g., UNAIDS, 1999; Gundersen, Kelly & Jemison, 2006), orphans in this paper are maternal orphans who do not live with their fathers (who may or may not be alive).

3.4 Results

Table 3.3 presents summary information for all the variables utilized in the regression analyses, including means for the two dependent variables. The sample is evenly split between boys and girls, about 33 % of the sample are orphans. In addition, when interacted with gender, there is once again an even split by gender and orphan status. Approximately 17 % of the sample are female orphans, and a similar percentage are male orphans. Also, about 33 % the sample are female non-orphans, almost exactly the percentage who are male non-orphans. The children are also roughly evenly distributed across the respective age groups. In terms of household characteristics, most adults work in the farming sector. Less than half of the homes are in good or fair condition. The average household size is approximately 5 people and most individuals were interviewed at home.

Table 3.4 presents results from the bivariate ordered probit analysis. The results show that girls and boys are equally likely to report food insecurity using both measures,

except for orphan girls. Female orphans are more likely to report eating fewer meals the previous day relative to non-orphans of both genders and male orphans. This implies a gender effect (girls eat less) among orphans that is not present among non-orphans. In addition, there is an orphan effect (orphans eat less) among females that is not there among boys. Other personal characteristics of the child have no major impact on either measure, with the exception of children aged 6-9 and 13-15 who are less likely to report having inadequate food than children aged 16-18 (the omitted group). In addition, the value of ρ is positive (0.325) and statistically significant, which means that unobserved factors affect both measures of food insecurity in a similar manner (positively or negatively) after controlling for other factors.

I also briefly describe some of the other findings. Household size is a strongly positive predictor for both measures. As would be expected, children in households with someone with a better job are less likely to report food insecurity by either measure. For example, in comparison to a child in a household with an adult employed in the casual labor sector (the omitted category), a child in a household with an adult employed in the formal sector is significantly less likely to report food insecurity as measured by food inadequacy or the number of meals consumed the previous day. Another metric of household economic well-being, the assessment by the interviewer of the quality of the house, shows a similar effect: a child living in a good or fair quality house (versus a poor or extremely poor quality house) is significantly less likely to report food insecurity. Location controls were also strongly associated with both measures.

3.5. Conclusions

Using data from a large scale survey in 2004 in Zimbabwe, I find that gender is an important factor in determining self-reported assessments of food insecurity among a very vulnerable group of children, namely orphan girls. This result holds for the number of meals ("objective") measure of food insecurity. All other categories of boys and girls report roughly the same level of deprivation across both measures of food insecurity. In addition, these reports are roughly similar across the age gradient. These results imply that while all other groups of children are equally likely to say that they get enough food, orphan girls are more likely to report eating fewer meals. This may reflect different expectations of orphans girls compared to other categories of children of what constitutes "enough". This result is important for policymakers who aim to improve child food insecurity. In order to achieve this goal, they may wish to target benefits to children based on their gender and orphan status, rather than to the entire household.

The results from this study in terms of gender differences are very enlightening given studies carried out in other countries in Africa (e.g. Kimhi, 2004; Sauerborn, Berman, & Nougtara, 1996; DeRose, Das, & Millman, 2000) which point to the egalitarian nature of gender allocation of food resources within homes in Sub Saharan Africa, as opposed to South East Asia. The results reiterate the need to investigate resource allocations to more vulnerable subgroups, in this case, orphan girls. In relation to the results regarding orphans, future research needs to be carried out to investigate the content, quality and size of the meals being consumed by all categories of children (boys, girls, orphans, non-orphans), for a more objective definition of "enough".

Table 3.1 Food insecurity status by gender (raw counts)
Food inadequacy measure

Question: How often do you say you have enough food?				
	Girls		Boys	
	Raw counts	%	Raw counts	%
Never	297	10.29	283	9.87
Rarely	682	23.64	725	25.29
Sometimes	1467	50.85	1490	51.97
Always	439	15.22	369	12.87
N	2885		2867	

Table 3.2 Food insecurity status by gender (raw counts)
Number of meals measure

Question: How many meals did you eat yesterday?				
	Girls		Boys	
	Raw counts	%	Raw counts	%
0	3	0.10	4	0.14
1	313	10.85	310	10.81
2	1720	59.62	1739	60.66
3	800	27.73	777	27.10
>3	49	1.70	37	1.29
N	2885		2867	

Table 3.3 Descriptive Statistics

Variable	means
Dependent Variables	
Inadequate food measure	2.305
Number of meals measure	2.193
Child characteristics	
Female	0.501
Orphan	0.333
Female orphan	0.169
Male orphan	0.164
Female non-orphan	0.332
Male non-orphan	0.334
Age 6_9	0.266
Age10_12	0.265
Age13_15	0.257
Age16_18	0.211
Adult characteristics	
Adult works in formal sector	0.136
Adult works in farming sector	0.308
Adult works in trading sector	0.255
Adult works in casual labor/piecework sector	0.301
Household characteristics	
Quality of house is good or fair	0.458
Household size	5.174
	(2.060)
Location of interview	
Interview done at home	0.767
Interview done at school	0.079
Interview done in street	0.107
Interview done at institution	0.047
Number of observations	**5752**

Note: Standard errors for continuous variables provided in parentheses.

Table 3.4 Bivariate ordered probit estimates of the impact of gender and other variables on child reports of food insecurity

	I		**II**	
	Inadequate food measure		Number of meals measure	
Child Characteristics				
	Coef	S.E	Coef.	S.E
Age 6_9	0.084**	0.042	0.006	0.044
Age10_12	-0.054	0.042	0.003	0.044
Age13_15	-0.132***	0.042	-0.014	0.044
Orphan*male	-0.035	0.043	-0.061	0.045
Orphan*female	-0.017	0.043	-0.091**	0.045
Non-orphan*female	0.039	0.035	0.028	0.037
Household Characteristics				
Household size	0.016**	0.007	0.017**	0.007
Adult works in formal sector	0.186***	0.044	0.380***	0.045
Adult works in farming sector	0.164***	0.034	-0.004	0.035
Adult works in trading sector	0.192***	0.035	0.248***	0.036
Quality of house is good or fair	0.407***	0.033	0.395***	0.035
Location of Interview				
Interview done at home	-0.116	0.072	0.211***	0.075
Interview done at school	-0.238***	0.084	0.222**	0.088
Interview done in street	-0.517***	0.079	0.102	0.083
ρ (std. err.)	0.325*** (0.0147)			
N	5752			

Note: *** Significant at the p < .01 level; ** significant at the p < .05 level; * significant at the p < .10

CHAPTER FOUR

DIFFERENCES IN FOOD INADEQUACY AND FOOD INSECURITY BETWEEN ADULTS AND CHILDREN IN ZIMBABWE

4.1 Introduction

This paper examines whether adults and children in the same household in Zimbabwe differ in their assessments of food adequacy and being food secure. Household-based food insecurity measures have become the standard tool for measuring food security (Nord, Satpathy, Raj, Webb, & Houser, 2002). In almost all cases, however, the only response from the household is from the head of household. This response is used to categorize the entire household's food security status. In the process, the impressions of other household members – notably those of the children – are not considered. Neglecting other household members' assessments of their food security status may well skew estimates of overall food security, food security within different groups, and analyses of the determinants of food security. For instance, children may have a higher or lower probability of meeting their caloric and nutritional requirements than adults in many countries (Haddad, Pena, Nishida, Quisumbing, & Slack, 1996).

These differences may carry over to food insecurity, a measure correlated with food intakes. To date, however, due to survey methods that include only interviewing the household head, potential intra-household differences between children and adults have not been portrayed. In this paper this research lacuna is tackled by addressing the following questions using data from a survey of over 6,000 households across Zimbabwe in 2004.

How do reports of food inadequacy and food insecurity differ between adults and children? Identifying any differences in the responses of adults and children points to the

importance of using child reports when practitioners, policymakers and researchers are interested in child outcomes.

What is the pairwise correlation of adult and child reports of food inadequacy and food insecurity? This question is posed because even if the incidence of food insecurity under these measures is similar there may not be a high correlation between reports of food insecurity within the same household.

How does the orphan status of a child affect the overall incidence of child food inadequacy and food insecurity? It may also be relevant to examine whether or not orphans differ from non-orphans in their reports of food security. The HIV epidemic has hit sub-Saharan Africa especially hard and has led to rapid increases in the number of children being orphaned by AIDS. By 2004, over 12 million children had been orphaned by HIV, a substantial increase from the negligible numbers of the 1980s (UNAIDS, 2004b). As a result, there has been a surge in the number of households hosting orphans, with resultant implications for resource allocation as well as food insecurity. There is some evidence of discrimination against orphans in resource allocation across Africa, including school enrollment (Case, Paxson, & Ableidinger, 2004; Nyamukapa & Gregson, 2005) and food insecurity (Gundersen & Kelly, 2006). Based on this body of evidence, this paper will also investigate the impact of orphan status on reports of food insecurity by children.

4.2 Literature

Age preference in resource allocation occurs where an individual is prioritized in the allocation of resources (e.g., food) because of their age. The evidence as to whether or not age preference holds is mixed and seems to depend on cultural and socioeconomic contexts. In

general, parents are expected to display altruism towards their children (Eswaran & Ashok, 2004) and there is some evidence that they do. However, in many developing country settings, whether parents are altruistic or not can depend on individual family arrangements (e.g. expected stability of marriage; number of wives; whether children are biological, foster or stepchildren; duration of marriage), as well as on institutional structures which may determine what is appropriate in terms of allocation. Although parents care about their children, levels of altruism vary across different types of families and seem to depend on culturally acceptable practices (Desai, 1992).

Some evidence suggests that low-income adults in developing countries give up their rights to food resources so that their children may be adequately nourished. For instance, in Peru, male adults within households were more likely to face seasonal caloric stress than children (Leonard, 1991). In Nepal, there was evidence of preferential treatment of young children over adults in food allocation (Gittlesohn, 1991); a finding corroborated by a separate study by Panter-Brick (1993). Two studies in Peru (Leonard, 1989; Graham, 1997) found that children were shown preference over adults in times of food scarcity; and Bouis and Pena (1997) found that preschoolers were favored in the intra-household distribution of food in the Philippines.

There are also situations in which adults may be prioritized over children. Sometimes it is due to parental ignorance as to the importance of certain foods for children. In a study of the provision of animal source foods to children in Ghana, it was found that there were adults who were ignorant of the benefits of some animal source foods to children and thus consumption was restricted to adults (Colecraft, et al., 2006). Differences in resource allocation between adults and children may also be due to differences in perceived productivity. If households are

concerned with maintaining their capacity to produce, they are more likely to prioritize the most productive members of the family in terms of resource allocation, a result found in Burkina Faso where adults were given priority in the intra-household allocation of health resources (Sauerborn, Berman, & Nougtara, 1996). This preference may extend to the allocation of food as well. Evidence from rural Bangladesh suggested a pro-adult bias in food allocation at the expense of children within the household (Abdullah & Wheeler, 1985). Gomna and Rana (2007) investigated the consumption of meat and fish in two fishing communities in two states in Nigeria. They found that the consumption of fish was influenced by the social structure within households. Fish consumption within households on a unit body weight basis was skewed toward heads of households who consumed 59 % more fish than their wives or children – probably due to the greater energy demands of men who engage in manual labour. Men usually got the main body of the fish, wives got the tail, and the children the head. The situation was similar in Guatemala, as household heads were more likely to have adequate diets when compared to other household members, particularly adolescents (Engle & Nieves, 1993). Also, children were found to be disfavored with regard to nonstaple foods in Mali (Dettwyler, 1986; 1987).

There is also the Cinderella hypothesis,which states that parents are less willing to invest in children who are not biologically theirs (Case, Lin & Mclanahan, 1999). First hinted at by Hamilton (1964) in the field of evolutionary biology, the basic idea is that investments in children by caregivers are most strongly motivated by biological relatedness. More recently, it has been found that the presence of a child's biological mother appears to increase food expenditures in the U.S. and South Africa (Case, Lin, & Mclanahan, 2000). In a South African study where food spending could be disaggregated by items purchased, households were found

to spend less on milk, fruit and vegetables, and more on tobacco and alcohol in the absence of a child's birth mother (Case, Lin, & Mclanahan, 2000).

Foster parenting is very common in Africa (Desai, 1992), and has increased exponentially with the HIV epidemic that has hit many countries in Southern Africa especially hard. Of the roughly two million deaths due to AIDS in 2007, 38 % occurred in Southern Africa. In addition, the subregion was also burdened with 35 % of the roughly 2.7 million new HIV infections in the same year. Furthermore, there were estimated to be approximately one million AIDS orphans in Zimbabwe alone (UNAIDS, 2008).

Some evidence suggests discrimination against orphans in Zimbabwe. Gundersen, Kelly and Jemison (2006) investigated the demand for schooling among orphans in Zimbabwe. They found strong evidence of discrimination as orphans were significantly less likely to go to school than non-orphans. They also found that the effect of being an orphan was especially large for older children.

4.3 Data and methodology

The data used in this study were taken from a survey of over 6,000 households across Zimbabwe in 2004. The survey was conducted by Catholic Relief Services (CRS) with funding from the U.S. Agency for International Development. The sample frame was derived from the 2002 national census and comprised five districts, selected to represent the five basic areas of community life in Zimbabwe: urban, peri-urban, rural, commercial farm, and resettlement. In each district, a sample of households was selected by taking a sample of wards within these districts; a sample of villages within each ward; a random sample of Enumeration Areas (EAs)

within each village; and a random sample of households in each selected EA. Finally, a household was retained in the sample if it contained a child between 6 and 18 years of age.

An adult in each household was asked demographic and economic questions pertaining to the household. In addition, a child between the ages of 6 and 18 was randomly selected from those children present in the household to answer several questions. For this paper, information from the adult regarding the economic and demographic characteristics of the household, as well as their reported assessments of household food insecurity, is used. I also use information from the child regarding his or her food insecurity status. While some food insecurity questions do not overlap, both the child and the adult were asked the following questions regarding their food intake: How often do you have enough food? (Responses were always, sometimes, rarely, never); and How many meals did you eat yesterday? (Responses were 0,1,2,3,>3). These two measures reflect individual intake of food within the household.

The use of multiple measures of food insecurity in this study is consistent with the recommendations of Maxwell et al. (1999). The first measure, in the language of Barrett (2002), is a characterization of the physiological aspects of food consumption, even if it is a more "subjective" measure. The second measure can be characterized as measuring one aspect of a households' rationing strategy in response to limited food supplies, and can be considered a more "objective"[5] measure of food insecurity.

For the first question, food intake is deemed *inadequate* (a binary indicator takes on a value of 1) if the respondent rarely or never has enough food, and is 0 otherwise (always or sometimes has enough food). For the second question a respondent is deemed *food insecure* (a

[5] Although the number of meals measure counts as a more "objective measure" of food insecurity, it is still not perfect because a) there is no real information as to how representative the previous day was in terms of meals consumed, and b) there is no information as to the content, quality and size of the meals in question.

binary variable takes on the value of 1) if the individual had 0 or 1 meals the previous day, and 0 otherwise (had 2 or more meals).

Presentation of the data begins with table 4.1 where the extent to which adults and children report different levels of food inadequacy is explored. Table 4.1 presents the raw counts of responses to the food inadequacy question - how often do you have enough food? - organized by child and adult responses. In table 4.2 this information is further categorized into adequate versus inadequate food intakes based on the responses in table 4.1. Table 4.2 reveals that about 59 % of adults and children have the same reports of food inadequacy. Regarding differences between adults and children, 17.7 % of children report that their food intakes are inadequate while the adult reports his/her food intakes are adequate; 23.0 % of children report that their food intakes are adequate while the adult reports that they are inadequate. These results indicate that there is a large number of households where perceived food intake adequacy differs between children and adult. In tables 4.3 through 4.6, the same information is presented by orphan and non–orphan status. In both cases, the pattern is the same – there are large differences in reports of food inadequacy between adults and children within the same household.

Similar analyses were conducted for the food insecurity measure – the number of meals consumed the previous day. In table 4.7, the raw counts of responses to the question are presented and then categorized into food secure/insecure categories based on adult-child responses to create table 4.8. Per the results in table 4.8, in comparison to food inadequacy (table 4.2), a larger percentage (about 80 %) of adults and children agree on their food security status based on the number of meals eaten the previous day. This measure may, however, overstate the level of convergence as only 55 % of the adults and children reported the same

number of meals consumed the previous day (the diagonal in table 4.7). In other words, as with the food inadequacy measure, there is a large number of households where the adult and child have different levels of individual food insecurity. The pattern is very similar for orphans versus non-orphans (tables 4.9 through 4.12), showing that there are major differences in perceptions of food security for children versus adults in these households, regardless of orphan status.

The reports of food inadequacy and insecurity are compared in tables 4.13 though 4.16. In table 4.13, the comparisons show that children are significantly less likely than adults to report that their food intakes are inadequate – 34.5 % versus 39.9 %. Also, adults are significantly more likely than children to report being food insecure (i.e., having an inadequate number of meals). In tables 4.14 and 4.15, this comparison is carried out for adults and orphans and adults and non-orphans, respectively. While adults report higher percentages of not getting enough to eat (food inadequacy and food insecurity) in both tables for both measures, the differences between adults and children for both measures are much smaller for orphans than for non-orphans. In table 4.16, the food reports of orphans are compared to those of non-orphans for both measures. Orphans were significantly more likely than non-orphans to report inadequate food intakes and being food insecure, providing some preliminary evidence of orphans being treated differently than biological children (the Cinderella hypothesis).

Bivariate probit model

A bivariate probit model is utilized to estimate the determinants of differences in adult and child reports of food inadequacy or food insecurity. This analysis is done twice, once for each measure discussed above. The model can be thought of as simultaneously estimating binary probits, while allowing for correlated errors.

Consider the following latent variable model which consists of two equations relating the latent child reports of food insecurity or food inadequacy (FI_c*) and adult reports of food insecurity or food inadequacy (FI_a*) to individual characteristics of the child and household characteristics:

$$FI_{ci}^* = \beta_c X_{ci} + \varepsilon_{ci} \quad (4.1)$$

$FI_{ci} = 1$ if $FI_{ci}^* > 0$

$FI_{ci} = 0$ otherwise

$$FI_{ai}^* = \beta_a X_{ai} + \varepsilon_{ai} \quad (4.2)$$

$FI_{ai} = 1$ if $FI_{ai} > 0$

$FI_{ai} = 0$ otherwise.

Where FI refers to food insecurity or food inadequacy, c refers to the child, a refers to the adult, and i is the individual. This is the standard approach for the probit model, which assumes that the errors are normally distributed and are independent of each other. However, if the two errors are correlated, as would be expected of the adult and child responses to each of the food insecurity measures, then estimating the biprobit model is more relevant than estimating two independent probits (Greene, 2007). The bivariate probit model allows for a situation where cov (ε_{ci} , ε_{ai}) = a constant r, instead of zero as is assumed in standard probit specifications. The following bivariate probit model is consequently estimated for both the food inadequacy and food insecurity measures:

$$FI_{ci} = \Phi (\mathbf{\beta'X}_{ci} + \mathbf{\gamma'AGE}_{ci} + \mathbf{\varphi'}GIRL_{ci} * ORPHAN_{ci} + u_{ci}) \quad (4.3a)$$

$$FI_{ai} = \Phi (\mathbf{\beta'X}_{ai} + \mathbf{\gamma'AGE}_{ai} + \mathbf{\varphi'}GIRL_{ai} * ORPHAN_{ai} + u_{ai}) \quad (4.3b)$$

The joint estimation of the model yields measures of the correlations between u_{ci} and u_{ai}. The correlation coefficient, denoted as ρ, estimates how unobserved factors jointly affect the outcomes of interest. A negative value of ρ indicates that, after controlling for observed factors, unobserved factors positively affecting the child reports of food inadequacy or food insecurity are negatively related to the relevant adult reports and vice versa. The converse holds for positive values of ρ, as a positive value indicates that unobserved factors positively (or negatively) affecting the child reports of food inadequacy or food insecurity are positively (or negatively) related to the relevant adult reports and vice versa. If ρ= 0, this indicates that there is no correlation between the unobserved factors affecting the child reports of food inadequacy or food insecurity and the unobserved factors affecting the corresponding adult reports (Garasky, Stewart, Gundersen & Lohman, forthcoming).

Dependent and independent variables

The dependent variables utilized in this study are derived from tables 4.1 and 4.7. For the food inadequacy measure, two dummy variables are constructed, one for the child and one for the adult that take the value of 1 if food intake is inadequate (i.e. individual answered rarely or never having enough food) and 0 otherwise. Likewise, for the food insecurity measure, two dummy variables are created, one for the adult and one for the child that take the value of 1 if the individual is food insecure (one or no meals the previous day), and zero otherwise.

The independent variables identified in equations (4.3a) and (4.3b) are defined as follows: i denotes a household, **AGE** is a vector reflecting the age of a child (categories of 6-9, 10-12 and 13-15, with 16-18 omitted); GIRL=1 if a child is a girl and 0 if a boy; **X** is a vector of covariates reflecting a household's economic and non-economic conditions; and u is an error term. The vector **X** includes the following variables: household size (continuous measure), the

sector of employment of a household member(s) (indicator variables for the formal sector, agricultural sector and trading sector; the omitted group is casual labor or piecework sector); whether the interviewer considers the housing unit to be of good or fair quality (indicator variable = 1) or poor quality (variable = 0); and the location of the interview (indicator variables for at school, at home and in the street, with at an institution as the excluded location). It should be noted that household income was not obtained in this survey. As such, employment sector and housing quality to some extent proxy for this omitted variable. In addition, ORPHAN=1 if a child is an orphan, 0 otherwise. The gender and orphan variables are included in the equations as interaction terms in four categories, namely female orphans, male orphans, female non-orphans and male non-orphans (the omitted category).

Regarding orphan status, an orphan is defined as a child (a) who does not live with either of his or her parents and (b) for whom no evidence of a mother being alive is available. This method of identifying orphan status is based on the structure of the survey. Out of concern for the interviewed child, the surveyors did not ask about the status of a child's mother or father. Through other questions on the survey, however, it was possible to ascertain whether or not the mother is alive. Unfortunately, the same could not be done for the father. Using definitions employed in other studies (e.g., UNAIDS, 1999; Gundersen, Kelly & Jemison, 2006), orphans in this paper are maternal orphans who do not live with their fathers (who may or may not be alive).

4.4 Results

Table 4.17 presents summary information for all of the variables utilized in these analyses for the full sample, and also by orphan status. The sample is evenly split between boys

and girls. About 33 % of the sample is orphans. In addition, when interacted with gender, there is once again an even split by gender and orphan status. Approximately 17 % of the sample are female orphans, and a similar percentage are male orphans. Also, about 33 % the sample are female non-orphans, almost exactly the percentage who are male non-orphans. The children are also roughly evenly distributed across the respective age groups. In terms of household characteristics, most adults work in the farming sector. Less than half of the homes are in good or fair condition. The average household size is approximately 5 people and most individuals were interviewed at home.

The bivariate probit results for the food inadequacy measure are presented in table 4.18. Similarly, results for the food insecurity measure are presented in tables 4.19.

Food inadequacy measure

Using food inadequacy as the dependent variable (table 4.18), neither the gender nor the age of the child are significant predictors. The exception occurs for the youngest children, a child in the age group 6-9, who, when compared to a child aged 16-18, has a lower likelihood of reporting food inadequacy. Similarly, child characteristics had no impact on adult reports of food inadequacy, with the exception of a male orphan. Adults living with a male orphan were significantly less likely to report being food inadequate.

All of the household characteristics included in these analyses speak to the socio-economic condition of the household. Across all specifications, in general, working in a more financially lucrative sector (i.e., a sector other than the omitted piece rate / casual labor category) is negatively associated with both the adult and the child in the household being food inadequate. More specifically, when the adult works in the formal sector, both the child and the adult are significantly less likely to report being food inadequate. The pattern is also the same

when the adult works in the farming or trading sector. In addition, house quality is also found to be an important predictor. There is a strong negative association between food inadequacy for both adult and child and quality of the house.

Looking at the correlation between adult and child reports, the value of ρ is positive (0.181) and statistically significant, which means that unobserved factors affect adult and child reports in a similar manner (positively or negatively) after controlling for other factors.

Food insecurity

In table 4.19 a similar analysis is carried out for the food insecurity measure. Based on this measure, children aged 6-9 are significantly more likely than children aged 15 -18 to report being food insecure, but there is no effect for this age group on the adult report of food insecurity (col II). In addition, adults with children aged 13-15 are significantly more likely to report being food insecure. This means that based on the number of meals measure, the youngest children are significantly more likely to be in homes where the child is food insecure but the adult is not, while the opposite is true for children aged 13-15. In addition, there is some evidence of the Cinderella hypothesis as female orphans are significantly more likely to report having one meal or less.

The effects of household characteristics utilizing the food insecurity measure are consistent with those found in table 4.18. In general, there is a negative association between working in a sector that provides greater economic reward and adult and child reports of food insecurity.

The value of ρ for this specification is 0.232 and, as in table 4.18, is statistically significant. This means that unobserved factors affect adult and child reports in a similar manner (positively or negatively) after controlling for other factors.

4.5 Discussion

Previous research on food insecurity using household-based measures has been forced to implicitly assume that the perception of food insecurity is uniform across household members. This assumption is due to the structure of the interviews – it is almost always the household head answering the surveyor's questions. Using a unique data set from Zimbabwe with adult and children responses to food inadequacy and food insecurity questions, this paper considered how adults and children's reports of food intake may differ. Results indicate that they do differ. Across both measures, children are less likely to not have enough to eat compared to adults. Though this is the case, the differences are not uniform across households – a substantial number of households have instances where the children are food inadequate or food insecure while the adult is not. There is also some evidence, based on the measure of food inadequacy, that there is a tendency to protect younger children and discriminate against female orphans in food distribution supporting the Cinderella hypothesis, which states that parents are less willing to invest in children who are not biologically theirs.

Another interesting finding is that the results differed by the "subjective" measure of food adequacy ("How often do you have enough food?") and the "objective" measure of food insecurity ("How many meals did you eat yesterday?"). Younger children were more likely to say that they had enough food, but less likely to get at least two meals. This finding reiterates the need for multiple measures to comprehensively capture the full picture of food insecurity in the household.

4.6 Conclusion

In conclusion, there are several implications of this paper for policymakers and practitioners in Zimbabwe and, as relevant, elsewhere. The presumption that all household members have the same level of food adequacy and security is false around 40 % of the time for the food inadequacy measure and 20 % of the time for the food insecurity measure. Evaluations of programs designed to address food needs and assessments of the problem derived from descriptions of food insecurity may wish to take into account these differences across household members. In response to this finding, if the policy goal is to improve child food insecurity, policymakers may wish to target benefits to children (rather than to the household level).

Table 4.1 Food inadequacy status by adult reports and child reports: All children

Raw counts for food inadequacy measure (all children)

Question: How often do you say you have enough food?

Child Reports	Adult reports				Totals
	always	sometimes	rarely	never	
Always	102	407	187	112	808
Sometimes	220	1710	667	360	2958
Rarely	90	639	495	183	1407
Never	68	219	131	162	580
Total	480	2975	1480	817	5752

Table 4.2 Categorization of food inadequacy measure (all children)

Child Reports	Adult Reports		Totals
	no	yes	
no	42.44	23.03	65.47
yes	17.67	16.87	34.53
Totals	60.10	39.90	

Table 4.3 Food inadequacy status by adult reports and child reports: Orphans

	Raw counts for food inadequacy measure (orphans) Question: How often do you say you have enough food?				
Child reports	Adult reports				Totals
	always	sometimes	rarely	never	
Always	30	119	65	30	244
Sometimes	75	577	215	115	982
Rarely	30	230	158	68	486
Never	29	78	52	47	206
Total	164	1004	490	260	1918

Table 4.4 Categorization of food inadequacy measure (orphans)

Child Reports	Adult Reports		Totals
	no	yes	
no	41.76	22.16	63.92
yes	19.13	16.94	36.08
Totals	60.90	39.10	

Table 4.5 Food inadequacy status by adult reports and child reports: Non-Orphans

	Raw counts for food inadequacy measure (non-orphans) Question: How often do you say you have enough food				
Child reports	Adult reports				Totals
	always	sometimes	rarely	never	
Always	72	288	122	82	564
Sometimes	145	1,133	452	245	1,976
Rarely	60	409	337	115	921
Never	39	141	79	115	374
Total	316	1971	990	557	3834

Table 4.6 Categorization of food inadequacy measure (non-orphans)

Child Reports	Adult Reports		Totals
	no	yes	
no	42.77	23.47	66.24
yes	16.93	16.83	33.76
Totals	59.70	40.30	

Table 4.7 Food insecurity status by adult reports and child reports: All children

Raw counts for number of meals measure (all children)

Question: How many meals did you eat yesterday

Child reports	Adult reports					Totals
	none	1	2	3	>3	
None	0	1	3	3	0	7
1	0	144	388	89	2	623
2	0	422	2474	549	14	3460
3	0	166	879	509	23	1577
>3	0	6	45	33	2	86
Totals	0	739	3789	1183	41	5752

Table 4.8 Categorization of number of meals measure (all children)

Child Reports	Adult Reports		Totals
	no	yes	
no	78.70	10.30	89.0
yes	8.50	2.50	11.0
Totals	87.20	12.80	

Table 4.9 Food insecurity status by adult reports and child reports: Orphans

Raw counts for number of meals measure (orphans)

How many meals did you eat yesterday? (raw counts)

Child reports	Adult reports					Totals
	none	1	2	3	>3	
none	0	0	2	2	0	4
1	0	56	144	35	0	235
2	0	148	822	193	8	1171
3	0	46	272	152	11	481
>3	0	1	16	8	2	27
Totals	0	251	1256	390	21	1918

Table 4.10 Categorization of number of meals measure (orphans)

Child Reports	Adult Reports		Totals
	no	yes	
no	77.37	10.17	87.54
yes	9.54	2.92	12.46
Totals	86.91	13.09	

Table 4.11 Food insecurity status by adult reports and child reports: Non-Orphans

Raw counts for number of meals measure (non-orphans)

Question: How many meals did you eat yesterday?

Child reports	Adult reports					Totals
	none	1	2	3	>3	
None	0	1	1	1	0	3
1	0	88	244	54	2	388
2	0	274	1,652	356	6	2289
3	0	120	607	357	12	1096
>3	0	5	29	25	0	59
Totals	0	488	2533	793	20	3834

Table 4.12 Categorization of number of meals measure (non-orphans)

Child Reports	Adult Reports		Totals
	no	yes	
no	79.37	10.39	89.76
yes	7.92	2.32	10.24
Totals	87.29	12.71	

Table 4.13 Comparisons of food inadequacy and food insecurity: Adults and Children

	Adults	Children
Inadequate food intakes	39.90**	34.53
Food insecure	12.85**	10.95

Notes: ** and * indicate the differences between the two categories are significant at the 99 and 95 % confidence levels, respectively, using the chisquare test.

Table 4.14 Comparisons of food inadequacy and food insecurity: Adults and Orphans

	Adults	Orphans
Inadequate food intakes	39.10*	36.08
Food insecure	13.09	12.46

Notes: ** and * indicate the differences between the two categories are significant at the 99 and 95 % confidence levels, respectively, using the chisquare test.

Table 4.15 Comparisons of food inadequacy and food insecurity: Adults and Non-Orphans

	Adults	Non-Orphans
Inadequate food intakes	40.30**	33.76
Food insecure	12.72**	10.24

Notes: ** and * indicate the differences between the two categories are significant at the 99 and 95 % confidence levels, respectively, using the chisquare test.

Table 4.16 Comparisons of food inadequacy and food insecurity: Orphans and Non-Orphans

	Orphans	Non-Orphans
Inadequate food intakes	19.13*	16.93
Food insecure	9.54*	7.92

Notes: ** and * indicate the differences between the two categories are significant at the 99 and 95 % confidence levels, respectively, using the chisquare test.

Table 4.17 Descriptive Statistics

Variable	Full sample	Orphans	Non-orphans
Dependent Variables			
Food Inadequacy measure			
Child food inadequate	0.345	0.361	0.338
Adult food inadequate	0.399	0.391	0.403
Number of meals measure			
Child food insecure	0.109	0.125	0.102
Adult food insecure	0.129	0.131	0.127
Independent Variables			
Child characteristics			
Female	0.501	0.507	0.499
Orphan	0.333	1.000	0.000
Female orphan	0.169	0.506	
Male orphan	0.164	0.493	
Female non-orphan	0.332		0.498
Male non-orphan	0.334		0.501
Age 6_9	0.266	0.214	0.293
Age10_12	0.265	0.260	0.267
Age13_15	0.257	0.285	0.244
Age16_18 (omitted category)	0.211	0.241	0.196
Adult characteristics			
Adult works in formal sector	0.136	0.117	0.145
Adult works in farming sector	0.308	0.315	0.305
Adult works in trading sector	0.255	0.255	0.255
Adult works in casual labor/piecework sector (omitted category)	0.301	0.313	0.295
Household characteristics			
Quality of house is good or fair	0.458	0.443	0.466
Household size	5.174	5.268	5.127
	(2.060)	(2.128)	(2.024)
Location of interview			
Interview done at home	0.767	0.742	0.780
Interview done at school	0.079	0.090	0.074
Interview done in street	0.107	0.113	0.103
Interview done at institution	0.047	0.055	0.043
Number of observations	**5752**	**1918**	**3,834**

Note: Standard errors for continuous variables provided in parentheses.

Table 4.18 Bivariate probit analyses: Food inadequacy

	I		II	
	Child food inadequate		Adult food inadequate	
Child Characteristics				
	Coef	S.E	Coef.	S.E
Age 6_9	-0.183**	0.052	0.025	0.050
Age10_12	-0.030	0.051	0.006	0.050
Age13_15	0.072	0.051	0.035	0.050
Orphan*male	0.011	0.053	-0.094*	0.051
Orphan*female	0.022	0.052	-0.046	0.051
Non-orphan*female	-0.026	0.043	-0.024	0.041
Household Characteristics				
Household size	-0.013	0.009	0.006	0.008
Adult works in formal sector	-0.110**	0.054	-0.587***	0.055
Adult works in farming sector	-0.162***	0.041	-0.160***	0.039
Adult works in trading sector	-0.189***	0.042	-0.179***	0.041
Quality of house is good or fair	-0.505***	0.040	-0.253***	0.039
Location of Interview				
Interview done at home	0.182**	0.086	-0.218***	0.083
Interview done at school	0.317***	0.099	-0.211***	0.097
Interview done in street	0.706***	0.095	-0.251***	0.092
Constant	-0.208**	0.106	0.222**	0.103
ρ (std. err.)	0.181*** (0.022)			
N	5752			

Note: *** Significant at the p < .01 level; ** significant at the p < .05 level; * significant at the p < .10 level.

Table 4.19 Bivariate probit analyses: Food insecurity

	I		**II**	
	Child food insecure		Adult food insecure	
Child Characteristics				
	Coef	S.E	Coef.	S.E
Age 6_9	0.125*	0.066	0.017	0.064
Age10_12	0.097	0.066	0.093	0.063
Age13_15	0.013	0.067	0.126**	0.063
Orphan*male	0.086	0.066	0.014	0.064
Orphan*female	0.141**	0.065	-0.010	0.064
Non-orphan*female	-0.015	0.056	0.003	0.052
Household Characteristics				
Household size	-0.011	0.011	0.002	0.010
Adult works in formal sector	-0.230***	0.074	-0.486***	0.074
Adult works in farming sector	-0.065	0.051	-0.260***	0.050
Adult works in trading sector	-0.059	0.054	-0.270***	0.053
Quality of house is good or fair	-0.287***	0.051	-0.075	0.049
Location of Interview				
Interview done at home	-0.111	0.101	0.025	0.104
Interview done at school	-0.109	0.118	0.076	0.121
Interview done in street	-0.142	0.113	-0.084	0.117
Constant	-0.985**	0.130	-0.998***	0.130
ρ (std. err.)	0. 232*** (0.032)			
N	5752			

CHAPTER FIVE

THE RELATIONSHIP BETWEEN CHILDHOOD OBESITY AND FOOD INSECURITY: A NONPARAMETRIC REGRESSION ANALYSIS

5.1 Introduction

Childhood obesity is a major public health concern in most developed countries throughout the world (Koplan, Liverman, & Kraak, 2005). In the United States, the problem is especially severe as recent estimates indicate that 16.3% of U.S. children are considered obese and another 15.6% are overweight (Ogden, Carroll, & Flegal, 2008). In addition to energy imbalance and genetic factors, environmental factors such as the availability of food can also cause a predisposition to obesity (Ebbeling, Pawlak, & Ludwig, 2002; Krebs et al., 2007; Parsons, Power, Logan, & Summerbell, 1999).

Another U.S. public health concern relates to the availability of food. Food insecurity is defined as the uncertainty of having, or the inability to acquire, enough food for all household members to sustain active, healthy living because of insufficient money or other resources (Nord, Andrews & Carlson, 2008). Approximately one in five children in the U.S. lives in a food insecure household (Nord, Andrews & Carlson, 2008). As with obesity, food insecurity has been shown to lead to a plethora of medical problems for children (Alaimo, Olson, Frongillo, & Briefel, 2001a; Alaimo, Olson, & Frongillo, 2001b; Cook et al., 2004; Daniels, 2006; Kleinman et al., 1998; Murphy et al., 1998; Skalicky et al., 2006; Slack & Yoo, 2005; Whitaker et al., 2006).

This study examines the relationship between childhood obesity and food insecurity using a nonparametric regression technique with two large nationally representative data sets

from the U.S.: The National Health and Nutrition Examination Survey (NHANES) and the Child Development Supplement (CDS) of the Panel Study of Income Dynamics (PSID). The research on the relationship between childhood obesity and food insecurity is mixed. Some studies have found a positive relationship (e.g. Dubois, Farmer, Girard, & Porcherie 2006; Casey, Szeto, Lensing, Bogle, & Weber, 2001; Jyoti, Frongillo & Jones, 2005; Casey, Simpson, Gossett, Bogle, Champagne, Connell, et al. 2006), others have found no relationship (e.g. Alaimo, Olson, Frongillo, & Briefel, 2001a; Kaiser, Melgar-Quiñonez, Lamp, Johns, Sutherlin, & Harwood, 2002; Martin & Ferris, 2007; Gundersen, Lohman, Eisenmann, Garasky, & Stewart, 2008; Bhargava, Jolliffe, & Howard, forthcoming, Gundersen, Garasky and Lohman, 2009), and others have found a negative relationship (e.g. Jimenez-Cruz, Bacardi-Gascon, & Spindler, 2003; Rose & Bodor, 2006; Matheson, Varady, Varady, & Killen, 2002). This work has used a variety of data sets and methods. Common to each of these papers is the use of parametric frameworks to examine the relationship.

This paper employs a nonparametric framework to study the relationship between obesity and food insecurity among low-income children. The analyses indicate that this relationship is nonlinear and complex. I find that relatively food secure children in this study are no more or less likely to be obese. However, among children who are more food insecure, the relationship is strongly positive. That is, the likelihood of being obese increases with greater food insecurity among low-income food insecure children. Additionally, this relationship varies across income-based and racial/ethnic subgroups.

I begin with a review of the literature related to childhood obesity and food insecurity, and how the two have been jointly examined. This review is followed by

discussions of these constructs, the nonparametric regression model, and the data being examined. A presentation of findings and conclusions complete the text.

5.2 Background

There has been a dramatic increase in the incidence of childhood obesity over the past few decades. Ogden et al. (2002, 2006, 2008) comprehensively studied the prevalence of obesity among children in the United States between 1963 and 2004 using The National Health and Nutrition Examination Surveys (NHANES). Their findings revealed a marked upward trend in the incidence of obesity in the U.S. from the 1960s to mid 2000s. The trend has since leveled off in the past four years. For children aged 6-11, obesity prevalence increased from about 4 % between 1963 and 1974, to 15.3 % by 1999-2000. The trend was very similar for children aged 12-19, increasing from 6.1 % in the early 1970s, to 15.5 % in 1999-2000.

There have been significant differences by racial groups. For example, African American and Hispanic children and adolescents have significantly higher rates of obesity prevalence than white children. In 1999-2000, about 26 % of white children aged 6-11 were overweight or obese (i.e., had BMIs over the 85^{th} percentile for age and gender). Comparable figures for African American and Hispanic children were 35.9 and 39.3 %, respectively. Between 2003 and 2006, almost 32 % of all children (aged 2-19) were overweight or obese. Prevalence rates for children aged 6-11 increased to 33.3 %, while the comparable figure among adolescents aged 12-19 was 34.1 %. Prevalence rates among white children increased to 30.7 % for children aged 6-11 between 2003 and 2006, compared to 34.9 % of black children, and 38 % of Hispanic children. These figures for black and Hispanic children

indicate a slight reduction in the rates of obesity or overweight between 2003 and 2006.

Overweight has been attributed to a variety of causes, including environmental and genetic factors. Among environmental factors, overweight has been linked to a sedentary lifestyle (Robinson, 2001). Several studies have found that overweight children spend less time in physical activities than children in lower BMI percentiles (Trost, et al. 2001; Andersen et al. 1998, Johnson et al. 2000). More specifically, excessive viewing of television and playing of video games have been blamed for decreased participation in physical activities by children (Robinson, 2001) and several studies have found a strong link between TV watching and increased BMI in children (Andersen et. al, 1998; Gortmaker, et al. 1996; Marshall et. al, 2004). Watching more than two hours of television or videos has been associated with being overweight or at risk for overweight (Mendoza, Zimmerman & Christakis, 2007). Among children from Mexico City, the risk of obesity increased by 12 % for each hour per day spent watching television (Hernandez et al. 1999).

Genetic factors have also been found to influence childhood obesity (Strauss &Knight, 1999; Maffeis, 1999; Farooq, 2005; Marti, Moreno-Aliaga, Hebebrand, & Martinez, 2004). There is some evidence that obese parents are more likely to have obese children (Strauss & Knight, 1999; Lake, Power & Cole, 1997), although there are questions as to whether this correlation is due to nature or nurture. Stunkard et al. (1986), in their study of Danish adoptees, found a strong relationship between the weight class of adoptees and the BMI of their biological parents, but no correlation between weights of adoptees and their adoptive parents. They concluded that genetics play an important role in determining BMI. In addition to the strong association between the BMI of offspring and parental BMI, high BMI gain in childhood for parents was associated with a higher BMI and an increased risk of

overweight/ obesity in the offspring (Li et al. 2009). The inheritability of weight has been estimated to be 78% based on a study of twins (Stunkard, Foch & Hruse, 1986). This means that 78 % of the variability in weight across a population is explained by shared intrafamilial genetic factors. More recent studies in Finland and the United Kingdom have also found the inheritability of BMI to be very high, estimating it to be between 60 and 80 % (Koeppen-Schomerus, Wardle & Plomin, 2001; Pietilainen et. al, 1999).

Overweight and obesity in children have immediate and long-term health consequences (Daniels, 2006; Ebbeling, Pawlak & Ludwig, 2002). Overweight has been associated with metabolic disorders in children (Daniels, 2006). These categories of diseases were long associated with adult obesity, but now are showing up in children at an alarming rate. These diseases include insulin resistance, the metabolic syndrome, dyslipidemia (abnormal levels of fat in the blood), and type 2 diabetes mellitus (Daniels, 2006; Ebbeling, Pawlak & Ludwig, 2002; Fagot-Campagna et al., 2000; Ludwig & Ebbeling, 2001; Klein et al., 2004). Overweight or obesity is also associated with dyslipidaemia, chronic inflammation, hypertension, increased blood clotting tendency, hyperinsulinaemia and endothelial dysfunction. These symptoms combined are called the insulin resistance syndrome, and put the individual at risk for cardiovascular disease (Ebbeling, Pawlak & Ludwig, 2002; Freedman et al., 1999; Greenhalgh, 1997; Srinivasan et al. 2002). Overweight or obesity has also been known to lead to pulmonary complications and skeletal abnormalities in children. Most common among pulmonary complications are sleep apnea (Patel, 2005, Redline et. al, 1999, Rhodes et al. 1995), and asthma (Figueroa-Munoz, Chinn & Rona, 2001; Luder, Melnik, & DiMaio, 1988). Skeletal abnormalities of note include Blount disease, a mechanical deficiency in the medial tibial growth plate in adolescents that

results in bowing of the tibia, a bowed appearance of the lower leg, and an abnormal gait (Daniels, 2006; Dietz, Gross & Kirpatrick, 1982), and capital femoral epiphysis, a disorder of the femur which is rotated externally from under the growth plate, causing pain, creating difficulty in walking, and often requiring surgical repair (Daniels, 2006; Loder et al. 1993).

Besides the physical consequences of disease, obese children also often suffer emotionally and psychologically. Many obese children have been found to develop a negative self-image (Davison & Birch, 2001), have trouble making friends (Strauss & Pollack, 2003), and be more likely to develop depressive symptoms (Strauss, 2000; Ebbeling, Pawlak & Ludwig, 2002). In summary, the physical and psychological conditions associated with overweight and obesity lead obese children to live a decreased quality of life, and very often results in reduced life expectancy among these children.

Food insecurity

Food insecurity is defined as the uncertainty of having, or the inability to acquire, enough food for all household members to sustain active, healthy living because of insufficient money or other resources (Nord, Andrews & Carlson, 2008). In 2007, 11.1 % of the U.S. population was found to be food insecure (Nord, Andrews & Carlson, 2008). Households with incomes below the poverty line had a food insecurity rate of 37.7 % which was substantially higher than the national average. Other groups with higher than average food insecurity rates included households with children headed by single women (30.2 %) or single men (18.0 %); households headed by a black person (22.2 %) and households headed by a Hispanic person (20.1 %). Overall, households with children reported food insecurity at about double the rate for households without children (15.8 vs. 8.7 %).

These characteristics reveal that food insecurity is closely associated with insufficiency of resources. Food insecurity has been found to be strongly correlated with many other measures of deprivation including low and fluctuating incomes (Alaimo, Olson, Frongillo, & Briefel, 2001a; Rose, 1999; Gundersen & Gruber, 2001; Ribar & Hamrick, 2003), homelessness (Gundersen, Weinreb, Wehler, & Hosmer, 2003; Meyers et. al, 2005; Whitbeck, Chen & Johnson, 2005), lack of savings (Olson, Rauschenbach, Frongillo & Kendall, 1996; Rose, 1999), past and present unemployment and unstable employment (Sarlio-La¨hteenkorva & Lahelma, 2001), and lower levels of social capital (Martin, Rogers, Cook, & Joseph, 2004). Poor health, including physical disabilities, has a negative association with an individual's ability to acquire food, and thus increases the level of food insecurity, especially with the elderly (Klesges, et al. 2001). Depression among mothers is also associated with loss or reduction of welfare support, which leads to an increase in food insecurity (Casey et. al, 2004). Family structure is also an important factor – as children in cohabiting families experience lower levels of food insecurity than children in single parent families, but significantly higher levels of food insecurity than children in married two biological parent families (Acs & Nelson, 2002).

As with obesity, food insecurity has been shown to lead to a range of medical problems for children, including diminished psychosocial functioning (Kleinman et al., 1998), frequent stomachaches and headaches (Alaimo et al., 2001a), worse health outcomes (Cook, Frank, Berkowitz, Cook, Frank, Berkowitz, et al., 2004), increased odds of being hospitalized (Cook et al., 2004), higher levels of hyperactivity (Murphy et al., 1998), greater propensities to have seen a psychologist (Alaimo, Olson, & Frongillo, 2001b), behavior

problems (Slack & Yoo, 2005; Whitaker, Phillips, & Orzol, 2006), and higher levels of iron deficiency with anemia (Skalicky, Meyers, Adams, Yang, Cook, & Frank, 2006).

Connections between childhood obesity and food insecurity

On the surface, one might imagine that childhood obesity and food insecurity would be inversely related insofar as reductions in food intakes would be expected to lead to reductions in weight. Clearly, in the extreme, low food intakes will lead to declines in weight as is seen in developing countries. Dietz (1995), however, initiated a line of research that challenged this expected assumption and pondered on a positive relationship. Having noticed the paradox of hunger and obesity coexisting in the same individual, Dietz suggested that cyclical food restriction and binge eating may lead to this phenomenon, however leaving the proof of his hypothesis to succeeding researchers.

The paradoxical and counter intuitive positive relationship between childhood obesity and food insecurity has since been extensively investigated in the literature. Two major pathways, as suggested by Dietz (1995), have been confirmed by larger studies (Casey et. al, 2006). The first is binge eating based on a variable food availability cycle (Townsend, Peerson, Love, Achterberg, & Murphy, 2001), which has been linked to an increase in body fat and a decrease in lean muscle mass (Dinour et al. 2007, Dietz, 1995). Individuals tend to overeat when food is available, and thus gain weight despite the fact that they face instances when they cannot eat due to a limited availability of food (Polivy, 1996; Wilde & Ranney, 2000; Polivy & Herman, 1985; Polivy, Zeitlin, Herman, & Beal 1994).

The second, better known, pathway is the consumption of lower cost energy dense foods (Drewnowski & Specter, 2004; Dietz, 1995). Low-income individuals who find fresh healthy food unaffordable tend to eat cheaper, but less healthy, foods that are high in calories

and lead to obesity. In addition, these dense, cheap and convenient foods are of lower dietary quality and variety, and tend to contain fewer fruits, vegetables or healthy sources of dairy (Bronte-Tinkew et al., 2007; Kaiser & Melgar-Quiñonez, 2003; Casey et al. 2001).

More recent evidence confirms these findings. The binge-eating cycle has been more recently associated with the food stamp cycle (Dinour, et al. 2007), which refers to a 3-week period of overeating followed by a week of food restrictions, followed by more overeating when the monthly food stamp allotment is once again available. This cycle of feast and famine has been found to lead to increased rates of obesity among individuals who can be described as food insecure (Dinour et al. 2007; Townsend et al. 2001; Wilde & Ranney, 2000). In addition, increased consumption of more energy dense foods (Cavadini & SigaRiz, 2000; Kant, 2000; Putnam, Allhouse & Kantor, 2002; Basiotis & Lino, 2002; Adams, Grummer-Strawn & Chavez, 2003; Parker, 2007), high rates of consumption of caloric beverages with high sugar content, and increased snacking between meals (Zizza, Siega-Riz & Popkin, 2001; Ludwig, Petersen & Gortmaker, 2001) have all been found to contribute tremendously to the obesity epidemic.

Overall, the evidence about the relationship between childhood obesity and food insecurity is mixed. Consistent across this research is the use of parametric frameworks to examine this relationship. Parameteric frameworks assume that the data utilized were drawn from a particular distribution (e.g. normal, logistic). Parametric methods used to examine the relationship between childhood obesity and food insecurity have included fixed effects models (e.g., Jyoti, Frongillo & Jones, 2005) and multivariate logistic regression (e.g., Rose & Bodor, 2006) among several others. This study advances the understanding of this

relationship by using a methodology, nonparametric regression, that avoids being restricted to a particular distributional assumption.

5.3 Methodology

Measuring child weight status and food insecurity

The measurement of childhood obesity begins with measuring a child's height and weight. From this information, one can calculate a body mass index (BMI, kg/m2). As children's height and weight naturally increase with age and differ by gender, BMI is mapped into a percentile using age- and sex-specific reference values of the CDC growth charts for the U.S (Ogden, Carroll & Flegal, 2008). This is referred to as 'BMIPER' below.

Food insecurity status is derived from the methodology employed to calculate official food insecurity rates in the U.S. The USDA developed a set of 18 questions for households with children (10 for households without children) known as the Core Food Security Module (Nord, Andrews & Carlson, 2007). Some of the conditions respondents are asked about include "I worried whether our food would run out before we got money to buy more," (the least severe item), "Did you or the other adults in your household ever cut the size of your meals or skip meals because there wasn't enough money for food," "Were you ever hungry but did not eat because you couldn't afford enough food," and "Did a child in the household ever not eat for a full day because you couldn't afford enough food" (the most severe item for households with children). All 18 questions are provided in appendix one. Each of these questions is qualified by the proviso that the condition is due to financial constraints. As a consequence, individuals who have reduced food intakes due to, say, fasting for religious

reasons or dieting, would not be responding affirmatively to these questions. Food insecurity status is referred to as 'FI' below.

Nonparametric regression

Parametric regression analyses have a number of assumptions regarding the structure of the relationship between two or more variables of interest. For example, linear least squares regression assumes that the relationship between the variables is linear, the errors are normally distributed with constant variance, and the observations are sampled independently (Fox, 2000). Nonparametric regression does not require these assumptions and does not attempt to specify the form of the regression function. Instead, the weaker assumption of a smooth regression function is used with results typically presented graphically.

In this study, the general form of the relationship is expressed as:

$$BMIPER_i = f(FI_i) + \varepsilon_i \quad (5.1)$$

where i is a child, BMIPER and FI are as defined above, and ε is an error term.

While many methods of nonparametric regression exist, including kernel estimation and wavelength thresholding, I employ local polynomial regression because of its intuitive nature and wide availability across most statistical packages (Di Matteo, 2003). More specifically, locally weighted scatterplot smoothing (LOWESS) is utilized. LOWESS can be described as a series of overlapping locally weighted regressions (Di Matteo, 2003). For any given *i*, I estimate a linear regression with a fraction of the data around *i* called the local neighborhood. The size of the local neighborhood is called the *bandwidth.* Local polynomial regression estimation builds upon kernel estimation (locally weighted averaging) techniques which give greater weight to observations that are closer to the focal *i* and less weight to more remote observations (Statacorp, 2007).

In this study, the children are ordered by their FI values such that:

$FI_i \leq FI_{i+1}$ for i=1,…,N-1 (5.2)

where N is the number of children in the sample. Children with equal FI values are randomly ordered. For each value of $BMIPER_i$ a predicted value of $BMIPER_i$ ($BMIPER_i$') is calculated with coefficients derived from a linear regression model estimated with neighboring observations (children with corresponding values of BMIPER and FI). Specifically,

$BMIPER_i' = a' + b'(FI_i)$ (5.3)

The number of neighboring observations used to estimate (5.3) and calculate each $BMIPER_i$' is based on the selected bandwidth. Observations $i_- = \max(1, i-k)$ to $i_+ = \min(i+k, N)$ are used

where $k = \frac{N * bandwidth - 0.5}{2}$ (5.4)

Additionally, the observations are weighted in each regression such that greater weight is placed on observations closest to *i*. The weights for each observation *j* where $j = i_-, \ldots\ldots, i_+$ are defined by the following:

$$W_j = \left\{ 1 - \frac{\left|FI_j - FI_i\right|^3}{1{,}001 * \max\left(FI_{i+} - FI_i, FI_i - FI_{i-}\right)} \right\}^3 \quad (5.5)$$

Each $BMIPER_i$' is estimated using weighted values of FI_i in the estimation of (5.3) on the range of observations determined by the selected bandwidth.

Bandwidth selection

The bandwidth determines how many observations are in the neighborhood of the focal observation *i*. A bandwidth of 0.2, for example, means that the local neighborhood around *i* for the estimation of equation (5.3) includes 20 % of the total observations in the

study. The size of the bandwidth is very important as it determines the "smoothness" of the graphical results. A bandwidth that is too small leads to a graph that is too "rough", while a bandwidth that is too large may lead to oversmoothing and cover up important trends. While Fox (2000) contends that choosing a bandwidth is a little bit of an art, others (e.g., Grogger, 2007) encourage selection via the more rigorous process of cross validation.

The aim of cross validation when choosing an optimal bandwidth is to balance two statistical issues - bias and variability (Grogger, 2007). The bias of the estimate is the difference between the conditional population mean of the estimate ($\mu|fi_0$) and the estimator itself E(BMIPER|fi_0). Regarding variability, a narrow bandwidth results in relatively less data contributing to each sample average $\overline{bmiper}$, producing highly variable sample averages (Fox, 2000). Thus, while a narrow bandwidth reduces the bias of the estimate it leads to greater variability in the estimation of the predicted values. The opposite occurs with a bandwidth that is too wide –the variability of the estimate is minimized, but the bias is increased. The optimal bandwidth trades off between bias and variability.

Balancing bias and variability in practical terms means choosing the bandwidth that minimizes the mean squared error (MSE) of the estimator (Fox, 2000). The MSE of the estimator can be defined as:

$$\text{MSE}\left(\hat{b}miper \mid fi_o\right) = E\left[\left(\hat{b}miper \mid fi_o - \mu \mid fi_0\right)^2\right] \qquad (5.6)$$

where the right hand side is the sum of the variance and squared bias (Fox, 2000). The process is repeated at each focal value of *x* for which f(*fi*) = $\mu|fi$ is to be estimated. For these purposes, the mean square error is calculated as $\frac{1}{n}\sum_{i=1}^{n} e_i^2$; where $e_i = BMIPER_i - \hat{B}MIPER_i$.

5.4 Data

Two large nationally representative data sets from the U.S. are utilized for these analyses for comparative purposes. The National Health and Nutrition Examination Surveys (NHANES) is a program of studies conducted by the National Center for Health Statistics, Centers for Disease Control (NCHS/CDC) to assess the health and nutritional status of adults and children in the United States. NHANES examines a nationally representative sample of about 5,000 persons each year, about half of whom are children. Height and weight are measured with an automated data collection system by a trained technician in NHANES mobile examination centers. With respect to food insecurity, children are classified into four food security categories based on responses to the 18 questions in the Core Food Security Module (CFSM). The categories are food secure (FS), marginally food secure (MFS), food insecure without hunger and food insecure with hunger.[6] It is important to note that the NHANES data released to the public do not provide the responses to the full set of 18 CFSM questions, but only provide data for the four categories mentioned above. Data for this study come from the 1999-2002 NHANES.

We also analyze data from the Child Development Supplement (CDS) of the Panel Study of Income Dynamics (PSID). The PSID, begun in 1968, is a longitudinal study of a representative sample of individuals and the family units which reside in the United States. In 1997, a refresher sample of post-1968 immigrant families and their adult children was introduced to keep the study representative of the U.S. population. A major content

[6] These categories were recently renamed by the USDA. While the first two labels remain unchanged and remain food secure and marginally food secure, the last two have been renamed as follows: **food insecurity without hunger** – now called *low food security*, and **food insecurity with hunger** – currently *very low food security*. The categorizations are arrived at via the same methodology, only the labels were changed (ERS, 2009).

expansion was introduced in 1997 as well. The Child Development Supplement (CDS) focuses on the human capital development of children age 0-12 in PSID families (PSID, 2005). A second round of the CDS (CDS-II) was conducted in 2002. CDS-II measures of children's height and weight were obtained by trained personnel (e.g., nurses or field interviewers). The 2003 PSID administered the full 18-question Core Food Security Module (Bickel, Nord, Price, Hamilton, & Cook, 2000) and made these data publicly available. The Core Food Security Module (CFSM) has been found to be highly reliable and valid with a Cronbach's alpha of 0.856 with extreme values and 0.743 with extreme values excluded (Hamilton et al., 1997).

We examine both data sets as the NHANES provides a much larger sample of children relative to the CDS/PSID. The CDS/PSID, however, provides a more precise evaluation of food security status relative to the NHANES.

Study samples

Since food insecurity is rare among households above 200% of the poverty line, the sample for each data set was limited to households below this threshold (Nord, Andrews & Carlson, 2008). The study sample for the NHANES is 6724 children. The sample for the CDS is 959. To examine how the relationship might vary across groups, I analyzed a series of subsamples along with the full samples. I present results for the full study sample as well as for white children, black children, Hispanic children, children in households with incomes below the poverty line, and children in households with incomes between 100 and 200 % of the poverty line.

5.5 Results

Descriptive information

Tables 5.1 and 5.2 present descriptive information for all demographic subgroups represented in this analysis. Information on average BMI percentiles (table 5.1), and food insecurity categories (table 5.2) is presented for both data sets. Please note that the results will be discussed utilizing the new food insecurity labels: food secure (FS), marginally food secure (MFS), low food secure (LFS) and very low food secure (VLFS). As seen in table 5.1, on average, low-income children in the NHANES dataset are at about the 64^{th} BMI percentile for their age and gender with white children reporting the lowest average percentile and Hispanic children the highest. This is slightly higher than the mean for the full sample of children regardless of income (63.17). The pattern is similar for the CDS data, where the mean BMI percentile for the full sample of children is 65.72, while the comparable mean for all children below 200 percent of the poverty line is 67.04. As in the NHANES, for the group of low income children, white children report the lowest average BMI percentiles, while Hispanic children report the highest.

This pattern is repeated for food insecurity and is similar for both data sets (table 5.2). While the majority of the children are food secure, there are wide differences by race and economic status. White children have the lowest rates of food insecurity, while Hispanic children have the highest rates. Also, the percentage of children below the poverty line in low food secure households is about double that of children in households between 100 and 200 percent of the poverty line. The pattern is very similar for children who report very low food security, except the percentages are lower and black children have the highest rates of very low food security.

Tables 5.3 and 5.4 provide parametric regression results that are provided for comparative purposes. In table 5.3, results are presented for a simple regression of BMI percentile on each of the food insecurity categories for the NHANES data set. Compared to food secure children (the omitted category), children in very low food secure households are significantly more likely to be associated with a higher BMI percentile. In table 5.4, a similar regression using the CDS is carried out, this time based on the number of food insecurity questions answered in the affirmative. In general, there is no apparent relationship between the food insecurity indicators and BMI percentile, with the exception of children in households which answered nine food insecurity questions affirmatively. They were significantly more likely than food secure children (in households that provided zero affirmative responses (the omitted category)) to be associated with a higher BMI percentile.

Nonparametric regression results

I first establish the bandwidth for the regressions. I do this by estimating the mean squared error for bandwidths ranging from 0.1 to 0.9 in intervals of 0.1 (table 5.5). This process is carried out separately for the NHANES and CDS data sets. In both cases, the optimal bandwidth is 0.5. While the process requires selecting a bandwidth with the lowest MSE, this is balanced against the number of valid observations. Invalid observations exist because there is lack of sufficient variability within some bandwidth limits to create predicted values. Consequently, for both data sets, I pick the bandwidth (0.5) with the lowest MSE, where over 60 % of the observations are valid in the nonparametric regressions. At this bandwidth, MSE is declining.

As earlier noted, the representation of food insecurity in the NHANES data set is limited to the four food insecurity categories. In figure 5.1, BMI percentile is on the vertical

axis, while the food insecurity categories are on the horizontal axis with values ranging from one (food secure), to four (very low food security). The first graph presents the nonparametric results for all children and appears to be rather flat, which would hint at no relationship between the two variables. However, on closer scrutiny, it seems that there is an uptick in the graph between categories three (low food security (LFS)) and four (very low food security (VLFS)), showing a positive relationship between the two variables in that region. Figure 5.2 presents a similar graph for all children, this time using the CDS which contains the full set of 18 food insecurity questions. For comparison to figure 5.1, the USDA defines a household as food secure if it responds affirmatively to zero questions; as marginally food secure if it responds affirmatively to one or two questions; as low food secure if it responds affirmatively to three to seven questions, and as very low food secure if it responds affirmatively to eight or more questions. The relationship depicted in Figure 5.2 is similar to that in figure 5.1. The line is relatively flat until the VLFS region is reached, and is positive thereafter.

Figure 5.3 presents the same information by race of children using the NHANES. With the exception of black children, for whom there is no apparent relationship between the two variables, the graphs for white and Hispanic children reveal an uptick once again around the LFS and VLFS regions. The equivalent graph using the CDS (figure 5.4) reveals a very strong positive association between the two variables. For white children, the graph begins to swing upwards from about 6 affirmative questions (the low food secure region), and remains positive for the rest of the graph. For Hispanic children, the graph shows some cyclical behavior, rising and falling, but is once again showing a positive association in the LFS region. For black children, the relationship is basically flat (as it was in the NHANES).

The third group of graphs examines this relationship by socio-economic status. Using the NHANES (figure 5.5), for children below the poverty line, the graph is unambiguously flat until the LFS and VLFS regions. It then it swings upwardly very sharply, showing a strong positive relationship between BMI percentile and food insecurity in that region. For children between 100 and 200 % of the poverty line, the relationship seems to be slightly negative, as we move from food secure to very low food secure children. In the equivalent graphs using the CDS (figure 5.6), the positive association between children facing severe food insecurity and BMI percentile is once again unambiguous, even for children between 100 and 200 % of the poverty line, although the association is stronger for children in poverty.

5.6 Conclusion

Previous work on the relationship between childhood overweight and food insecurity has reached mixed conclusions. The work in this paper departs from this previous work by considering a specification of this relationship with nonparametric models. Moreover, two data sets (NHANES and CDS) that are nationally representative of the United States are used. Additionally, both data sets provide precise information on child height and weight and information derived from the full set of CFSM questions.

Findings from the nonparametric regressions reveal a relationship between food insecurity and childhood obesity that is nonlinear and complex. More specifically, there is a strong positive association between food insecurity and age-gender based BMI percentile for children who are low food secure or very low food secure. In addition, this positive association is consistent across a range of racial and socio-economic subgroups.

Understanding the relationship between food insecurity and childhood obesity has significant policy implications. If there is a positive relationship, this indicates that efforts to combat food insecurity are likely to be associated with reductions in childhood obesity as well. The results found here indicate that there may be a positive association for low-income food insecure children. If so, this would then raise the benefits in any cost-benefit analysis of efforts to reduce food insecurity or childhood obesity among these children. If instead the relationship were insignificant as it appears to be among relative more food secure low-income children, then there would be no spillovers from addressing food insecurity or childhood obesity independently.

Our findings are of particular importance for the U.S. Food Stamp Program (now called the Supplemental Nutrition Assistance Program -- SNAP). The central goal of SNAP -- the largest food assistance and the largest near-cash entitlement program in the United States -- is to alleviate food insecurity and hunger in the United States (U.S. Department of Agriculture, Food and Nutrition Service, 1999). Food stamps have arguably been successful in meeting this goal (Borjas, 2004; Gundersen & Kreider, 2008; Gundersen & Oliveira, 2001; Yen, Andrews, Chen, & Eastwood, 2008). One of the ancillary benefits of reducing food insecurity through the Supplemental Nutrition Assistance Program may be reductions in childhood obesity.

Table 5.1 Descriptive statistics: BMI percentile

	NHANES		CDS	
	Mean	SE	Mean	SE
Full sample				
All children	63.175	0.003	65.717	0.006
N	8410		2540	
Children below 200 percent of the poverty line				
All Children	64.119	0.363	67.039	0.942
White Children	60.987	0.562	63.823	1.994
Black Children	63.547	0.809	67.562	1.196
Hispanic Children	67.811	0.619	69.293	2.722
Less than 100 % of the poverty line	64.263	0.529	67.715	1.389
Between 100 and 200 % of the poverty line	63.988	0.498	66.532	1.278
N	6724		959	

Notes: Data are taken from the 1999-2002 National Health and Nutrition Examination Survey (NHANES) and the second Child Development Survey CDS-II of the Panel Study of Income Dynamics (PSID).

Table 5.2 Descriptive statistics: Food insecurity status (%)

	NHANES				CDS			
	Food secure	Marginally food secure	Low Food Secure	Very low food secure	Food Secure	Marginally food secure	Low food secure	Very low food secure
All Children	54.730	13.240	20.320	10.950	67.470	11.990	14.390	6.150
White Children	62.810	10.310	14.880	11.050	71.300	8.520	15.700	4.480
Black Children	52.060	15.900	18.530	13.130	66.900	14.080	12.320	6.690
Hispanic Children	43.890	16.640	28.540	10.250	65.000	7.500	20.830	6.670
Less than 100 % of the poverty line	40.790	15.760	27.470	14.970	61.070	11.920	16.790	10.220
Between 100 and 200 % of the poverty line	67.330	10.960	13.840	7.300	72.260	12.040	12.590	3.100
N	6724				959			

Notes: Data are taken from the 1999-2002 National Health and Nutrition Examination Survey (NHANES) and the second Child Development Survey (CDS-II) of the Panel Study of Income Dynamics (PSID). Based on responses to the 18-question Core Food Security Module, a child is defined as food secure if the household responds affirmatively to zero questions; as marginally food secure if the household responds affirmatively to one or two questions; as low food secure if the household responds affirmatively to three to seven questions, and as very low food secure if the household responds affirmatively to eight or more questions.

Table 5.3 Simple ordinary least squares regression of food insecurity and BMI percentile: NHANES

	BMI percentile	
Food insecurity categories		
	Coeff.	Std Err.
Marginally Food secure	1.147	1.109
Low Food Secure	-0.038	0.940
Very Low Food Secure	4.258***	1.199
Constant	63.508	0.486
N	6724	
R^2	0.0020	

Note: *** Significant at the p < .01 level; ** significant at the p < .05 level; * significant at the p < .10 le

Table 5.4 Simple ordinary least squares regression of food insecurity and BMI percentile: CDS

	BMI percentile	
Number of questions answered affirmatively		
	Coeff.	Std Err.
one	1.203	2.993
two	-0.356	3.754
three	3.715	4.840
four	1.467	4.576
five	2.977	5.659
six	1.431	5.758
seven	-11.820	6.352
eight	-5.676	9.818
nine	19.347**	9.323
ten	-5.621	7.907
eleven	4.228	8.897
twelve	-8.993	13.126
thirteen	1.056	14.662
fourteen	-6.895	20.699
fifteen	9.724	20.699
sixteen	30.228	20.699
constant	66.704***	1.238
N	959	
R^2	0.0138	

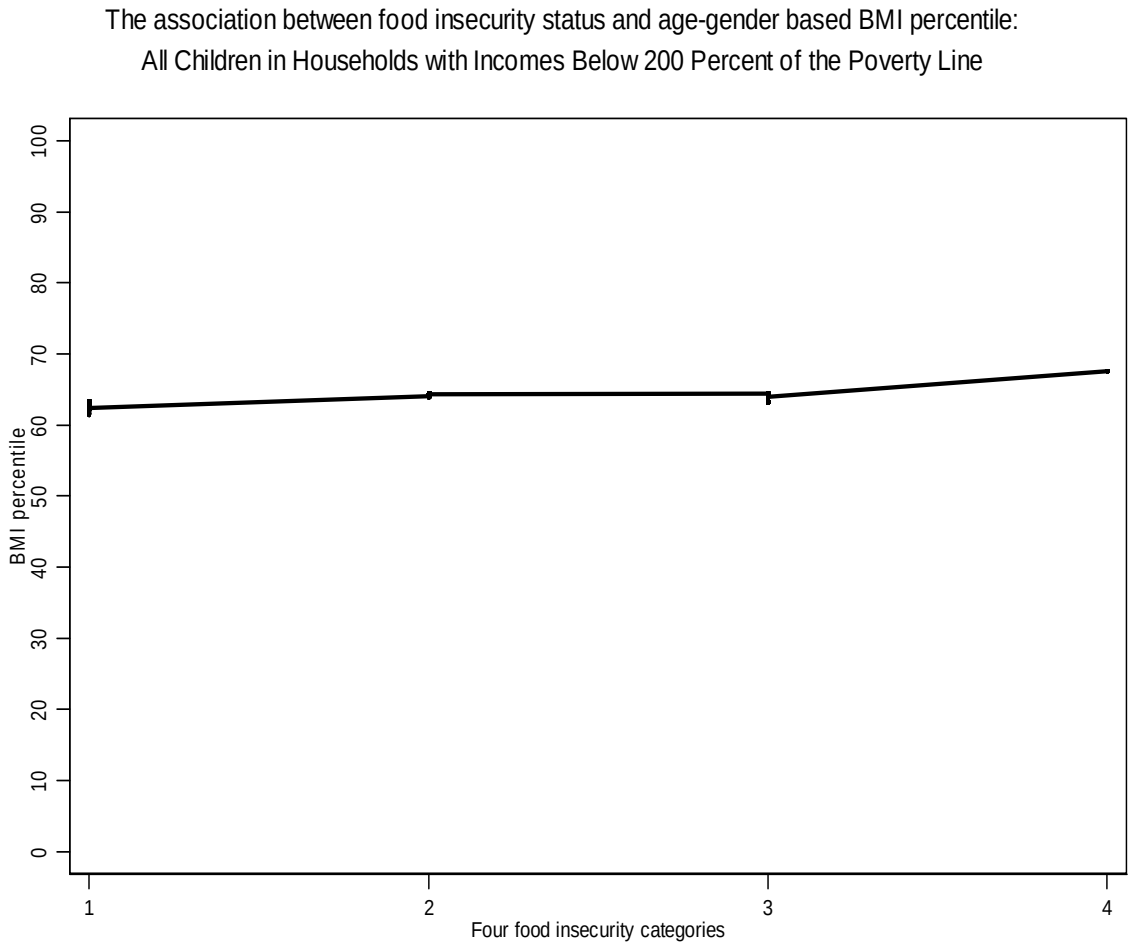
Note: *** Significant at the p < .01 level; ** significant at the p < .05 level; * significant at the p < .10 level.

Table 5.5 Choosing the optimal bandwidth

	NHANES		CDS	
Bandwidth	Mean square error	Valid observations	Mean square error	Valid observations
0.1	839.78	1998 (29.7%)	804.13	428 (44.6%)
0.2	859.08	3554 (52.8%)	833.83	497 (51.8%)
0.3	859.19	3992 (59.4%)	835.91	545 (56.8%)
0.4	861.98	4326 (64.3%)	843.54	593 (61.8%)
0.5	**861.03**	**4659 (69.3%)**	**839.50**	**641 (66.8%)**
0.6	861.56	4993 (74.3%)	840.59	689 (71.8%)
0.7	870.92	5326 (79.2%)	845.97	737 (76.9%)
0.8	876.70	5660 (84.2%)	845.17	785 (81.9%)
0.9	879.11	5994 (89.1%)	846.66	833 (86.9%)
N	6724		959	

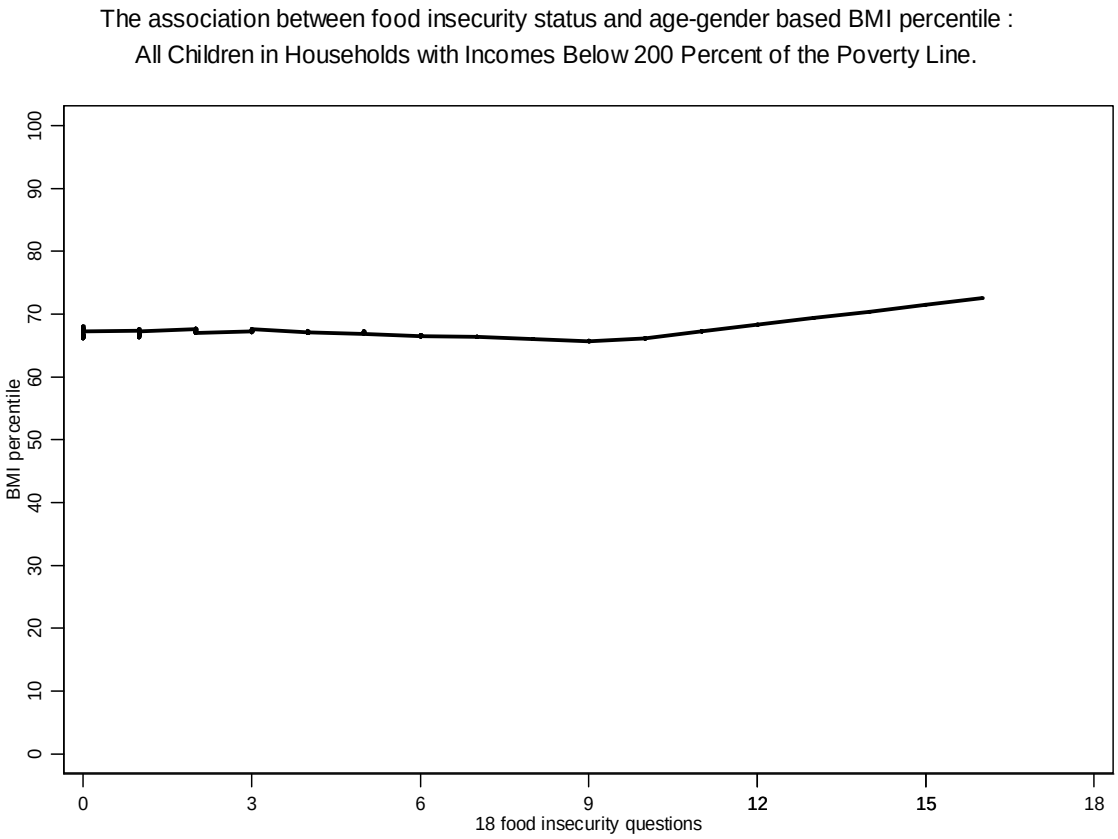
Note: percentage of valid observations in parentheses.

Figure 5.1 Non-parametric graphs for all children: NHANES



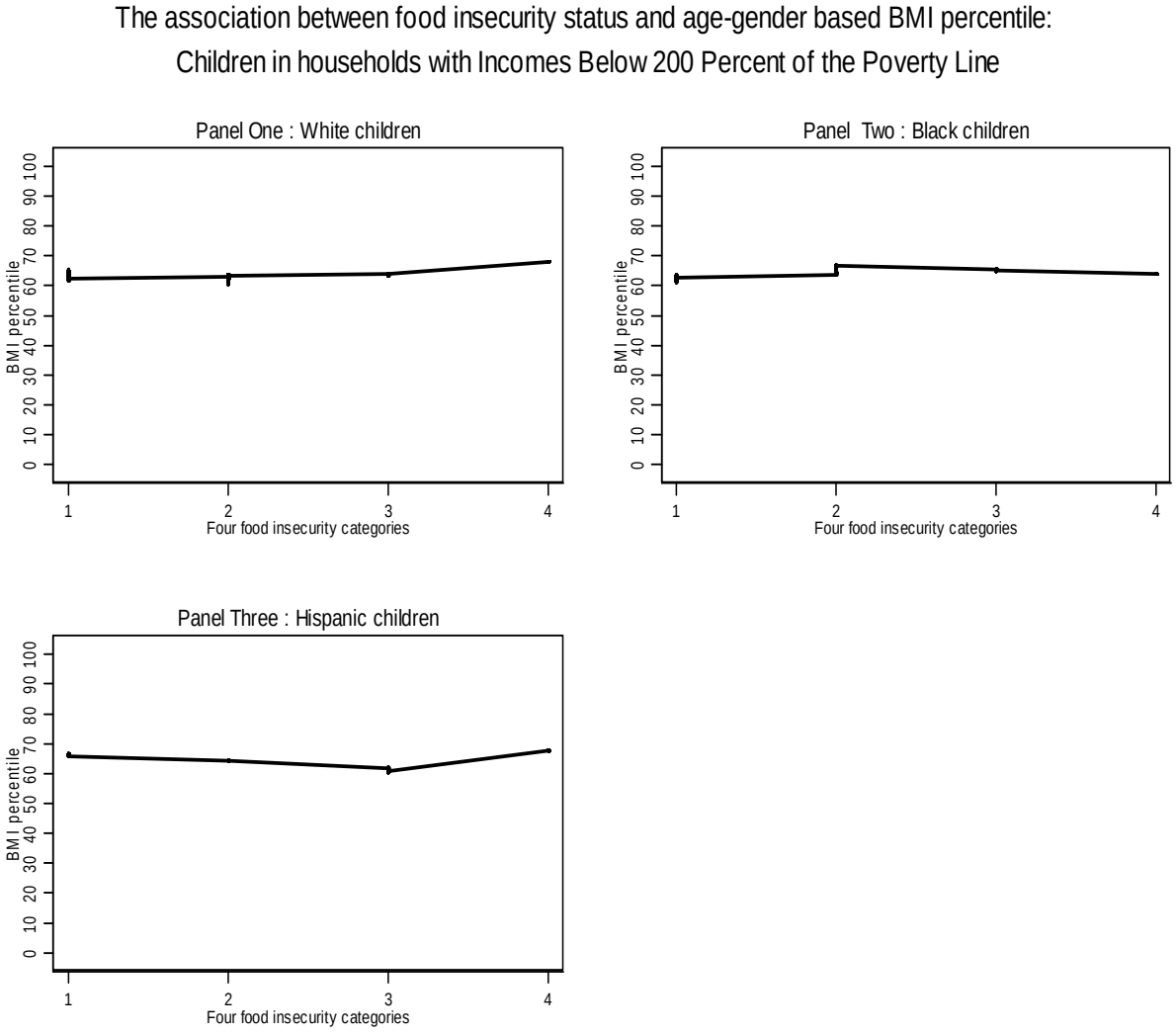
Note: The four food insecurity categories are as follows: 1 is food secure; 2 is marginally food secure; 3 is low food secure; 4 is very low food secure.

Figure 5.2 Non-parametric graphs for all children: CDS



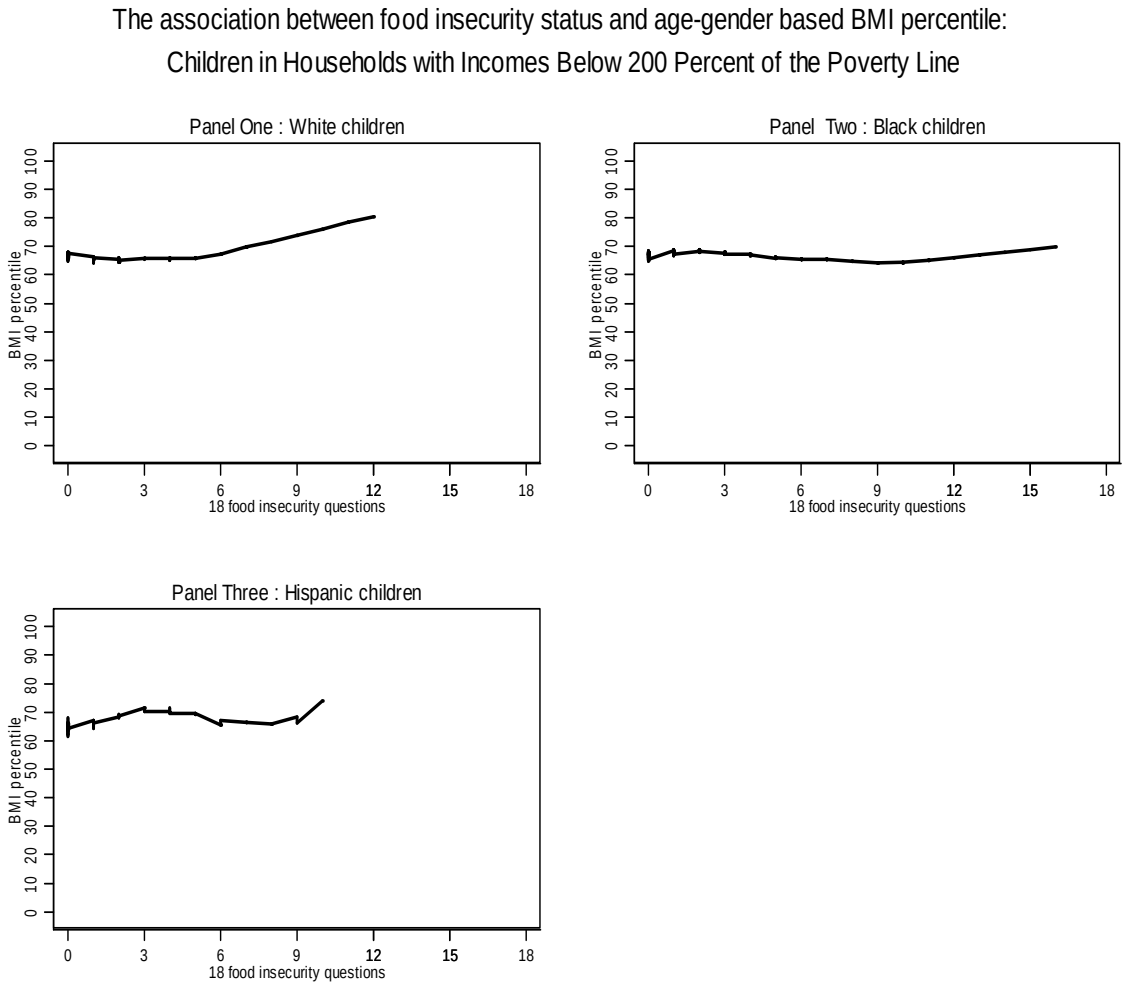
Note: Based on responses to the 18-question Core Food Security Module, a child is defined as food secure if the household responds affirmatively to zero questions; as marginally food secure if the household responds affirmatively to one or two questions; as low food secure if the household responds affirmatively to three to seven questions, and as very low food secure if the household responds affirmatively to eight or more questions.

Figure 5.3 Non-parametric graphs by racial categories: NHANES



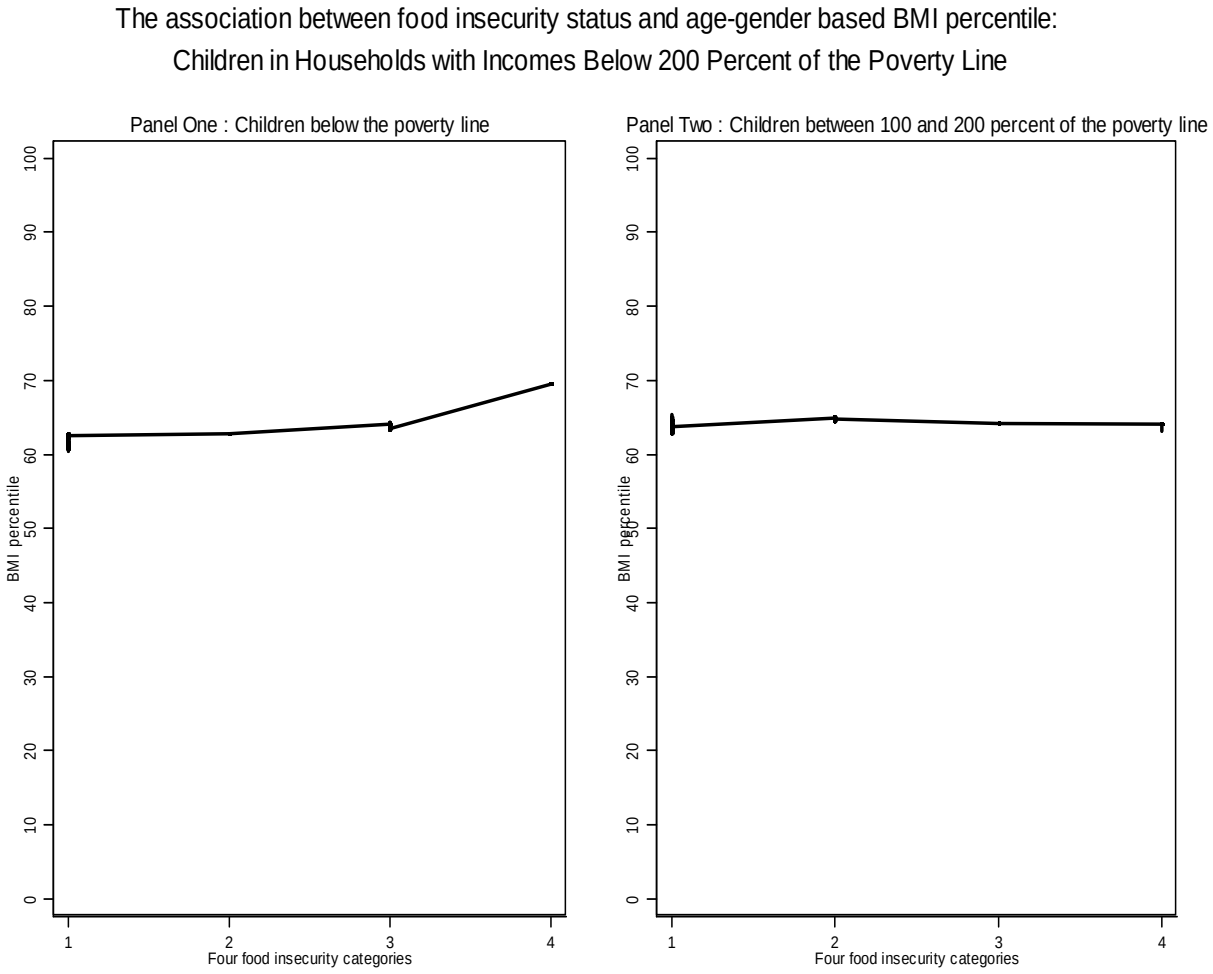
Note: The four food insecurity categories are as follows: 1 is food secure; 2 is marginally food secure; 3 is low food secure; 4 is very low food secure.

Figure 5.4 Non-parametric graphs by racial categories: CDS



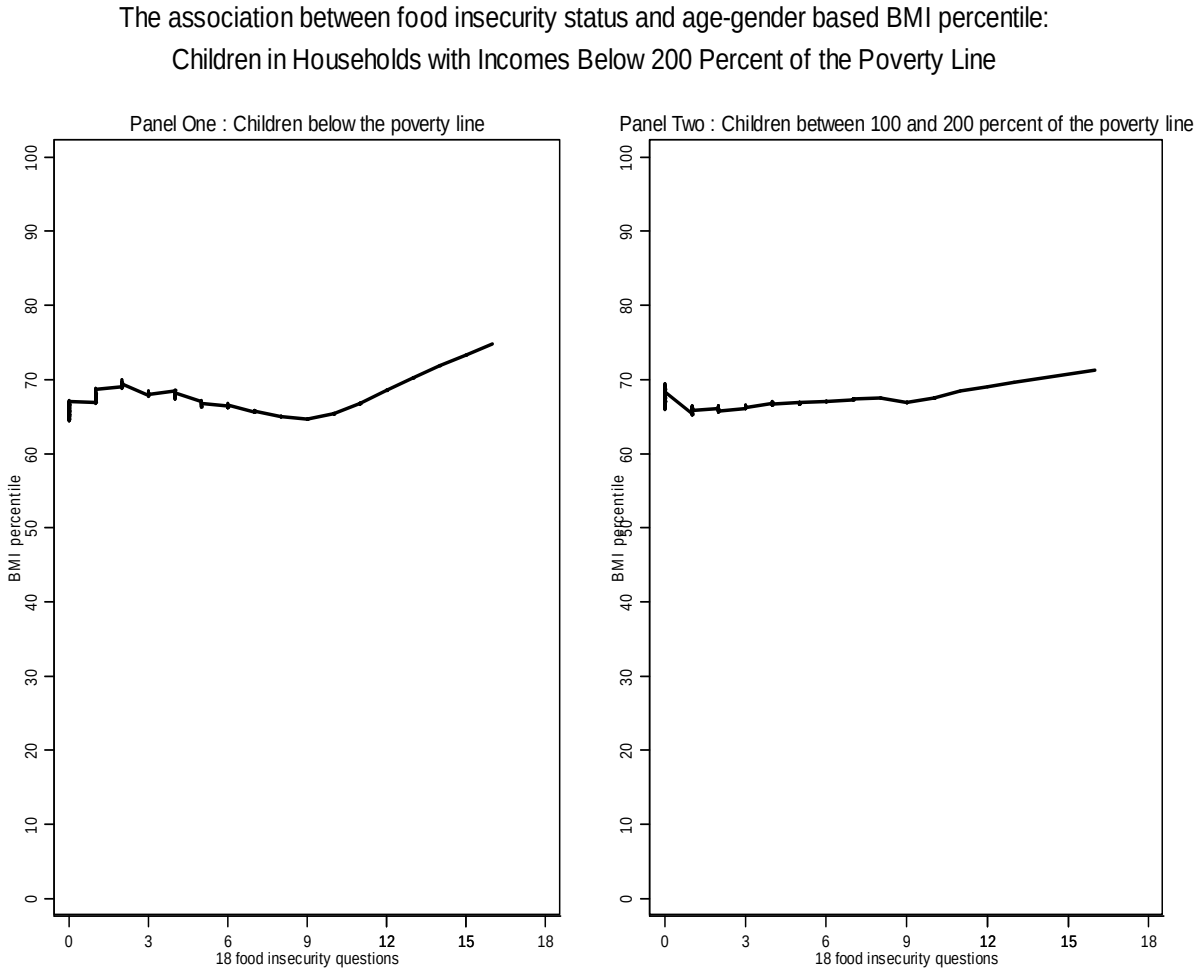
Note: Based on responses to the 18-question Core Food Security Module, a child is defined as food secure if the household responds affirmatively to zero questions; as marginally food secure if the household responds affirmatively to one or two questions; as low food secure if the household responds affirmatively to three to seven questions, and as very low food secure if the household responds affirmatively to eight or more questions

Figure 5.5 Non-parametric graphs by income categories: NHANES



Note: The four food insecurity categories are as follows: 1 is food secure; 2 is marginally food secure; 3 is low food secure; 4 is very low food secure.

Figure 5.6 Non-parametric graphs by income categories: CDS



Note: Based on responses to the 18-question Core Food Security Module, a child is defined as food secure if the household responds affirmatively to zero questions; as marginally food secure if the household responds affirmatively to one or two questions; as low food secure if the household responds affirmatively to three to seven questions, and as very low food secure if the household responds affirmatively to eight or more questions

CHAPTER SIX

GENERAL CONCLUSIONS

6.1 Summary

The papers in this dissertation were aimed at investigating three major issues that affect the welfare of children. These are the intra-household allocation of resources, food insecurity and obesity. The questions of food insecurity and intra-household allocation were investigated in Zimbabwe, while the relationship between food insecurity and obesity was investigated in the United States. Analyses of these issues were carried out via three papers found in chapters 3, 4 and 5.

Paper 1: *Are there differences in the allocation of food resources between boys and girls within households in Zimbabwe?*

Using data from a 2004 household-based survey, differences between boys and girls in self-reports of food insecurity in Zimbabwe were examined. Bivariate comparisons of child responses were provided to highlight the magnitudes of differences by gender in perception of food insecurity, while bivariate ordered probit regressions provided more insight into sources of these differences.

Paper 2: *Are there differences in the allocation of food resources between children and adults within households in Zimbabwe?*

This paper was also focused on the intra-household allocation of food, this time between adults and children. The 2004 household-based survey conducted in Zimbabwe was also used in this study. Bivariate comparisons were utilized to highlight the magnitudes of differences in perception of food insecurity, while bivariate probit regressions provided more insight into sources of these differences.

Papers 3 *What is the relationship between food insecurity and obesity among children in the United States?*

This paper utilized nonparametric regression approaches and two nationally representative data sets (the 1999-2002 National Health and Nutritional Examination Survey (NHANES) and the Child Development Supplement (CDS) of the Panel Study of Income Dynamics (PSID)) to answer this question. Nonparametric methods were utilized to portray possible subtleties in the relationship between food insecurity and obesity over the full range of body mass index (BMI) based percentiles of children in different racial and socio-economic categories.

6.2 Findings

With regards to paper 1, findings revealed gender as an important factor in determining self-reported assessments of food insecurity among a very vulnerable group of children, namely orphan girls. This result held for the number of meals ("objective") measure of food insecurity. All other categories of boys and girls reported roughly the same level of deprivation across both measures of food insecurity. In addition, these reports were roughly similar across the age gradient. These results imply that while all groups of children are equally likely to say that they get enough food, orphan girls are more likely to report eating fewer meals. This may reflect different expectations of orphans girls compared to other categories of children of what constitutes "enough".

Findings from paper 2 were a little different. Across both measures (food inadequacy and food insecurity), children were more likely than adults to report being food secure. The differences were not uniform across households – a substantial number of households had

children who were food inadequate or food insecure while the adult was not. There was also some evidence, based on the food inadequacy measure, of a tendency to protect younger children and discriminate against female orphans in food distribution supporting the Cinderella hypothesis, which states that parents are less willing to invest in children who are not biologically theirs.

Another interesting finding is the results differed by the "subjective" measure of food adequacy ("How often do you have enough food?") and the "objective" measure of food insecurity ("How many meals did you eat yesterday?"). Younger children were more likely to say that they had enough food, but less likely to get at least two meals. This finding reiterates the need for multiple measures to comprehensively capture the full picture of food insecurity in the household.

For the third paper, findings from the nonparametric regressions revealed a relationship between food insecurity and childhood obesity that is nonlinear and complex. More specifically, there is a strong positive association between food insecurity and age-gender based BMI percentiles for children who are low food secure or very low food secure. In addition, this positive association is consistent across a range of racial and socio-economic subgroups.

6.3 Policy recommendations

The results from this dissertation are important for policymakers. In the sample of households surveyed in Zimbabwe, the presumption that all household members have the same level of food adequacy and security is false around 40 % of the time for the food inadequacy measure and 20 % of the time for the food insecurity measure. Evaluations of

programs designed to address food needs and assessments of the problem derived from descriptions of food insecurity may wish to take into account differences across household members. More specifically, since evidence of discrimination against female orphans was found, the results are important for policymakers who aim to improve child food insecurity. In order to achieve this goal, they may wish to target benefits to children based on their orphan status, rather than to the entire household.

The third paper also birthed some significant policy implications. Understanding the relationship between food insecurity and childhood obesity is very important for policymakers. If there is a positive relationship, this indicates that efforts to combat food insecurity are likely to be associated with reductions in childhood obesity. The results found in the third paper indicate that there may be a positive association for low-income food insecure children. If so, this would then raise the benefits in any cost-benefit analysis of efforts to reduce food insecurity or childhood obesity among these children. These findings are of particular importance for the U.S. Food Stamp Program (now called the Supplemental Nutrition Assistance Program -- SNAP). The central goal of SNAP -- the largest food assistance and the largest near-cash entitlement program in the United States -- is to alleviate food insecurity and hunger in the United States. One of the ancillary benefits of reducing food insecurity through the Supplemental Nutrition Assistance Program may be reductions in childhood obesity.

APPENDIX

18-QUESTION CORE FOOD SECURITY MODULE

1. “We worried whether our food would run out before we got money to buy more.” Was that often, sometimes, or never true for you in the last 12 months?
2. “The food that we bought just didn’t last and we didn’t have money to get more.” Was that often, sometimes, or never true for you in the last 12 months?
3. “We couldn’t afford to eat balanced meals.” Was that often, sometimes, or never true for you in the last 12 months?
4. In the last 12 months, did you or other adults in the household ever cut the size of your meals or skip meals because there wasn’t enough money for food? (Yes/No)
5. (If yes to Question 4) How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?
6. In the last 12 months, did you ever eat less than you felt you should because there wasn’t enough money for food? (Yes/No)
7. In the last 12 months, were you ever hungry, but didn’t eat, because there wasn’t enough money for food? (Yes/No)
8. In the last 12 months, did you lose weight because there wasn’t enough money for food? (Yes/No)
9. In the last 12 months did you or other adults in your household ever not eat for a whole day because there wasn’t enough money for food? (Yes/No)
10. (If yes to Question 9) How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?
11. “We relied on only a few kinds of low-cost food to feed our children because we were running out of money to buy food.” Was that often, sometimes, or never true for you in the last 12 months?
12. “We couldn’t feed our children a balanced meal, because we couldn’t afford that.” Was that often, sometimes, or never true for you in the last 12 months?
13. “The children were not eating enough because we just couldn’t afford enough food.” Was that often, sometimes, or never true for you in the last 12 months?
14. In the last 12 months, did you ever cut the size of any of the children’s meals because there wasn’t enough money for food? (Yes/No)
15. In the last 12 months, were the children ever hungry but you just couldn’t afford more food? (Yes/No)
16. In the last 12 months, did any of the children ever skip a meal because there wasn’t enough money for food? (Yes/No)
17. (If yes to Question 16) How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?
18. In the last 12 months, did any of the children ever not eat for a whole day because there wasn’t enough money for food? (Yes/No)

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