SOCIO-ECONOMIC DETERMINANTS OF CHILD GROWTH IN FIVE DEVELOPING COUNTRIES: IMPLICATIONS FOR HEALTH AND DEVELOPMENT

by

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ABSTRACT

Malnutrition is one of the five major killers of children under five in the developing world (Gove, 1997). Using DHS data, and anthropometric indicators, this study describes changes in the nutritional status of children in Northeast Brazil, Guatemala, Mali, Uganda and Zimbabwe between the 1980's and 1990's. Results indicate that although there is a significant decrease in malnutrition in Northeast Brazil, there has been little progress and even deterioration of nutritional status in Guatemala, Mali, Uganda and Zimbabwe. There was a notable increase in wasting in all five countries, predominantly in rural areas. This study also examines several socio-economic determinants of growth. These determinants are compared both over time and across countries. A series of logistic regressions were performed based on a conceptual model of malnutrition. Results indicate that maternal education is a key predictor of stunting and radio ownership is an important predictor of underweight status. Other significant variables include place of residence, sanitation facilities, source of drinking water, immunization status and diarrhea prevalence. Reducing malnutrition is essential for social and economic development. Malnutrition consists of a complex array of determinants that requires comprehensive strategies to treat root causes. A concentrated effort is needed from national governments and the international community to promote the implementation and practical use of primary health care.

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Chapter 1: Introduction and Overview

The 'food problem' has slowly yielded to the 'public health problem' on the agenda of international discourse.

~Partha Dasgupta (1993)

1.0 Overview

Purpose of Study

The purpose of this thesis is to describe patterns and trends in the nutritional status of children in developing countries throughout the past decade using a multi-country approach. In addition, this study provides insight into the socio-economic determinants of growth from a global perspective.

The primary reason for using a comparative analysis in this thesis is that nutritional patterns vary among global regions, suggesting various causes of malnutrition (Victora, 1992). To gain a better understanding of the socio-economic factors influencing nutrition it is necessary to examine different regions of the world.

Approximately 12 million children under the age of 5 die each year, 99% of these deaths occur in developing countries (Gove, 1997). Malnutrition, one of the 5 major killers of children, is associated with 54% of these deaths. Malnutrition prevents one in three children in the developing world from attaining full physical and mental potential (Madzingira, 1995). The World Summit for Children set specific goals for improvements in maternal and child health for the decade 1990-2000 (United Nations, 1990). One of the major goals was to reduce severe and moderate malnutrition by half of 1990 levels among children under 5. As the year 2000 approaches, it is important to examine the changes and progress that have occurred throughout the last decade. Close monitoring of

each country is important to determine the influencing socio-economic determinants of health. This information can help to shape health policies and develop effective community health programs.

Objectives

There are three main objectives of this study:

- To describe changes in nutritional status of children under 5 in developing countries between the 1980's and the 1990's.
- To determine if socio-economic factors are affecting malnutrition over time.
- To compare socio-economic factors across countries.

Methods

This study used data from the Demographic and Health Surveys (DHS). Five countries were selected. Each country had one survey conducted in the 1980's and another survey in the 1990's. Descriptive and univariate statistics were utilized to describe changes in the nutritional status over time for all five countries. Logistic regression techniques were subsequently used to examine patterns and identify key determinants of malnutrition.

Organization of Study

The structure of the thesis is as follows. The first and present chapter consists of three sections. The first section outlines and defines key concepts in the field of health and development and develops a theoretical framework for the thesis. The need for

quantitative health research in developing countries is also addressed. The second section examines maternal-child health with a focus on the role of women in development. The final section examines the epidemiology of malnutrition, the relationship between health, development and malnutrition, the causes of malnutrition, and methods of measuring nutritional status.

Chapter Two is the literature review. The chapter discusses the statistical association between anthropometric indicators and outlines global trends in the nutritional status of children. The literature pertaining to the specific socio-economic determinants of growth used for this study is also reviewed.

Chapter Three explains the methods that were utilized for the study including a description of the source of data, sampling procedures, description of sample, description of the variables, and data analysis procedures. The countries selected for the study are profiled and the limitations of the study are also discussed in this chapter.

Chapter Four reports the findings of the study. The results are presented in several tables and figures and the main patterns and trends are summarized.

Chapter Five discusses the findings and places them in the context of other research. In addition this chapter integrates the findings of the study with the role of health in development. Recommendations are made for future research and policy directions.

1.1 Health and Development

Relationship between Health and Development

The relationship between health and development is complicated by the evasive definitions of both concepts. Definitions for health range from narrow medical views to

an 'ideal state' (Beaglehole & Bonita, 1997). The more narrow definition of health stems predominantly from medical professionals, who see health purely as 'the absence of disease' and should be controlled solely by those in the health field. The more widely cited definition understands health as an ideal state. This is the definition that is written in the preamble of the constitution of the World Health Organization (WHO, 1946): "health is a state of complete mental, physical and social well-being and not merely the absence of disease or infirmity." In the context of the WHO definition, health of human populations involves multiple interactions of social and economic factors, and the physical and biological environments (Phillips & Verhasselt, 1994). The nature in which health is defined is important for it often directs the type of health policy that is adopted. For instance, multi-sectoral approaches that address comprehensive lists of health determinants often stem from wide range definitions of health, while, using specific technologies to target selected diseases stems from narrow medical definitions (Rifkin & Walt, 1986).

A new era of health began in the 1970's when health became an important issue in development. The WHO and United Nations Children's Fund (UNICEF) noted that the promotion of health required the recognition of social, economic and environmental determinants of health, and therefore changes in health status could not be accomplished through the health care system alone (Asthana, 1994b). Primary health care (PHC), a strategy for health development, arose in 1978 at the Alma Ata conference. Primary health care is defined as:

> essential health care made universally accessible to individuals and families in the community by means acceptable to them, through their

> full participation and at a cost that the community and country can afford. It forms an integral part both of the country's health system of which it is the nucleus and of the overall social and economic development of the community (WHO, 1978, p.2).

The slogan 'Health for all by the year 2000' was subsequently coined by WHO, based on the principles of PHC and guided the philosophy in health care development throughout the 1980's and 1990's. This approach was designed to move away from the previous curative medical strategies to a community-oriented approach emphasizing health promotion and prevention. The essential components of PHC are summarized in Table 1.0.

Table 1.0 The Essential Components of Primary Health Care

1. Health Education
2. Environmental sanitation, especially of food and water
3. The employment of community or village health workers
4. Maternal and child health programs, including immunization and family planning
5. Prevention of local endemic diseases
6. Appropriate treatment of common diseases and injuries
7. Provision of essential drugs
8. Promotion of nutrition
9. Traditional medicine

Source: Alma-Ata Conference documents (1978)

Health promotion emerged in the 1990's as a unifying concept bringing together various fields of study (Macdonald & Bunton, 1992). The idea of health promotion is based on numerous developments in the health field including the strategies of primary

health care. Similar to the ideas of PHC, health promotion rejects the traditional medical view of health for a broader definition, which includes social and economic aspects. Health promotion also seeks to empower and increase community participation. The five principles of health promotion are summarized in Table 1.1.

Table 1.1 Five Major Principles of Health Promotion

1. Health promotion involves the population as a whole in the context of every day lives, rather than focusing on people at risk for specific diseases.
2. Health promotion is directed towards action on the determinants or causes of health.
3. Health promotion combines diverse, but complementary, methods or approaches.
4. Health promotion aims particularly at effective and concrete public participation.
5. Health professionals-particularly in primary health care-have an important role in nurturing and enabling health promotion.

Source: Kickbusch (1986)

One of the primary criticisms surrounding health promotion is that it is based predominantly on western ideology. Most of the work pertaining to health promotion evolved out of Canada[1] and Great Britain. It is therefore questionable whether this theory can be transferred to developing countries. There are two main arguments presented by Kickbusch (1986) which suggest that health promotion can be applied worldwide. Kickbusch argues that the philosophical underpinnings are relevant to both developed and developing countries. The difference lies in the 'entry point' of health promotion.

[1] Health promotion first appeared as a term and a concept in *A New Persepctive on the Health of Canadians,* a report published in 1975 by Marc Lalonde, the Canadian Minister of National Health and Welfare. In 1986, Jake Epp, Canadian Minister of National Health and Welfare published *Achieving Health for* All*: A Framework for Health Promotion*. The goal of this report was to attempt to translate theory into practice.

Developed countries require health promotion to encourage preventative participation and healthy public policies to decrease reliance on the medical establishment. In the context of developing countries, health promotion can be utilized to formulate health policies and primary health care. The second argument for using the theory of health promotion in developing countries is that it is important to unify the experiences of developed nations. Encouraging international health promotion can help to promote partnerships and to link global health strategies.

A second major criticism of health promotion is the inability of translating theory into practice. Becker (1986) suggests that health promotion in practice has led to exploitation of the examination of risk factors, provision of unreliable and inconsistent 'health' advice to the public and the encouragement of victim-blaming, while ignoring important social, economic and environmental factors related to health. It has also been suggested that health promotion fails to empower populations and "effectively constructs the individual subject as a "health consumer" in accordance with the model of consumer capitalism" (Grace, 1991, p.329). It is believed, however, that if the focus can remain on the core philosophy of health promotion and realistic goals can be set, the application of health promotion will have significant improvements on population health for all nations.

PHC was criticized for being too idealistic and not appropriate during time of economic crisis[2] (Asthana, 1994b). Therefore, shortly after Alma-Ata, the concept of selective primary health care (SPHC) was introduced. In contrast to the comprehensive nature of PHC, SPHC strives to use specific and economically beneficial technologies to

[2] The economic recession during the late 1970's and 1980's led to economic crisis in many developing countries. The World Bank and the International Monetary Fund imposed structural adjustment programs in heavily indebted countries which led to drastic cuts in social and health expenditures (Asthana, 1994a).

reduce specific diseases in targeted populations (Rifkin & Walt, 1986). SPCH maintains the traditional medical view that improvements in health come primarily from medical interventions without the collaboration of professionals outside the health field.

SPHC uses low-cost measures to improve the health of targeted groups, children in particular. Although proponents of SPHC believe that it is the most progressive way to achieve significant improvements in health, others have argued that SPHC is a `step backwards' in international health policy (Asthana, 1994; Rifkin & Walt, 1986). Critics argue that SPHC attempts to improve health by controlling disease in isolation, while failing to address root causes of ill health, such as poverty and inequality. SPHC uses a technological and cost-oriented approach that prevents community participation, one of the crucial ideas put forth by PHC. Since the 1980's the ideals of PHC have not been put to practical use and have been generally neglected for more selective national health policies (Asthana, 1994b).

The definitions of development are diverse and far ranging. The manner in which development is defined is reflective of political and inherent beliefs of the individual. Esteva (1992) traces the meaning of development from the post World War II era to the present, associating development with growth, evolution, and maturation. He criticizes the misuse and misinterpretation of development, particularly with respect to the predominant Western hegemony surrounding development issues. Although traditionally viewed as economically based, development in its broad definition includes elements such as distribution of resources, access to opportunities and political and human rights (Phillips & Verhasselt, 1994). Development has also been described as a process that increases human choices (Haq, 1995), and aspects of human dignity (Seers, 1969).

Although there continues to be wide debate surrounding the meaning of development, there is a general consensus that development is a process that improves the quality of human life (WHO, 1992, as cited in Phillips & Verhasselt, 1994).

One of the most controversial issues in development is the longstanding debate between economic growth and human basic needs (King, 1998). Should developing nations strive for swift economic growth, which may deepen inequalities, or should governments attempt to secure basic needs for the population at the risk of increasing inefficient economic strategies? Conventional economic theory proposes that inequalities are a necessary consequence for economic growth. Midgley (1997), however, suggests that 'distorted development' will follow economic growth in the absence of social development. Distorted development, a current problem of many developing countries, occurs when economic growth fails to reach the whole population.

Social development is "a process of planned social change designed to promote the well-being of the population as a whole in conjunction with a dynamic process of economic development." (Midgley, 1995, p.25). The purpose of social development is to integrate both economic and social development to enhance human welfare (Midgley, 1997). Without such integration those individuals that are the most deprived may not receive the benefits of economic progress. Investing in the health of people is one of the greatest resources for socioeconomic development (Abel-Smith, 1990; World Bank, 1993). It is imperative, to make health central to development (Herrell & Mulholland, 1998).

There is a complex interrelationship between health and development involving synergistic and reciprocal elements (Phillips & Verhasselt, 1994). Development is greatly

influenced by the health of the population. Poor health restricts economic growth by reducing the availability of labour, reducing the productivity of workers, creating dependency on others, and by wasting resources (Abel-Smith, 1990). Economic growth, on the other hand, can improve health by providing the necessary funds to ensure such things as safe drinking water, adequate sanitation facilities, immunization programs and health promotion activities. The relationship between health and economic development is difficult to generalize. Although increases in economic indicators often lead to improved health this is not always the case. Problems arise when there is unequal distribution of resources and the whole population does not benefit from economic improvements. Moreover, after a minimum per capita income is reached social and political factors become more influential in determining health status than national wealth (Beaglehole & Bonita, 1997). Social development is therefore critical to improvements in health and nutrition (Phillips & Verhasselt, 1994).

In recent years, international organizations such as the World Bank and the United Nations have recognized the importance of a healthy population. These organizations have incorporated health in economic policies and development strategies. In 1993, the World Bank dedicated an entire report to the relationship between human health, health policy and economic development. Good health was determined to be "a fundamental goal of development as well as a means of accelerating it" (World Bank, 1993, p.21).

As the year 2000 approaches, it is clear that the goals for *Health for All* have not been achieved. Discrepant social and economic development and various forms of persistent discrimination prevented equitable access to health care and resources (Herrell

& Mulholland, 1998). This thesis examines one indicator of development, nutritional status of children, to determine if there has been progress during the past decade. This study illustrates the importance of socio-economic factors in relation to child health and the need to incorporate broad base social changes in conjunction with economic development in order to improve health conditions.

Social Statistics in Developing Countries

It is now recognized that economic statistics are insufficient for monitoring the progress of development. Economic statistics should be complemented with social statistics for a more complete picture. Moreover, indicators typically used in developed countries are often not appropriate for poor countries (Cortinois, Vella & Ndiku, 1993). Cortinois and his associates (1993) argue that it is more relevant to collect information of the family, such as demographic features, literacy, living conditions of parents, financial standing and nutrition items.

There is a lack of current social statistics for many of the developing countries. Certain statistics are more readily attainable such as the percent of children completing primary schools, while others are more difficult to collect, such as the percent of children malnourished (UNICEF, 1994). In particular, there is a lack of data over time that is able to detect substantial change (Phillips & Verhasselt, 1994). The "data gap" in many of the poorer countries is contributed to lack of resources and systems (Lerer et al., 1998). A large proportion of developing countries continue to use social statistics from the eighties, many other statistics are manipulated through computerized techniques to present more up to date values (UNICEF, 1994). Studies involving comparative analyses

are often problematic due to lack of consistent definitions and operational terms of the objects of interest (Midgley, 1997).

1.2 Maternal-Child Health

Maternal-child health is one of the main components of primary health care. Mothers and children have been recognized as part of a more vulnerable population in many settings as they are the least powerful members of society (Price, 1993). Improving the health of women and children are an important part of social and economic development in communities. In the 1980's UNICEF launched a `child survival and development revolution' (CSDR). UNICEF aims to use a `targeted PHC strategy' with specific economically efficient health promotion strategies for children and mothers. It is widely recognized that the promotion of the health of women is an important aspect of improving the health of children (Price, 1994). The health of mothers and children are influenced by multiple factors including biological inheritance, individual circumstances and the physical, socio-economic and cultural environment in which they live.

Women generally face numerous challenges in their lives, with the greatest burden stemming from the status of women and the discrimination against them (Price, 1994). Women are often expected to both care and nurture her family and to also have a productive role, which may involve various types of work, usually extremely labour intensive. Women are more likely to be living in poverty, control fewer productive assets and work longer hours at lower wages than men (Beaglehole & Bonita, 1997). These factors all influence the health of the women, and thereby the health of her children. It is therefore, imperative to consider the role of women when examining the health and nutritional status of children. It should be noted that although this thesis examines the

role of women in relation to the health of children, this is only one aspect of women in development.

1.3 Malnutrition

What is malnutrition?

Malnutrition, is one of the most extensive and serious health problems in the developing world. Malnutrition in developing countries is often labeled undernutrition, or protein-energy malnutrition (PEM) because the child does not receive the necessary protein or calories necessary for growth and development (Foster, 1992). Severe forms of PEM can lead to nutritional disorders such as marasmus and kwashiorkor. Without proper care and medical intervention children with these disorders may die within a short period. Other forms of malnutrition involve micronutrient deficiencies such as lack of iron, iodine and vitamin A. In this study malnutrition will refer specifically to PEM.

Epidemiology of Malnutrition

Approximately one-third of the children in the world are affected by PEM (WHO, 1998). Most of these children are from developing countries. The risk of being an undernourished child varies in different parts of the world. South Asia has the highest levels of malnutrition, in both prevalence and absolute numbers. Children in Asia are 1.2 times more likely to be malnourished compared to African children, who in turn have a risk 3 times higher than Latin American children. Future predictions expect that the burden of malnutrition in terms of absolute numbers affected will shift from South Asia to sub Saharan Africa (Thompson, 1996).

Mortality rates for children under five are 2.5 times higher in children who are moderately underweight and 5 times higher in children who are severely underweight (WHO, 1998). Over 50% of deaths in children under five in developing countries are associated with malnutrition (Gove, 1997; WHO, 1998).

Relationship between Malnutrition, Health and Development

There is a strong synergistic relationship between nutrition and health; "good nutrition leads to good health and good health leads to good nutrition" (Foster, 1992, p.193). Good nutrition is important to the health development of individuals, families, and communities (UNICEF, 1998). At the individual level, malnutrition effects physical growth and development, health, and intellectual and social development. Poor physical and cognitive development rooted in undernutrition exacerbates the cycle of poverty and deprivation (Lerer, et al., 1998). These effects of childhood nutrition can extend into adulthood. Poor health and nutrition in female children can lead to a vicious cycle of malnutrition (Merchant & Kurz, 1993). Childhood PEM can lead to poor nutrition during reproductive years. An undernourished mother is more likely to have a low birth weight baby; low birth weight increases the chances of malnutrition during childhood. To break this cycle, it is important for female children to start life with adequate nutrition.

At community and national levels, there can be losses in human potential leading to great social and economic costs (Thompson, 1996). Dasgupta (1993) provides evidence illustrating a strong link between nutritional status, physical work capacity, endurance and physical productivity. "The nutritional well-being of people is a pre-condition for the development of societies. Governments will be unsuccessful in their

efforts to accelerate economic development in any significant long term sense until optimal child growth and development are ensured for the majority." (WHO, 1994 as cited in UNICEF, 1995) The importance of good nutrition is therefore not only of importance to present health but also to future well being and productivity of the child, and society.

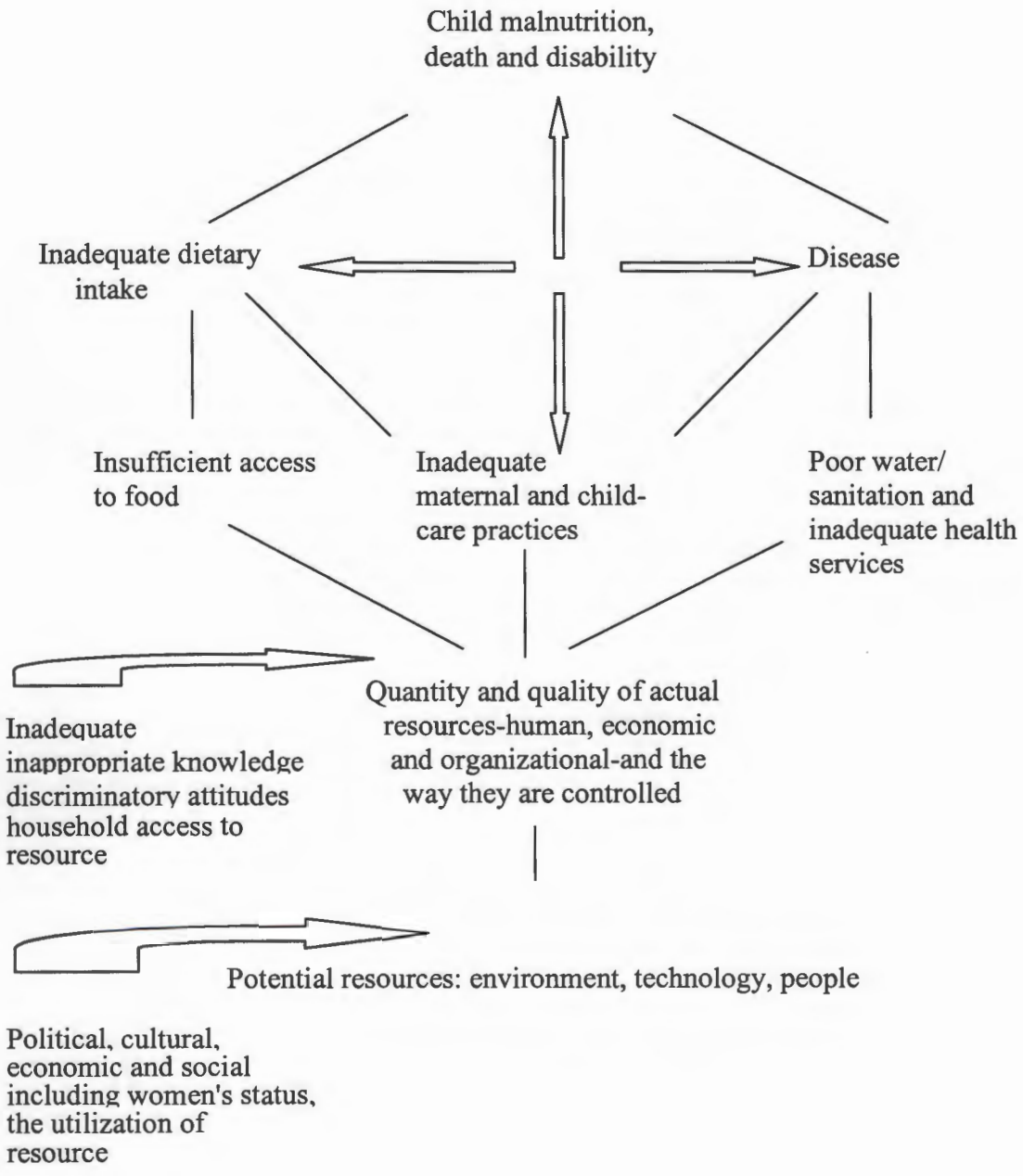
The Determinants of Malnutrition

The determinants of malnutrition (direct or indirect causes) are multi-factorial and complex. Numerous models and diagrams have been produced to attempt to explain the relationship between the causes of undernutrition. This section provides an overview using a conceptual framework and a description of the causes defined by UNICEF (1998).

The causes of malnutrition can be classified as immediate causes, underlying causes and basic causes (UNICEF, 1998). Good nutrition requires three important components: food, health and care. These factors are broken down further in Figure 1.0 in a general model of undernutrition. Determining the relationship among these factors is important for finding solutions and developing programs to combat malnutrition.

Of particular concern in developing countries is the synergistic relationship between malnutrition and infection, sometimes referred to as the malnutrition-infection-complex (Foster, 1992). Inadequate food intake coupled with illness are the two most influential immediate causes of malnutrition (UNICEF, 1998). Children who are malnourished have weakened immune systems increasing their susceptibility to infection; an infection exacerbates malnutrition through various biological processes such as

Figure 1.0 Causes of child malnutrition, conceptual framework developed in 1990 as part of the UNICEF Nutrition Strategy (UNICEF, 1998, p. 24)



reducing the body's absorption of nutrients (Foster, 1992). Most childhood deaths are the result of malnutrition combined with repeated infections.

Underlying causes contributing to malnutrition and disease include three main categories: household food security, access to health services and environmental health, and caring practices (UNICEF, 1998). Household food security is defined as sustainable access to resources to acquire the necessary food requirements for adequate nutrition. The accessibility to food includes financial, physical and social elements. Health services (preventative and curative) are extremely important for maintaining good health. It is essential to have health services that are both affordable and accessible. Environmental health determinants such as access to safe water, good sanitation facilities and safe food handling practices are important for good nutrition. These factors are extremely important in the malnutrition-infection-complex. Caring practices influencing the nutritional status of children include feeding practices, protection of the child's health, support and cognitive stimulation for children and care and support for the mother.

Poverty continues to be the most pressing issue in public health; poverty is the most basic cause of malnutrition and ill health (Lerer et al., 1998; WHO, 1998; Beaglehole & Bonita, 1997; Phillips & Verhasselt, 1994). Poor people lack the income for basic requirements such as food, clean water, and shelter needed for a minimum level of health and nutrition. In the world as a whole, people with low incomes tend to underconsume food, while people with a high income tend to overconsume food (Foster, 1992). Without progress towards reducing poverty there will continue to be inequality with respect to health and nutritional status. There are other important socio-economic

causes of malnutrition, these are of key interest in this study and are discussed in the following chapter.

Measuring Nutritional Status

Anthropometry, the science of measuring the human body, is the most popular epidemiological tool for assessing the health and nutritional status of children (Foster, 1992). Anthropometric indicators are not as accurate as other biological and biochemical methods, and cannot be considered a precise measurement of nutritional status, particularly at the individual level (Gorstein & Akre, 1988). This method, however, is relatively accurate at determining protein and calorie nutrition at the population level and can be achieved at a low cost. Moreover, anthropometric data is considered one of the most revealing statistics with respect to health (Dasgupta, 1993).

Three common anthropometric measurements used for this study include height-for-age (HA), weight-for-height (WH), and weight-for-age (WA) (Waterlow, 1992). Height-for-age measures stunting, which is an indication of chronic malnutrition. This measure is particularly useful for evaluating the effects of social and economic changes. Weight-for-height is a measure of wasting, which indicates present nutritional deficiency. Weight-for-age measures if a child is underweight, indicating both past and present nutritional status. Undernutrition refers to a child who is classified as stunted, wasted, and/or underweight (Sommerfelt & Stewart, 1994).

Anthropometric indicators require a reference population to compare an individual's growth status (Dibley et al., 1987). The reference population that is most commonly used comes from the World Health Organization/National Center for Health

Statistics/Centers for Disease Control (McMurray, 1996). The data were collected from two samples of healthy American children during the 1970's. The use of this American reference population in developing countries has been criticized for the assumption that children of different origins share the same potential for growth. Studies have demonstrated, however, that ethnic variations in growth are either small or non-existent during early childhood; instead poor growth stems from malnutrition and infectious diseases (Habitch et al., 1974). Ethnic differences in growth attainment are established during adolescence and not during early childhood (Falkner, 1986).

The most commonly used index for anthropometric indicators are Z-scores, which are standard deviations from the reference median (Dibley et al., 1987). Standardization has made it possible to evaluate nutritional changes and trends over time in nationally representative cross-sectional studies that have been conducted at various time frames (Gorstein & Akre, 1988). Cross-sectional data can be used to study differences between subgroups such as sex and can illustrate associations with socio-economic, environmental and demographic factors (McMurray, 1996).

1.4 Summary

Malnutrition is a serious problem in the developing world. Good nutritional status is important for normal growth and development. There are numerous biological, social, economic and environmental determinants of child growth. Targeting certain key pediatric diseases, therefore, is most likely not the answer to reducing malnutrition. Although PHC was initiated to take a multi-sectoral approach to health development, it has been pushed aside by more narrow medical technologies and cost-effective strategies. This study involves the examination of some of the socio-economic factors influencing

the nutritional status of children. It is believed that broad social changes coupled with economic development will have the greatest impact on the promotion of health. Such action will require support and dedication from national governments and international organizations. Anthropometric indicators are used to both examine global changes in the nutritional status of children and socio-economic influences of malnutrition.

Chapter Two: Literature Review

2.0 Introduction

The literature review is organized into four sections. The first section discusses the statistical association between the three anthropometric indicators; height-for-age, weight-for-height and weight-for-age. The second section outlines the global trends of the nutritional indicators that have been observed. The third section discusses the socio-economic determinants of growth. The determinants are reviewed with respect to the choice of variables chosen for this study. The final section summarizes the key findings in the literature.

2.1 Statistical Association between Nutritional Indicators

The three most commonly used anthropometric indicators, described in the previous chapter, include height-for-age (stunting), weight-for-height (wasting) and weight-for-age (underweight). Waterlow (1992), a prominent researcher in this field, examined the statistical associations between indicators in a number of studies. He determined that most populations have a weight-for-age fairly well correlated with height-for-age. Waterlow did not comment on the association between weight-for-age and weight-for-height. Keller (1983, as cited in Waterlow, 1992) found no correlation between weight-for-height and height-for-age. These two indicators, however, explain more than 95% of the variance in weight-for-age. This field remains unsettled.

2.2 Global Trends of Nutritional Indicators

Victora (1992) noted that there was a low prevalence of wasting in Latin American children. This is surprising because these children were living in impoverished areas, with high levels of mortality and morbidity, and high levels of stunting. Using data from the

WHO, Victora tested the distribution of weight-for-height, height-for-age and weight-for-age in different continents and the associations between the indicators. Cross-sectional data were collected from 175 studies from the 1960's, 1970's and 1980's. The studies are broken down by region in Table 2.0. Using individual studies as the units of analysis, Victora calculated median prevalences of the indicators for each region and used Pearson's correlation coefficient and linear regression to analyze the association between indicators. The analysis was restricted to children between the ages of 12 to 23 months because this is the age range when wasting is most prevalent.

The median prevalences of malnutrition are presented in Table 2.0. Stunting had the highest prevalence (except in Asia) and wasting had the lowest prevalence of the three indicators. Asia had the highest prevalence of all three indicators and Latin America had the lowest prevalences. Stunting demonstrated little variability in prevalence among regions, while wasting varied sevenfold. The correlation results are presented in Table 2.1. There was a strong correlation between wasting and stunting prevalences for Asia and the Mediterranean, a weak correlation for Latin America and no association for Africa.

The results of this study do not explain the association between stunting and wasting. It is interesting that correlations between wasting and stunting vary among regions. Victora (1992) interprets the varying patterns of global nutrition as an indication of some differences in causes of undernutrition. He recommends developing a better understanding of these factors and the reasons why the associations of the indicators are different around the world.

Table 2.0 Median Prevalences of Malnutrition and Estimated Under-five Mortality Rates (U5MR), by Region

	Prevalence of malnutrition[1]				
	Wasting	Stunting	Underweight	U5MR	No. of studies
Africa	10.1	41.1	35.7	146	89
Latin America	2.7	33.8	22.8	85	37
Asia	18.8	47.0	52.9	72	32
Eastern Mediterranean	5.8	38.6	25.4	99	17

Source: Victora (1992)

[1]Percentage of children below the National Center for Health Statistics median minus two standard deviations.

Table 2.1 Correlation of the prevalences of wasting on stunting by region

Region	r[1]	p[2]
Africa	0.044	0.7
Latin America	0.311	0.06
Asia	0.700	<0.001
Eastern Mediterranean	0.652	<0.001

Source: Victora (1992)

[1] r = correlation coefficient
[2] p = probability value

Trends in child malnutrition were examined by Sommerfelt & Stewart (1994). The researchers published a Demographic and Health Surveys technical report comparing the nutritional status of children under 5. There were 19 countries included in the study; 7 from sub-Saharan Africa, 3 from Near East/North Africa, 2 from Asia and 6 from Latin America/Caribbean. The countries were all DHS-I studies ranging from 1985 to 1990. The percentage of children stunted, wasted, and underweight were calculated using Z-scores below minus 2 standard deviations according to the WHO/CDC/NCHS International Reference Population.

Three main patterns emerged: (1) levels of stunting were much higher than levels of underweight combined with a small proportion of children wasted (approximating levels of the International Reference Population); (2) high levels of stunting with even higher levels of children underweight, wasting had a higher prevalence than other countries; (3) relatively equal levels of stunting and underweight, and wasting was more common than expected. The first pattern was typical in Latin American, North African countries and Uganda and Zimbabwe, the second pattern was seen in countries such as Mali and Sri Lanka and the third pattern included most sub-Saharan African countries. The patterns are explicitly stated and confirm the findings of Victora (1992). There is, however, no explanation given for possible reasons for the different nutritional patterns.

The worldwide distribution of PEM was described using the WHO Global Database on Child Growth (de Onis, Monteiro, Akre & Clugston, 1993). The database consists of anthropometric data on children under 5 using the WHO/CDC/NCHS international reference population. Cross-sectional data were used from nationally representative surveys carried out in developing countries in Africa, Asia, Latin America and Oceania between 1980 and 1992. The study determined differences in nutritional status between regions and also differences within each region. Regional prevalences for height-for-age, weight-for-height, and weight-for-age were calculated by weighting national prevalences according to the population of children under five in each country in 1990. Global prevalences were then obtained by calculating the mean number of undernourished children in each area.

The results of the global estimates for the prevalence of the anthropometric indicators are summarized in Table 2.2. Stunting had the highest prevalence for all three

regions, while wasting had the lowest prevalence. The risk of being underweight was 1.5 times higher in Asia than in Africa, and 2.3 times higher in Africa than in Latin America. There were similar differences for prevalences in stunting and wasting, except levels of stunting in Africa were similar to those in Latin America and levels of wasting in Africa were similar to levels in Asia.

Table 2.2 Global Estimates for the Prevalence[a] and Number of Underweight, Stunted, and Wasted Children in Developing Countries

	% underweight	% stunted	% wasted
Africa	27.4(31.6)[b]	38.6 (44.6)	7.2 (8.3)
Asia	42.0 (154.1)	47.1 (172.8)	10.8 (39.6)
Latin America	11.9(6.5)	22.2 (172.8)	2.7 (1.5)
Oceania	29.1(0.3)	41.9 (0.4)	5.6 (0.1)
All developing Countries	35.8 (192.5)	42.7 (229.9)	9.2 (49.5)

Source: deOnis, Monteiro, Akre and Clugston (1993)

[a] % Below –2 standard deviations of WHO/NCHS reference value
[b] Figures in parentheses are millions of children

This study found that there were regional differences in the prevalences of the nutritional indicators (see Table 2.3). The highest levels of stunting, wasting and underweight were in southern Asia. The lowest prevalences of these indicators were in northern Africa and in all three Latin America regions.

Table 2.3 Regional Estimates for the Prevalence[a] of underweight, stunted and wasted children in developing countries, ranked in descending order

% underweight		% stunted		% wasted	
Southern Asia	60.5	Southern Asia	60.3	Southern Asia	17.3
South-eastern Asia	37.8	Eastern Africa	47.0	Western Africa	9.5
Western Africa	32.8	South-eastern Asia	43.2	South-eastern Asia	7.6
Eastern Africa	31.0	Melanesia	42.2	Eastern Africa	6.0
Melanesia	29.5	Western Africa	37.9	Northern Africa	5.8
Eastern Asia	21.3	Eastern Asia	32.1	Melanesia	5.5
Caribbean	19.4	Central America	29.8	Central America	4.6
Central America	17.7	Caribbean	25.9	Eastern Asia	3.6
Northern Africa	11.3	Northern Africa	25.4	Caribbean	2.2
Southern America	8.4	Southern America	18.1	Southern America	1.9

Source: deOnis, Monteiro, Akre and Clugston . (1993)

[a] % Below –2 standard deviations of the WHO/NCHS reference value

The purpose of the study was to determine the worldwide magnitude of PEM. The study also describes varying patterns of undernutrition, but the researchers do not comment on why there are regional and global differences in anthropometric indicators. They treat all three nutritional indicators as a general category of undernutrition and conclude that growth retardation is rooted in poverty and lack of education.

Common trends of nutritional indicators have been described in the aforementioned studies. The patterns that have emerged indicate that there are regional and continental differences in nutritional status. A better understanding of the socio-economic determinants of these anthropometric indicators may help to explain, in part, the reasons for global differences in nutritional status.

2.3 Determinants of Growth

This section reviews the literature of the determinants of growth in children. The determinants are first reviewed individually with respect to their relationship to malnutrition. This is followed by a discussion of six studies that have attempted to

understand the relationships among numerous determinants of growth. The purpose of this review is to describe methodologies and results of studies that have examined socio-economic determinants and to provide a background for this study.

Specific examination of determinants of growth

It is generally accepted that rural residents have poorer health than urban residents. People living in rural areas tend to have less access to health care services and to cash with which to buy food and other services (Phillips & Verhasselt, 1994). The flip side to this view is that the provision of services is not necessarily better in cities. The urban poor may be just as disadvantaged as their rural counterparts. There is evidence that nutrition, family support and environmental factors such as clean water are better in rural areas for some countries. There have been explosions of population in some cities that have lead to squatter settlements or `septic fringes' which have extremely poor sanitation conditions leading to widespread of infectious diseases and other health problems (Basch, 1990). Poor nutritional status is a reflection of poverty and impoverished conditions which can exist both in rural and urban areas.

Distinguishing place of residence is important when attempting to determine progress and changes of nutritional status that have occurred over time. Child growth was examined in China before and after economic reforms to compare the effect of the reforms on the growth of children in urban and rural areas (Shen, Habicht & Chang, 1996). The authors used five large-scale cross-sectional surveys between 1975 and 1992 that examined the growth of children in China between the ages of 2 to 5. Using height-for-age as the measurement of growth, analysis of variance was utilized to examine differences

between urban and rural growth and secular trends. In 1975, before economic reforms, the results indicated that children in urban areas were only slightly shorter compared to children in rural areas. Between 1987 and 1992 there were improvements in child growth, but the changes were not equal. Children in urban areas had a greater increase in growth compared to rural children. The authors conclude that although there have been great improvements in the nutritional status of children since the reforms, the changes are not the same in all areas of the country. Mean differences should be carefully considered and are not necessarily indicative of overall improvement.

Gender differentials in child survival is an important and widely debated topic. Girls have a biological advantage in child survival, but in many countries girls have higher mortality rates than boys (Merchant & Kurz, 1993). There is evidence of a parental preference for boys in many developing countries leading to inequalities in intra-household allocation of resources. Chen (1980) noted in Bangladesh that girl children were fed less and suffered from greater malnutrition (Dasgupta, 1993). There were similar infection rates but parents were more likely to buy medication for boys and there was a tendency for boys to have quicker recoveries.

Particular regions of the world have demonstrated gender disparities such as parts of Asia and North Africa (Hill & Upchurch, 1995). Latin America countries do not tend to display gender differences with respect to undernutrition. Svedberg (1990, 1996) and Klasen (1996) have debated whether there is a gender bias in sub Saharan Africa. Both authors analyzed anthropometric indicators using various national data from sources such as UNICEF and DHS. Svedberg (1990, 1996) determined that there is either no gender bias or an anti-male bias in nutritional status. He concluded that his results do not imply an

overall female advantage in the quality of life but that undernutrition is more common in boys than girls in sub Saharan Africa. Klassen (1996) re-analysed data from Svedberg's (1990) study and provided additional evidence. Klassen found that there was an anti-female bias. Klassen concluded that more research is needed to confirm his conclusions and suggested using time series for health and mortality indicators to conduct further examinations of gender differences.

Hill and Upchurch (1995) explored gender bias in child health using data from the DHS. Thirty-five countries were examined from the Americas, sub Saharan Africa, Middle Eastern Crescent and other Asian countries. Results indicated that more boys were stunted than girls. Girls were also less likely to be wasted, although these differences were considerably smaller. The authors confirmed that there was a gender bias with respect to mortality but concluded that nutritional differences were not the key to differences in mortality rates.

There appears to be an association between maternal education and the health status of children. Cleland and Ginneken (1988) determined that for every year of maternal education there was an average of 7 to 9% decline in child mortality (Bicego & Boerma, 1993). Caldwell (1993) examined 11 countries in Asia, Africa and Latin America. The countries had low per capita incomes but relatively good health achievements. He found that education of females at childbearing age had the highest correlation with health success. Increasing female education is a central factor in improving maternal and child health (Beaglehole & Bonita, 1997).

In another study, Bicego & Boerma (1993) examined the statistical association of maternal education and child health and survival. Using DHS data, 17 countries from

Asia, Africa, and Latin America were examined using multivariate logistic and hazard regression with stunting and underweight status as the outcome variables. There was a strong relationship between maternal education and stunting even after controlling for socioeconomic variables. An even stronger relationship was found between maternal education and underweight status. This relationship, however, was significantly decreased once economic variables were included in the equation. This study illustrates that the impact of maternal education is different according to nutritional indicator.

Victora and his associates (1992) conducted a prospective study to examine the role of maternal education on various infant and child outcomes. The purpose of the study was to determine the association between education of the mother and child health indicators controlling for other socio-economic factors. The researchers followed a cohort of 6011 children born in a city in Southern Brazil. Information was collected by interviews with the mother at the hospital, city-wide mortality surveillance system and a follow-up examination of the children when they were 12-27 months. Data analysis included cross-tabulations and chi-squared tests using length-for-age, weight-for-age and weight-for-length as continuous outcome variables. Multiple logistic regression was used to adjust for several confounding variables (age, racial group, family income, education of father/partner). After controlling for other socio-economic variables, the effect of maternal schooling remained significant on the nutritional status of their children.

As more women join the labour force, the impact of a working mother on the health and nutritional status of children has come into question. The two major effects of maternal work status that have been hypothesized include the positive income effect and the negative time effect (Leslie, 1988). More simply stated, women bringing in more

income increase household resources such as food, but will spend less time in the household caring and nurturing children.

Leslie (1988) reviewed 50 studies that examined women's work and child nutritional status. The findings of these studies were complex and contradictory. Some of the studies found that there was a positive association between maternal work and child nutritional status. The children had better nutrient intake and better physical growth, but these effects were small and not consistent. Other studies found that there was a negative association, but did not find a causal relationship. The author concluded that there is little evidence of a negative relationship between maternal work status and nutritional status of children and suggests that there should be country specific research to account for differing patterns in female labour force participation.

The relationship among female employment, childcare strategies, and nutritional status were examined in a study involving Nicaraguan children (Lamontagen, Engle & Zeitlin, 1997). Households were sampled by randomized block design in low income urban communities. Data collection involved an interview, observations of feeding and childcare practices and anthropometric measurements of the children. Using height-for-age, weight-for-age and weight-for-height as the outcome measurements, multiple regressions were performed to determine the independent effects of women's employment and adequacy of childcare on child nutritional status controlling for possible confounding variables. The study found that children of working mothers had significantly higher weight-for-heights than children of mothers who were not employed. This relationship did not change once socioeconomic status, maternal education, paternal financial support, childcare adequacy and the sex and age of the child were controlled. The variables that distinguished between

mothers who provided adequate care and mothers that did not include; the provision of a larger variety of food, the increased likelihood of completing measles vaccinations and better hygienic practices.

There are direct links between the health of a child and the adequacy of sanitation facilities and water supplies. The 1980's, the International Drinking Water Supply and Sanitation Decade, led to a greater proportion of the world achieving access to safe water and sanitation facilities (Beaglehole & Bonita, 1997). The world population, however, also increased during this time leading to a large number of people without safe water and adequate sanitation. Currently there are more people with access to safe water than to adequate sanitation facilities (Esrey, 1996). Safe water has been the target of many development programs and there have been great improvements during the past few years. Sanitation coverage in populations, however, is slipping.

Esrey (1996) examined the impact of incremental improvements of water and sanitation on health status. DHS data was analyzed for 8 developing countries which included Burundi, Ghana, Togo, Uganda, Sri Lanka, Morocco, Bolivia, and Guatemala. Controlling for household, maternal and child-level variables, a series of multiple regressions were performed with anthropometric measurements and diarrhea prevalence as outcome variables. Esrey found that children had less bouts of diarrhea, and had a better nutritional status with improved sanitation at each of three levels of water supply. The health benefits from improved sanitation were greater than improvements in water conditions. The benefits from improved water supply only occurred if there were improvements in sanitation and when there were optimal water conditions. These results

indicate that there should be greater emphasis on improving community sanitation facilities in conjunction with improved water supplies.

Diarrhea is the most frequently and consistently reported disease influencing nutritional status (Black, 1991; Ulijasek, 1990) Childhood infectious disease reported to influence growth include diarrhea, measles, respiratory diseases, tuberculosis, malaria and intestinal parasitic. Black (1991) estimated 10-80% of growth retardations can be attributed to diarrheal disease. Malnutrition can make a child more susceptible to diarrhea, episodes of diarrhea can increase nutritional deficiency (Huffman & Martin, 1994). A study in North India examined the impact of nutrition on diarrheal disease. The case fatality rate was 24 times greater for severely undernourished children compared to children with adequate nutrition. The impact that diarrheal disease has on the growth of children has been questioned by some researchers. A study conducted in Bagladesh found that the effects of diarrhea are only temporary and that controlling diarrhea may not improve nutritional status (Briend et al., 1988). Lutter and his associates (1989) found that diarrhea did not have a negative impact on growth in children who were adequately nourished. Diarrhea, however, did impact negatively on growth when children were malnourished.

Ulijasek (1990) examined 10 studies, which examined the effects of PEM on immunization outcome. Tetanus and diphtheria were not found to effect nutritional status, while BCG, measles, typhoid and polio did show an effect. Measles is considered to be an important infectious disease with respect to malnutrition because there is a high risk of death upon infection (Sommerfelt & Stewart, 1994; Ulijasek, 1990). These diseases are best prevented by vaccinations.

General examination of determinants of growth

The study described previously by Sommerfelt and Stewart (1994) examined differentials in levels of undernutrition according to bio-demographic characteristics, socioeconomic characteristics, recent illness, and vaccination history. The authors distinguished the determinants for each indicator, but discussed the results as a general category of undernutrition. Results indicated that there were small differences in nutritional status with respect to sex of the child, with the exception of the Dominican Republic where boys were much more likely to be malnourished compared to girls. Children were more likely to be undernourished if they lived in rural areas compared to urban areas. There was a greater prevalence of undernutrition in mothers with no education and the lowest prevalence among mothers with secondary or higher education. The children of mothers who did not work were more likely to be undernourished. There was a strong correlation between undernutrition and sanitation facilities, malnutrition is more common in children where there is a lack of toilet facilities. Source of drinking water was an important determinant, malnutrition was more prominent for children who drank surface water. The study also found children who did not receive a vaccination for measles, as well as children who had diarreal illness were more likely to be malnourished. This study includes all the determinants of undernutrition previously discussed but the relationship between the variables were not addressed.

The health and nutritional status of Guatemalan children were investigated in relation to the effects of socio-economic determinants (Pebley & Goldman, 1995). The study used data from the National Survey of Maternal and Child Health (ENSMI)

conducted in Guatemala in 1987. Using height-for-age as the outcome variable regression techniques were performed to assess the effects of various covariates. The findings concluded that poverty and poor living conditions lead to deficits in the height of children. The growth of children was also influenced by ethnicity, father's occupation, land distribution in the area where they live, and maternal education.

Malnutrition in children under 5 was examined in Zimbabwe for the effect of socioeconomic and health factors (Madzingira, 1995). Using data from the 1988 Zimbabwe Demographic and Health Survey, separate forward stepwise logistic regressions were performed using height-for-age, weight-for-age and weight-for-height as the dependent variables. The independent variables included various socioeconomic, environmental and health-related variables. The author determined that the most statistically significant independent variables were the greatest predictors of nutritional status. These variables included birth status of the child, residence, diarrhoeal status, birth weight, maternal education and duration of breastfeeding. Separate analyses were performed and results are reported for each anthropometric indicator. The findings, however, are discussed in a general category of nutritional status. Such discussion prevents a closer inspection of the reasons why the variables were different for each nutritional indicator.

Vella and his associates (1994) examined the determinants of stunting in Northwest Uganda. Length and height of 1072 children under 5 were measured in 30 villages using random sampling. After 2 years the same children were measured again. Questionnaires were administered to collect information on socioeconomic and health-related variables. The data were analyzed using logistic regression with height-for-age as the outcome

variable. Of the variables measured there were three variables that were significant for predicting stunting; father's lack of income besides agriculture, mothers lack of education and the presence of stunting at baseline.

The prevalence and socio-economic determinants of malnutrition were investigated in Sikasso, Mali (Bouvier et al., 1995). Surveys were implemented every year for 5 years in a sample of 491 families. Logistic regressions were performed using wasting and stunting as outcome variables. No strong associations were found between wasting and socio-economic determinants. Stunting showed strong associations for education levels of mother and father and with the family assets. This study is important for it shows that in this sample the causes of malnutrition were different for stunting and wasting.

The associations between stunting and wasting, in children under five, were examined globally to attempt to explain the variability among nations (Frongillo, de Onis, & Hanson, 1997). The data came from the WHO Global Database on Child Growth. The authors used nationally representative studies that were done after 1980. Seventy countries were included from Africa, Asia and Latin America. Using a comprehensive conceptual model, underlying causes and basic causes of malnutrition were analyzed. Specific variables were selected for multiple linear regression models through correlation and factor analyses. Results found that once social, economic, and demographic factors were accounted for, differences between global patterns of wasting and stunting were eliminated. Most of the variability among nations was explained by national factors. More of the variability of stunting than wasting could be explained. Energy availability was the only factor associated both with stunting and wasting. Stunting was associated with female literacy, health expenditures and gross national product, while wasting was associated

with immunization. These results indicate that there are differences in causation in stunting and wasting. These results have implications for intervention strategies. Solutions should target those determinants that are causing the greatest burden of malnutrition.

2.4 Summary

The nutritional status of children varies in different parts of the world and according to the choice of nutritional indicator. There are also differing statistical associations of anthropometric indicators among regions. Victora (1992) noted that the varying prevalences of anthropometric indicators and associations between these indicators may be contributed to different causes of undernutrition. The work of Frongillo and his associates (1997) further suggest that there are different causes for stunting and wasting. There is a need of a greater understanding of the social and economic determinants of malnutrition with respect to each indicator.

This section has linked various socio-economic factors to child growth. Some factors such as maternal education and adequate sanitation have strong and positive impacts on child nutrition, while the relationships between malnutrition and factors such as maternal work status and sex of the child are not as clear. Most studies examine one anthropometric indicator at a time, or discuss the determinants of growth as a general category of undernutrition. The studies that have examined determinants according to specific indicators have found that relationships are different according to the choice of indicator (Bouvier et al., 1995; Bicego & Boerma, 1993). The relationship between varying nutritional patterns and the socio-economic determinants of growth of each indicator is explored. The present study adds to this body of research by examining these relationships over time.

The studies reviewed have described trends in nutritional status of children over time and others have described differentials of malnutrition. This study builds on this long tradition of research by relating some of the key determinants of malnutrition to patterns of nutritional status. Furthermore, most of the studies examining the determinants of growth have focused on one country. This study compares nutritional and socio-economic factors across countries. An attempt is made to determine common determinants for all five countries.

Chapter Three: Methods

Monitoring the nutritional status of children and women is a fundamental instrument for the goal of ending malnutrition.

~ Stewart Macpherson (1993)

3.0 Source of data

The data for this thesis came from Demographic and Health Surveys (DHS, 1998). Funded by the United States Agency for International Development (USAID), DHS assists developing countries in the implementation of nationally representative surveys. Based on multistage random sampling, these surveys contain demographic and health data as well as background information. Originating in 1984, DHS has implemented three phases of surveys, DHS-I (1984-1989), DHS-II (1988-1993) and DHS-III (1992-1997). DHS surveys are a powerful source for comparing data between countries (Caulfield, Bentley & Ahmed, 1996; Esrey, 1995; Fosu, 1994; Bicego & Boerma, 1993; Forsberg, Van Ginneken & Nagelkerke, 1993).

While there is a shortage of surveys measuring social indicators of development in most developing countries, DHS has been acclaimed as one of the best sources of data and is used by many researchers in various fields. There is a wide body of literature that discusses the quality of DHS data (Le & Verma, 1997; Sommerfelt & Stewart, 1994; Sommerfelt & Stewart, 1993; Boerma & Sommerfelt, 1993). A few key points will be summarized that are relevant to this particular study.

DHS surveys have not been conducted at regular intervals. At this time, it is not possible to examine each country after a ten year span, with the exception of Brazil. Each country, however, has had the first survey conducted in the late 1980's and the second

survey in the mid 1990's. This allows for a comparison before and after the World Summit for Children. Furthermore, as the year 2000 approaches, this study will describe changes and progress that occurred throughout the 1990's.

DHS surveys are cross-sectional, therefore it is not possible to evaluate nutritional and health status of children at an individual level. Cross-sectional data are useful for depicting national patterns and can show strong associations with certain socio-economic, environmental and demographic factors (McMurray, 1996).

Like other large sample surveys, information in DHS surveys are highly subjected to reporting and recall biases (Boerma & Sommerfelt, 1993). Most of the health information such as diarrhea prevalence and age of the child is obtained from maternal reporting which inevitably leads to recall bias. Weight and height measurements are measured by the researchers, so the measurements are not influenced by reporting bias but there will contain some measurement errors. Misclassification biases have also been noted, and are extremely difficult to correct. Boerma & Sommerfelt (1993) suggested that these biases are not too problematic if they are fairly random, but caution should be extended when interpreting individual level data.

3.1 Sampling Procedures

Purposive sampling was utilized to select countries for analysis. Countries were selected on the following criteria: the country must have been surveyed during the mid- to-late 1980's and then surveyed five to ten years later, and the survey must contain a child anthropometry segment. Only five countries met the stipulated criteria: Brazil, Guatemala, Uganda, Mali and Zimbabwe. A further description of the surveys can be seen in Appendix A.

3.2 Country Profiles

Brazil is the largest country in South America (total area = 8,511,965 square kilometers) (Gale, 1998). The population (1996) in Brazil is approximately 160 million with an annual growth rate of 1.7%. The adult literacy rate is 81%. Of the five countries in this study, Brazil ranks the highest on the human development index (HDI) (see Table 3.1). The Gross Domestic Product (GDP) per capita (1994) in US dollars is 5,362 (United Nations, 1997). Urban growth has been extremely fast and as of 1991, 75% of the population were living in urban areas (Gale, 1998). Brazil has a highly diversified economy and large variations in levels of development. Appearing to lead many other developing countries in economic development, Brazil also has one of the most inequitable distributions of incomes in the world. The Northeast region is the poorest part of Brazil, and displays lower social development than other regions.

Guatemala, located in Central America (total area = 108,890 square kilometers) has a population (1996) estimated to be 10.5 million with an annual population growth rate of 2.9% (Gale, 1998) Guatemala, similarly to Brazil, has a medium ranking on the HDI, but falls below Brazil by .21. The literacy rate is considerably lower than Brazil's at 52%. The GDP per capita in US dollars (1994) is 3,208 (UNDP, 1997). The economy has been growing steadily in the 1990's, but the developmental process has been problematic due to natural hazards such as volcanoes, tropical storms and frequent earthquakes. Guatemala also has poor distribution of income and wealth; the wealthiest 10% of the population receive close to 50% of all income. More than half the population lives in poverty of which two thirds live in extreme poverty.

Mali, located in Western Africa (total area = 1.24 million square kilometers), has a population (1997) of 9.8 million with an annual growth rate of 2.9% (Gale, 1998). Mali ranks extremely low on the HDI, among the lowest five countries in the world. The literacy rate is 15%. Mali is one of the ten poorest countries in the world with a per capita income in US dollars (1994) of 543 (UNDP, 1997). With limited land available to agriculture, most economic activity, fishing and farming, is concentrated in one area (Gale, 1998). Furthermore, Mali is burdened by recurring droughts. There was economic progress in the early 1980's after a series of adjustment and stabilization programs but progress slowed considerably in 1987. Mali is extremely dependent on foreign aid and is vulnerable to fluctuations in world prices.

Uganda, located in Eastern Africa (total area = 236,040 square kilometers), has a population (1995) of approximately 19 million people with an annual growth rate of 2.9% (Gale, 1998). Uganda has a low rating on the HDI, slightly higher than Mali. The literacy rate is considerably higher than Mali's at 62%. Blessed with significant natural resources the Ugandan economy has great potential, however, political instability and inconsistent economic management have made Uganda one of the poorest countries in the world with a GDP per capita in US dollars (1994) of 1370 (UNDP, 1997). After periods of economic setbacks throughout the 1980's there has been economic progress including significant decreases in inflation after 1987 (Gale, 1998).

Zimbabwe is situated in Southern Africa (total area = 390,759 square kilometers) with a population (1991) of 11.5 million with an annual growth rate of 3.1%. Zimbabwe rates low on the HDI, but has the highest score of the three African countries. The literacy rate for Zimbabwe is the highest among the selected countries at 85%. Zimbabwe

is a lower-middle income country with a GDP per capita in US dollars (1994) of 2,196 (UNDP, 1997). Throughout the 1980's, Zimbabwe experienced periods of economic growth along with foreign exchange crisis and droughts. Economic reform began in 1991 but there have been persistent problems with budget deficits.

Table 3.0 Human Development Index ratings for all five countries (HDI) (Human Development Report, 1997)

Country	HDI	HDI Ranking (of 175 countries)	HDI Classification
Brazil	.783	68	Medium
Guatemala	.572	117	Medium
Mali	.229	171	Low
Uganda	.328	159	Low
Zimbabwe	.513	129	Low

The human development index is a measure of development composed of three indicators: life expectancy, literacy and income. The index is measured on a scale from zero-to-one with higher values signifying higher levels of human development.

Latin America has seen tremendous progress in child health in the past fifty years. The under 5 mortality rate (U5MR) dropped from 15% in 1960 to 5% in 1993, the lowest rate in the developing world (UNICEF, 1998). Brazil and Guatemala have similar U5MR and infant mortality rates (IMR), as seen in Table 3.2. Guatemala, however, has a much higher percent of children underweight (identical to the percent of children underweight in Mali), and the social indicators of Guatemala are among the worst in Latin America (Gale, 1998).

Sub-Saharan Africa has displayed the slowest progress for child health in the world (UNICEF, 1998). Mali demonstrates the poorest child health of the selected countries, ranking seventh for the U5MR, a rate approximately four times higher than Brazil and Guatemala. Uganda has a low U5MR; there is no available data for the percent of children underweight, but Uganda displays the lowest percent of low birthweight babies born between 1990 and 1994. Zimbabwe falls in the middle of the Latin American countries and Uganda for all selected health indicators.

Table 3.1 Selected child health indicators

Country	Under-5 Mortality Rate 1996	Under-5 Mortality Rank 1996	Infant Mortality Rate 1996	Underweight children under age 5 (%) 1990-1996	% of infants with low birth weight 1990-1994
Brazil	52	79	44	6	11
Guatemala	56	74	43	27	15
Mali	220	7	134	27	17
Uganda	141	30	88	-	26
Zimbabwe	73	65	49	16	14
World	88	175	60	30	17

Source: UNICEF (1998)

Definitions of the indicators:

Under-5 mortality rate-Probability of dying between birth and exactly five years of age expressed per 1,000 live births
Under-5 mortality rank-Rank of country in descending order of their estimated 1996 under-5 mortality rate out of 175 countries.
Infant mortality rate-Probability of dying between birth and exactly one year of age expressed per 1,000 live births.
Underweight-Moderate below two standard deviations from median weight for age of reference population
Low birthweight-Less than 2500 grams.
- data not available

3.3 Description of Sample

The surveys were cross-sectional household surveys administered to women of childbearing age, regardless of marital status. The respondents were women 15-44 years of age in Brazil and Guatemala and 15-49 in Mali, Uganda and Zimbabwe. Anthropometric measurements of children were assessed in a nationally representative sample with the exception of Brazil 1986, which recorded anthropometry in the Northeast region. Only children from the Northeast region were, therefore, selected from the Brazil 1996 survey to maintain consistency. Children were measured at specific ages varying among surveys between 0 to 66 months. To increase comparability between surveys children were selected if their age fell between 3-35 months. The data were further reduced to remove subjects with missing data and flagged cases. Flagged cases were extremely improbable Z-scores determined by DHS.

3.4 Description of Variables

Outcome measures. The three anthropometric measurements described in Chapter one (height-for-age, weight-for-height, and weight-for-age) were calculated by dividing the provided percent Z-score by 100. DHS calculated percent Z-scores from the median of the International Reference Population developed by the United States Centers for Disease Control and recommended by the World Health Organization (Sommerfelt & Stewart, 1994). Weight-for-height, was removed from multivariate analyses, however, due to the small percent of children in the surveys that were classified as wasted.

Predictor variables. Nine predictor variables were chosen for the multivariate analysis. These variables were adopted from a DHS comparative study, which used numerous differentials to compare the nutritional status of children across countries

(Sommerfelt & Stewart, 1994). These researchers have extensive knowledge of determinants of child health and an excellent working knowledge of DHS data. The variables were clear and could be easily adapted to this study. The variables were classified into three categories: socio-economic, environmental and health. Each category represented a level in the hierarchial relationship of the determinants of malnutrition.

The socio-economic variables included place of residence, maternal education, maternal work status, radio ownership, and sex of child. Current place of residence was defined as rural or urban according to the individual country's national statistical office. Maternal education was defined as the highest level of schooling attended, regardless of whether or not the woman completed the level. Secondary and higher education was collapsed into one level because of the small number of women achieving higher education in these surveys. Mother's work status was defined as whether or not the woman was working at the time of the survey and if she was working for cash wages. Radio ownership has been included as a proxy of household income (Sommerfelt & Stewart, 1994). A family owning a radio is more likely to have greater financial security than a family that does not own a radio. Furthermore, radio ownership increases exposure to health education and information. Sex of the child was included to control for both for the biological and the social importance.

The environmental variables included source of drinking water and sanitation facilities. Both variables were important in addressing the synergistic relationship of malnutrition and disease (Esrey, 1996). The variables were collapsed into three levels to maintain simplicity. Moreover, surveys differed in the manner that the variables were defined (eg. whether or not the wells were differentiated between protected or not

protected); these levels helped to maintain consistency between surveys. Source of drinking water was categorized into piped water, well/pump water or surface water. Sanitation facilities were categorized as flush toilets, latrines or no facilities.

Immunization status and diarrhea prevalence were included as indicators of general health and also to address the disease-nutrition cycle. Immunization status was classified into three categories; measles vaccination, other vaccination or no vaccination. Measles was included as a separate level for immunization status due to the importance of this vaccination with respect to nutritional status (Sommerfelt & Stewart, 1994; Ulijasek, 1990). The surveys classified diarrheal illness according to whether or not the child was ill during the preceding 24 hours or in the past two weeks. This study dichotomized the variable as either diarrhea or no diarrhea.

3.5 Data Analysis Procedures

All analyses were performed using the Statistical Package for Social Sciences (SPSS) version 8.0. The data analysis was conducted in two stages. In the first stage, univariate techniques were used to describe patterns and trends of nutritional status over time and to compare these trends between countries. Multivariate techniques were used in the second phase to produce models with a set of predictor variables for malnutrition. These models were used to compare patterns of key factors over time. An attempt was made to determine if there are common determinants for all five developing countries.

Univariate Analysis:

The percent of children that were stunted, wasted and underweight were calculated for each survey using the cut-off points of minus 2 standard deviations. These

measurements provided a general description of trends and nutritional changes. T-tests were then performed to determine if there were significant changes in each anthropometric measurement between the first and second survey of each country. Separate T-tests were also performed to determine if there were changes in nutritional status with respect to place of residence and sex of the child within each country as well as over time. The statistical associations between all three anthopometric indicators were examined by Pearson's correlations.

Multivariate Analysis:

Data analysis was guided by a conceptual framework of malnutrition (see Figure 3.0). Conceptual frameworks can be important in aiding multivariate analyses that study complex hierarchial interelationships of determinants of disease (Victora, Huttly, Fuchs& Olinto. 1997). The choice of factors and the ordering of variables were therefore not based purely on statistical relationships. Relying on systematic, mechanical and traditional algorithms (such as stepwise regression) fails to account for theoretical or statistical relationships and can lead to various sources of error (Rothman & Greenland, 1998). The regression models were built by entering the variables in three steps following the categories of socio-economic, environmental and health (see Figure 3.1). This method illustrated how the factors influence each other.

Figure 3.0 Conceptual framework of risk factors for malnutrition in developing countries

SOCIOECONOMIC			
MATERNAL REPRODUCTIVE			ENVIRONMENTAL
GESTATIONAL			
BIRTHWEIGHT			PERINATAL
CHILD CARE	DIET	INFECTIOUS DISEASE	PREVIOUS MORBIDITY
MALNUTRITION			

Source: Adapted from Victora, Huttly, Fuchs & Olinto, 1997

Figure 3.1 Logistic Regression Models

Model 1 **Socioeconomic**	**Model 2** **Socioeconomic and Environmental**	**Model 3** **Socioeconomic, Environmental and Health**
Sex of child	Sex of child	Sex of child
Urban-rural residence	Urban-rural residence	Urban-rural residence
Maternal education	Maternal education	Maternal education
Mother's work status	Mother's work status	Mother's work status
Radio ownership	Radio ownership	Radio ownership
	Source of drinking water	Source of drinking water
	Sanitation facilities	Sanitation facilities
		Immunization status
		Diarrhea prevalence

A series of logistic regressions were performed for each survey. The goal of this analysis was to attempt to produce models that encompassed a set of predictor variables that influence nutrition. Through these models, comparisons were made to examine changes in nutritional status over time and among countries.

Logistic regression is an extremely popular and useful method in public health research (Hosmer, Taber, & Lemeshow, 1991). This statistical method was chosen for this analysis since the predictor variables are all discrete. Logistic regression allows the use of discrete, continuous or a combination of both types of variables (Tabachnick & Fidel, 1997). Moreover, logistic regression allows for the easy interpretation of odds ratios, a key role in understanding the risk factors of malnutrition.

Hosmer, Taber, & Lemeshow (1991) stress the importance of assessing the fit of logistic regression models before attempting to interpret results. Two elements were used as measures of goodness-of-fit: chi-square of the model, and the classification table for predicted versus observed. The chi-squares were significant for all of the stunting and underweight models. Three surveys for the wasting models had chi-squares that were not statistically significant. In most of the models classification was over 70% and many were greater than 90%. The concern of these models, however, was the poor classification of cases (stunted, underweight, wasted). The wasted models had extremely poor classification of cases, this is most likely due to the small prevalence of wasting in the samples. Due to the poor model fits, the wasting models were not analyzed in the study.

3.6 Limitations of the Study

The present study had several limitations that should be noted. First of all, the presentation of mean averages of each nutritional indicator at a national level was not able to represent regional disparities within countries. Furthermore, the averages of the anthropometric indicators were not able to account for reasons behind changes in these

indicators; the measurements were only able to *describe* changes and patterns of nutritional status.

The goal of this study was not to produce an exhaustive list of determinants, but rather to examine trends in a few key predictor variables. Many important factors are therefore not examined in this study such as calorie intake, seasonal variation, and access to health care. Moreover, these factors are not available in DHS surveys. The analysis is also not able to address factors such as the impact of AIDS and structural adjustment programs that have wiped out some of the progress made in public health throughout the past decade.

The selected countries cover two regions in the developing world, Latin America and sub-Saharan Africa, providing an interesting comparison for analysis. The small sample size will, however, prevent generalizations to these regions and to other developing nations. In particular, Asian countries where malnutrition has the highest prevalence, were not available for analysis.

The small prevalence of wasting in the study samples led to inadequate logistic regression models. This prevented an examination of the determinants of wasting. The stunting and underweight models were also problematic. The underweight models, in particular, contain some unexplainably high odds ratios. Data considerations for logistic regression preceded the analysis; these included ratio of cases to variables, adequacy of expected frequencies, multicollineariy and outliers (Tabachnick & Fidel, 1997). These assumptions were adequately met. The chi-square tests indicated that the models were appropriate for analysis. The only explanation that can be extended to rationalize the problematic logistic regression results is the 'nature of the data'.

Chapter Four: Research Findings

4.0 Introduction

This chapter presents the results of the data analyses described in chapter Three. The structure of the chapter is as follows. The first section is an overview of the tables and figures, which present the main results of the study. The second section summarizes the descriptive statistics. The third section summarizes the univariate results. The fourth section is a summary of the descriptive and univariate results. The fifth section presents the multivariate results followed by a summary of these results. All univariate and multivariate results were considered significant at the .05 level, unless otherwise specified.

4.1 Compilation of Tables and Figures

The results of the analyses are summarized in several tables and figures. Table 4.0 presents the percent of children undernourished for each anthropometric indicator. Table 4.1 is a more complex description of the anthropometric indicators. Figure 4.0 distinguishes anthropometric indicators according to residence and Figure 4.1 according to sex of the child. Figures 4.2 and 4.3 summarize T-test results of intra-country comparisons for place of residence and sex of the child. Table 4.2 summarizes T-test results of the changes in nutritional status over time; similar tables are presented with respect to place of residence (Table 4.3) and sex of the child (Table 4.4). Figure 4.5 shows the predictor variables that were significant for each logistic regression model with stunting as the outcome variable and a similar presentation is seen in Figure 4.6 using underweight as the outcome variable. Odds ratios for full logistic regression models can be seen in Table 4.7 for stunting and in Table 4.8 for underweight children.

4.2 Descriptive Statistics

Results indicate several marked patterns in nutritional status (Table 4.0). The countries display similar patterns of undernutrition, with the exception of Mali. During the 1980's and 1990's, Brazil, Guatemala, Uganda and Zimbabwe have a larger percent of stunted than underweight children combined with a low percent of wasted children. Over time, three trends occur. First, the countries show a decrease in the prevalence of stunting. Second, the countries show an increase in the prevalence of wasting. Third, Latin American countries show a decrease in the prevalence of underweight children, while African countries show increases in the percent of children who are underweight. Mali displays a higher prevalence of children underweight than children who are stunted combined with high rates of wasting. Over time, this pattern is maintained but there is an increase in all three indicators.

Further categorizing as suggested by Waterlow and his associates (1977) leads to a richer description of nutritional status (Table 4.2). This categorization illustrates that the percent of children stunted *and* wasted increases over time (except Northeast Brazil). The percent of children that are underweight but are not stunted or wasted also increases (except Mali). The percent of children, who are not stunted, wasted or underweight is an indicator of good nutritional status. Northeast Brazil displays quite a large increase in this indicator, while Guatamala, Uganda and Zimbabwe show only a slight increase. Mali shows an almost 20% decrease.

Place of residence clearly indicates differences in the levels of undernutrition (Figure 4.0). The percent of children stunted and underweight are greater in rural areas than in urban areas. The levels of wasting vary according to country and time. Over time,

the percent of children who were wasted increases in both rural and urban areas. The changes in prevalence of children stunted and underweight varied between surveys.

The nutritional indicators are compared with respect to the sex of the child in Figure 4.1. Generally there is a higher prevalence of undernourishment in male compared to female children. This gender gap, however, is small. Over time, male children show decreases in stunting (except in Mali) and increases in wasting. The percentage of boys underweight decreases in the Latin America countries but increases in African countries. Female children also demonstrate increases in wasting but showed no consistent pattern changes for the other two indicators.

Table 4.0 Anthropometric Indicators

Country	Year	% Stunted	% Wasted	% Underweight	Sample Size
Brazil (NE)	1986	29.2	0.9	14.0	644
Brazil (NE)	**1996**	**17.2**	**2.8**	**8.0**	**1306**
Guatemala	1987	57.7	1.3	33.2	2207
Guatemala	**1995**	**53.7**	**4.5**	**32.3**	**4908**
Mali	1987	22.9	11.3	29.9	948
Mali	**1996**	**33.0**	**24.8**	**43.6**	**4263**
Uganda	1988	42.5	2.0	23.7	2297
Uganda	**1995**	**34.8**	**6.2**	**26.2**	**3350**
Zimbabwe	1988	29.8	1.2	12.6	1496
Zimbabwe	**1994**	**24.0**	**5.9**	**17.5**	**1907**

Table 4.1 Combination of Anthropometric Indicators

Country	Year	% Stunted Only	% Wasted Only	% Stunted and Wasted	% Underweight (not stunted or wasted)	% Not stunted, wasted or underweight	Total*	Sample Size
Brazil (NE)	1986	28.4	0.2	0.8	0.9	69.7	100.0	644
Brazil (NE)	**1996**	**16.9**	**2.5**	**0.4**	**1.6**	**78.5**	**99.9**	**1306**
Guatemala	1987	57.0	0.6	0.7	1.4	40.1	99.8	2207
Guatemala	**1995**	**51.0**	**1.8**	**2.7**	**2.2**	**42.1**	**99.8**	**4908**
Mali	1987	18.8	7.2	4.1	6.3	63.3	99.7	948
Mali	**1996**	**23.9**	**15.7**	**9.1**	**5.7**	**45.2**	**99.6**	**4263**
Uganda	1988	41.1	0.7	1.4	2.0	54.6	99.8	2297
Uganda	**1995**	**32.4**	**3.7**	**2.5**	**3.4**	**57.4**	**99.4**	**3350**
Zimbabwe	1988	29.3	0.7	0.5	1.9	67.3	99.7	1496
Zimbabwe	**1994**	**22.7**	**4.6**	**1.3**	**3.4**	**67.8**	**99.8**	**1907**

*Total % all approximate 100.0.

Figure 4.0 Anthropometric Indicators for Urban versus Rural Residence

BRAZIL

Year	1986	**1986**	1996	**1996**
Residence	Urban	**Rural**	Urban	**Rural**
Sample Size	313	**331**	890	**416**
% stunted	22.7	**35.3**	13.6	**25.0**
% wasted	1.6	**0.3**	2.9	**2.6**
% underweight	11.2	**16.6**	7.1	**10.1**

GUATEMALA

Year	1987	**1987**	1995	**1995**
Residence	Urban	**Rural**	Urban	**Rural**
Sample Size	615	**1592**	1126	**3782**
% stunted	46.8	**61.9**	39.3	**58.0**
% wasted	1.3	**1.3**	3.4	**4.8**
% underweight	25.2	**36.2**	20.7	**35.6**

MALI

Year	1987	**1987**	1996	**1996**
Residence	Urban	**Rural**	Urban	**Rural**
Sample Size	493	**455**	1306	**2957**
% stunted	19.1	**27.0**	26.1	**36.0**
% wasted	10.3	**12.3**	26.5	**24.1**
% underweight	25.8	**34.3**	37.7	**46.2**

UGANDA

Year	1988	**1988**	1995	**1995**
Residence	Urban	**Rural**	Urban	**Rural**
Sample Size	378	**1919**	917	**2433**
% stunted	26.7	**45.6**	24.3	**38.8**
% wasted	1.3	**2.2**	5.5	**6.5**
% underweight	15.6	**25.3**	18.0	**29.3**

ZIMBABWE

Year	1988	**1988**	1994	**1994**
Residence	Urban	**Rural**	Urban	**Rural**
Sample Size	350	**1146**	424	**1483**
% stunted	16.0	**34.0**	17.5	**25.8**
% wasted	1.4	**1.1**	5.4	**6.0**
% underweight	6.9	**14.4**	11.3	**19.6**

Figure 4.1 Anthropometric Indicators for Sex of Child

BRAZIL

Year	1986	**1986**	1996	**1996**
Sex of child	Male	**Female**	Male	**Female**
Sample Size	322	**322**	651	**655**
% stunted	31.7	**26.7**	20.0	**14.5**
% wasted	1.2	**0.3**	2.8	**2.9**
% underweight	14.6	**13.4**	9.1	**7.0**

GUATEMALA

Year	1987	**1987**	1995	**1995**
Sex of child	Male	**Female**	Male	**Female**
Sample Size	1091	**1116**	2457	**2451**
% stunted	58.7	**56.7**	55.0	**52.4**
% wasted	1.1	**1.5**	5.3	**3.6**
% underweight	32.4	**33.9**	32.6	**31.9**

MALI

Year	1987	**1987**	1996	**1996**
Sex of child	Male	**Female**	Male	**Female**
Sample Size	497	**451**	2101	**2162**
% stunted	22.7	**23.1**	33.6	**32.4**
% wasted	14.3	**8.0**	25.8	**23.8**
% underweight	30.2	**29.5**	42.7	**44.4**

UGANDA

Year	1988	**1988**	1995	**1995**
Sex of child	Male	**Female**	Male	**Female**
Sample Size	1124	**1173**	1623	**1727**
% stunted	44.7	**40.4**	37.4	**32.4**
% wasted	2.0	**2.0**	7.0	**5.5**
% underweight	24.6	**22.8**	28.8	**23.7**

ZIMBABWE

Year	1988	**1988**	1994	**1994**
Sex of child	Male	**Female**	Male	**Female**
Sample Size	729	**767**	936	**971**
% stunted	31.0	**28.7**	24.6	**23.4**
% wasted	1.5	**0.9**	7.4	**4.4**
% underweight	13.6	**11.7**	19.8	**15.2**

4.3 Univariate Analysis

Intra-country comparisons indicate statistically significant differences between urban and rural residence for stunting and underweight status (Figure 4.2). Place of residence for wasting, however, is significantly different only in Uganda and Zimbabwe. Examining differences according to sex of the child indicates that in most cases there are no statistically significant differences (Figure 4.3). Uganda and Zimbabwe display the highest rates of sex differences.

There are significant changes in nutritional status over time for all countries (Table 4.2). When distinguishing place of residence there are changes in anthropometric indicators over time for urban and rural residence (Table 4.3). There were, however, three exceptions: wasting in rural Brazil (NE), wasting in urban Guatemala and stunting in urban Zimbabwe. There are also statistical differences in nutritional status when examining sex of the child over time (Table 4.4). The cases that are not statistically significant include wasted females in Brazil (NE) and Guatemala, wasted males in Brazil (NE) and underweight males in Uganda.

Table 4.5 shows the results of the Pearson's correlations between the prevalences of stunting and wasting, underweight and wasting, and stunting and underweight for each country during the 1980's and 1990's. There are strong direct correlations between the prevalences of stunting and underweight, weaker correlations between wasting and underweight and no association between stunting and wasting. There were increases in the magnitude of the correlations between wasting and underweight for each country during the 1990's. The correlations between stunting and underweight decreased over time, except in Zimbabwe.

Figure 4.2 T-test[1] Results: Urban versus Rural Residence (Intra-Country Comparisons)

BRAZIL			
Year	Indicator	t(df)	p-value
1986	stunted	4.50(642)	.000
1996	**stunted**	**6.50(1304)**	**.000**
1986	underweight	3.56(642)	.000
1996	**underweight**	**4.78(1304**	**.000**
1986	wasted	0.63(642)	.266
1996	**wasted**	**0.01(1304)**	**.496**
GUATEMALA			
Year	Indicator	t(df)	p-value
1987	stunted	6.97(2205)	.000
1995	**stunted**	**13.3(4906)**	**.000**
1987	underweight	5.96(2205)	.000
1995	**underweight**	**10.4(4906)**	**.000**
1987	wasted	1.51(2205)	.066
1995	**wasted**	**1.95(4906)**	**.026**
MALI			
Year	Indicator	t(df)	p-value
1987	stunted	2.83(946)	.003
1996	**stunted**	**6.83(4261)**	**.000**
1987	underweight	2.69(946)	.004
1996	**underweight**	**4.69(4261)**	**.000**
1987	wasted	1.09(946)	.137
1996	**wasted**	**-0.50(4261)**	**.309**
UGANDA			
Year	Indicator	t(df)	p-value
1988	stunted	0.92(2295)	.000
1995	**stunted**	**9.23(3348)**	**.000**
1988	underweight	0.89(2295)	.000
1995	**underweight**	**8.24(3348)**	**.000**
1988	wasted	0.30(2295)	.000
1995	**wasted**	**2.94(3348)**	**.002**
ZIMBABWE			
Year	Indicator	t(df)	p-value
1988	stunted	8.31(1494)	.000
1994	**stunted**	**3.66(1905)**	**.000**
1988	underweight	8.71(1494)	.000
1994	**underweight**	**5.69(1905)**	**.000**
1988	wasted	9.81(1494)	.000
1994	**wasted**	**4.52(1905)**	**.000**

[1]two-tailed independent T-test

Figure 4.3 T-test[1] Results: Male versus Female Child (Intra-Country Comparisons)

BRAZIL			
Year	Indicator	t(df)	p-value
1986	stunted	-.515(642)	.304
1996	**stunted**	**-2.39(1304)**	**.009**
1986	underweight	-.113(642)	.455
1996	**underweight**	**-1.14(1304)**	**.129**
1986	wasted	0.10(642)	.459
1996	**wasted**	**0.21(1304)**	**.418**

GUATEMALA			
Year	Indicator	t(df)	p-value
1987	stunted	-0.21(2205)	.419
1995	**stunted**	**-2.41(4906)**	**.008**
1987	underweight	-0.14(2205)	.445
1995	**underweight**	**-2.27(4906)**	**.012**
1987	wasted	-0.53(2205)	.298
1995	**wasted**	**-1.67(4906)**	**.047**

MALI			
Year	Indicator	t(df)	p-value
1987	stunted	-.386(946)	.350
1996	**stunted**	**-1.14(4261)**	**.127**
1987	underweight	-1.40(946)	.081
1996	**underweight**	**0.09(4261)**	**.465**
1987	wasted	-2.42(946)	.008
1996	**wasted**	**-0.15(4261)**	**.440**

UGANDA			
Year	Indicator	t(df)	p-value
1988	stunted	-3.29(2295)	.001
1995	**stunted**	**-3.62(3348)**	**.000**
1988	underweight	-2.26(2295)	.012
1995	**underweight**	**-2.45(3348)**	**.008**
1988	wasted	-0.90(2295)	.184
1995	**wasted**	**-0.80(3348)**	**.211**

ZIMBABWE			
Year	Indicator	t(df)	p-value
1988	stunted	-2.06(1494)	.020
1994	**stunted**	**-1.20(1905)**	**.115**
1988	underweight	-0.18(1494)	.428
1994	**underweight**	**-2.83(1905)**	**.003**
1988	wasted	1.19(1494)	.118
1994	**wasted**	**-3.47(1905)**	**.001**

[1] two-tailed independent T-test

Table 4.2 T-Test[1] Results for Changes in Nutritional Status over Time

Country	Indicator	*t(df)	p-value
Brazil (NE)	Stunted	-8.95(1320.1)	.000
Brazil (NE)	Underweight	-4.52(1200.1)	.000
Brazil (NE)	Wasted	1.90(1443.7)	.029
Guatemala	Stunted	-4.58(4248.1)	.000
Guatemala	Underweight	-2.42(4486.8)	.008
Guatemala	Wasted	2.44(5185.5)	.008
Mali	Stunted	5.73(1561.3)	.000
Mali	Underweight	8.65(1477.9)	.000
Mali	Wasted	8.38(1631.0)	.000
Uganda	Stunted	-6.24(4952.2)	.000
Uganda	Underweight	2.30(5104.4)	.011
Uganda	Wasted	38.5(5584.1)	.000
Zimbabwe	Stunted	-6.09(3289.8)	.000
Zimbabwe	Underweight	4.56(3277.5)	.000
Zimbabwe	Wasted	11.7 (3339.7)	.000

* equal variances were not assumed
[1] two-tailed independent T-test

Table 4.3 T-test[1] Results in Changes of Nutritional Status over Time: Rural versus Urban Residence

Country	Residence	Indicator	*t(df)	p-value
Brazil (NE)	rural	Stunted	-4.68(723.0)	.000
Brazil (NE)	rural	Underweight	-2.51(684.6)	.006
Brazil (NE)	rural	Wasted	0.97(742.5)	.166
Brazil (NE)	urban	Stunted	-5.70(549.8)	.000
Brazil (NE)	urban	Underweight	-2.30(503.3)	.011
Brazil (NE)	urban	Wasted	1.68(589.4)	.05
Guatemala	rural	Stunted	-3.67(3049.3)	.000
Guatemala	rural	Underweight	-1.89(3180.1)	.030
Guatemala	rural	Wasted	2.06(3713.3)	.020
Guatemala	urban	Stunted	-4.40(1171.0)	.000
Guatemala	urban	Underweight	-2.82(1293.2)	.003
Guatemala	urban	Wasted	1.05(1442.3)	.147
Mali	rural	Stunted	3.67(645.7)	.000
Mali	rural	Underweight	5.24(609.0)	.000
Mali	rural	Wasted	5.31(680.8)	.000
Mali	urban	Stunted	2.27(999.0)	.012
Mali	urban	Underweight	5.37(1014.4)	.000
Mali	urban	Wasted	6.29(1082.6)	.000
Uganda	rural	Stunted	-4.41(4126.4)	.000
Uganda	rural	Underweight	2.89(4213.0)	.002
Uganda	rural	Wasted	9.88(4304.0)	.000
Uganda	urban	Stunted	-1.89(692.4)	.030
Uganda	urban	Underweight	2.49(726.1)	.007
Uganda	urban	Wasted	5.97(751.0)	.000
Zimbabwe	rural	Stunted	-7.22(2568.4)	.000
Zimbabwe	rural	Underweight	2.83(2546.0)	.003
Zimbabwe	rural	Wasted	10.5(2586.0)	.000
Zimbabwe	urban	Stunted	-.03(741.7)	.490
Zimbabwe	urban	Underweight	4.23(748.3)	.000
Zimbabwe	urban	Wasted	5.24(756.1)	.000

*equal variances not assumed
[1]two-tailed independent T-test

Table 4.4 T-test[1] Results for Changes in Nutritional Status over Time: Male versus Female

Country	Sex of child	Indicator	t(df)	p-value
Brazil (NE)	Male	Stunted	-5.57(665.4)	.000
Brazil (NE)	male	Underweight	-2.76(577.3)	.003
Brazil (NE)	male	Wasted	1.30(699.5)	.098
Brazil (NE)	female	Stunted	-7.10(649.7)	.000
Brazil (NE)	female	Underweight	-3.66(623.0)	.000
Brazil (NE)	female	Wasted	1.38(742.3)	.084
Guatemala	male	Stunted	-2.45(2103.8)	.007
Guatemala	male	Underweight	-0.86(2227.6)	.195
Guatemala	male	Wasted	2.18(2589.6)	.015
Guatemala	female	Stunted	-4.00(2141.8)	.000
Guatemala	female	Underweight	-2.57(2254.6)	.005
Guatemala	female	Wasted	1.26(2591.2)	.103
Mali	male	Stunted	4.25(822.1)	.000
Mali	male	Underweight	5.34(795.6)	.000
Mali	male	Wasted	4.55(868.7)	.000
Mali	female	Stunted	3.88(737.3)	.000
Mali	female	Underweight	6.94(684.1)	.000
Mali	female	Wasted	7.49(767.9)	.000
Uganda	male	Stunted	-4.58(2458.1)	.000
Uganda	male	Underweight	1.55(2551.6)	.061
Uganda	male	Wasted	7.66(2674.4)	.000
Uganda	female	Stunted	-4.24(2492.9)	.000
Uganda	female	Underweight	1.72(2544.3)	.043
Uganda	female	Wasted	7.95(2584.7)	.000
Zimbabwe	male	Stunted	-4.78(1622.9)	.000
Zimbabwe	male	Underweight	4.46(1592.3)	.000
Zimbabwe	male	Wasted	10.5(1625.1)	.000
Zimbabwe	Female	Stunted	-3.87(1664.8)	.000
Zimbabwe	Female	Underweight	2.00(1680.0)	.023
Zimbabwe	Female	Wasted	6.08(1709.5)	.000

*equal variances not assumed
[1]two-tailed independent T-test

Table 4.5 Correlation of the Prevalences of Anthropometric Indicators, by Survey

Survey	Stunted/Wasted	Underweight/Wasted	Stunted/Underweight
Brazil 1986	.115*	.241*	.559*
Brazil 1996	-.017	.272*	.380*
Guatemala 1987	-.014	.122*	.526*
Guatemala 1995	.024	.286*	.480*
Mali 1987	.115*	.423*	.583*
Mali 1996	.044	.461*	.506*
Uganda 1988	.075*	.201*	.539*
Uganda 1995	.027	.345*	.517*
Zimbabwe 1988	.022	.216*	.430*
Zimbabwe 1994	-.010	.337*	.444*

*Correlation is significant at the 0.01 level (2-tailed).

4.4 Summary of Descriptive and Univariate Results

Results indicate that there were significant changes in nutritional status between the 1980's and 1990's. The type of change varies depending on the choice of indicator. There was a decrease in stunting (except Mali) but an increase in wasting. There was a decline in the percent of children underweight in the Latin American countries but there were increases in the African countries. Place of residence is an important differential in nutritional status, there are higher rates of children undernourished living in rural areas than in urban areas. Over time, nutritional changes occur in both urban and rural areas. Boys are more likely to be undernourished compared to girls. These differences, however, are small and in most cases are not statistically significant.

4.5 Multivariate Results

Model fits:

The original logistic regression models had relatively poor fits; specifically there was poor classification of the models. An inspection of the standardized residuals indicated 0-5% of the sample were outliers (data points that were outside 2 standard deviations), these were subsequently removed to determine their influence. Although outliers have been discussed widely in the literature, there is little information and guidelines concerning multivariate outliers (Chatterjee & Yilmaz, 1992). The removal of the outliers changed the results and improved the overall fit of the models. It was therefore deemed appropriate to remove the outliers, which reflect the results presented here.

Logistic Regression Results:

The logistic regression results were analyzed in two parts: (1) All three models for each survey were examined to determine patterns of variables that were statistically significant in the models. These were compared over time and across countries. (2) The full model was selected for all surveys and odds ratios were compared to examine the quantitative contribution of each predictor variable.

Part 1

Stunting

The results of the logistic regression models using stunting as the predictor variable are summarized in Figure 4.4. The models display various patterns across country and over time.

Two variables, which are common to all countries for Model 1 include place of residence, and maternal education. Sex of the child is included for all countries except Mali. Radio ownership is included for Guatemala, and the African countries. In Model 2 sanitation facilities is significant except in Mali. Source of drinking water is included for Brazil and Uganda. In Model 3, immunization status is included for all countries and diarrhea prevalence is included for all African countries. Although each sequential model typically maintains the variables from the previous models, place of residence displays two different patterns. In Brazil and Zimbabwe, residence is included in Model 1, but is no longer significant in Models 2 and 3. Mali and Uganda maintain place of residence for all three models. Guatemala displays the first pattern during the 1980's and the second pattern during the 1990's.

Over time the variables in Model 1 did not change, except with some differences with respect to sex of the child and radio ownership. In Model 2, source of drinking water, which is not included in the 1980's models appears in the 1990's models. Type of sanitation facilities is more prominent during the 1980's than the 1990's.

Underweight

The results of the logistic regression models using stunting as the predictor variable are summarized in Figure 4.5. These models are not as comparable as the stunting models. Brazil, Mali and Zimbabwe have very few variables included in the 1980's models. There are, however, a few observations that can be made.

Radio ownership and place of residence are common variables in Model 1. Maternal education is significant, except in Brazil. Maternal work status is significant for

the Latin American countries and Uganda. Model 2 includes type of sanitation facilities for Guatemala, Uganda and Zimbabwe, and source of drinking water for Brazil, Uganda and Zimbabwe. Model 3 includes immunization status for all countries, although the measles vaccination appears more frequently. Diarrhea prevalence is also common to all countries.

In general, the models contain more variables during the 1990's compared to the 1980's. In particular, place of residence and maternal education become more prominent. Unlike the stunting models, the addition of the environmental variables did not alter place of residence. Environmental variables are not significant during the 1980's (except in Guatemala). During the 1990's type of sanitation facilities and source of drinking water are included in Models 2 and 3. The health variables remain, relatively unchanged.

Figure 4.4 Summary of the Significant Predictor Variables for each Logistic Regression Model: Stunting Models

(NE)BRAZIL-86	GUATEMALA-87	MALI-87	UGANDA-88	ZIMBABWE-88
Model1	Model 1	Model 1	Model 1	Model 1
Res	Res	Res	Res	Res
Edu(1)	Edu(1)	Edu(1)	Edu(1)	Edu(1)
Edu(2)	Edu(2)	Edu(2)	Edu(2)	Edu(2)
Sex	Radio	Radio	Radio	Radio
			Sex	Sex
Model2	Model 2	Model 2	Model 2	Model 2
Edu(1)	Edu(1)	Res	Res	Edu(1)
Sex	Edu(2)	Edu(1)	Radio	Edu(2)
Sanit(1)	Radio	Edu(2)	Sex	Radio
Sanit(2)	Sanit(1)	Radio	Sanit(2)	Sex
	Sanit(2)			Sanit(1)
Model 3	Model 3	Model 3	Model 3	Model 3
Edu(1)	Edu(1)	Edu(1)	Res	Edu(1)
Sex	Edu(2)	Edu(2)	Radio	Edu(2)
Sanit(1)	Radio	Radio	Sex	Radio
Sanit(2)	Sanit(1)	Immun(1)	Sanit(2)	Sex
Immun(2)	Sanit(2)	Immun(2)	Immun(1)	Sanit(1)
	Immun(1)	Diarrhea	Immun(2)	Immun(2)
	Immun(2)		Diarrhea	Diarrhea
(NE)BRAZIL-96	GUATEMALA-95	MALI-96	UGANDA-95	ZIMBABWE-94
Model 1	Model 1	Model 1	Model 1	Model 1
Res	Res	Res	Res	Res
Edu(1)	Edu(1)	Edu(1)	Edu(1)	Edu(1)
Edu(2)	Edu(2)	Edu(2)	Edu(2)	Edu(2)
Sex	Sex	Radio	Radio	
			Sex	
Model 2	Model 2	Model 2	Model 2	Model 2
Edu(1)	Res	Res	Res	Edu(1)
Edu (2)	Edu(1)	Edu(1)	Edu(1)	Edu(2)
Sex	Edu(2)	Edu(2)	Edu(2)	
Sanit(2)	Sex		Radio	
H2O(1)	Sanit(1)		Sex	
H2O(2)	Sanit(2)		H2O(1)	
			H2O(2)	
Model 3	Model 3	Model 3	Model 3	Model 3
Edu(1)	Res	Res	Res	Edu(1)
Edu(2)	Edu(1)	Edu(1)	Edu(1)	Edu(2)
Work	Edu(2)	Edu(2)	Edu(2)	
Sex	Sex	Immun(1)	Radio	
Sanit(2)	Sanit(1)	Immun(2)	Sex	
H2O(1)	Sanit(2)	Diarrhea	H2O(2)	
H2O(2)	Immun(1)		Immun(1)	
Immun(1)	Immun(2)		Immun(2)	
Immun(2)			Diarrhea	
Diarrhea				

Figure 4.5: Summary of the Significant Predictor Variables for each Logistic Regression Model: Underweight Models

(NE)BRAZIL-86	GUATEMALA-87	MALI-87	UGANDA-88	ZIMBABWE-88
Model 1	Model 1	Model 1	Model 1	Model 1
-	Edu(1)	Radio	Res	Radio
	Edu(2)		Edu(1)	
	Radio		Edu(2)	
			Work	
			Radio	
Model 2	Model 2	Model 2	Model 2	Model 2
-	Edu(1)	Radio	Res	Res
	Edu(2)		Edu(1)	Radio
	Radio		Work	
	Sanit(1)		Radio	
	Sanit(2)		Sex	
Model 3	Model 3	Model 3	Model 3	Model 3
Immun(1)	Edu(1)	Radio	Res	Res
Diarrhea	Edu(2)	Immun(2)	Edu(1)	Radio
	Radio	Diarrhea	Work	Immun(2)
	Sanit(1)		Radio	Diarrhea
	Sanit(2)		Immun(1)	
	Immun(1)		Immun(2)	
	Immun(2)		Diarrhea	
(NE)BRAZIL-96	GUATEMALA-95	MALI-96	UGANDA-95	ZIMBABWE-94
Model 1	Model 1	Model 1	Model 1	Model 1
Work	Res	Res	Res	Res
Res	Edu(1)	Edu(1)	Edu(1)	Edu(1)
Sex	Edu(2)	Edu(2)	Edu(2)	Edu(2)
	Work	Radio	Radio	Radio
	Radio		Sex	Sex
Model 2	Model 2	Model 2	Model 2	Model 2
Res	Res	Res	Res	Res
Work	Edu(1)	Edu(1)	Edu(1)	Edu(1)
Radio	Edu(2)	Edu(2)	Edu(2)	Edu(2)
Sex	Work	Radio	Radio	Radio
H2O(2)	Radio		Sex	Sex
	Sanit(1)		H2O(1)	H2O(1)
	Sanit(2)		H2O(2)	H2O(2)
			Sanit(1)	Sanit(1)
			Sanit(2)	Sanit(2)
Model 3	Model 3	Model 3	Model 3	Model 3
Res	Res	Res	Res	Edu(1)
Work	Edu(1)	Edu(1)	Edu(1)	Edu(2)
Radio	Edu(2)	Edu(2)	Edu(2)	Radio
Sex	Radio	Work	Radio	Sex
H2O(2)	Sanit(1)	Radio	Sex	H2O(1)
Immun(1)	Sanit(2)	Immun(1)	H2O(1)	H2O(2)
Diarrhea	Immun(1)	Immun(2)	H2O(2)	Sanit(1)
	Immun(2)	Diarrhea	Sanit(1)	Sanit(2)
	Diarrhea		Sanit(2)	Immun(2)
			Immun(2)	Diarrhea
			Diarrhea	

Part II

To keep the results clear and simple, only the results of the full logistic regression models are presented. The full model allows for the examination of the socioeconomic variables controlling for environmental and health variables, which is the main interest of this study. Moreover, the results of the first two models do not contribute any further meaning to the study.

The logistic results are presented in the form of odds ratios, an approximation of relative risk. For simplicity, only the odds ratios for the significant variables are presented. (see Table 4.7 for stunting models and Table 4.8 for underweight models) . For greater details concerning logistic regression results, refer to Appendix B. There is great variation in the odds ratios across countries and over time. There are, however, a couple of patterns that emerge.

Interpreting Odds Ratios

An odds ratio that is greater than 1 indicates that the child for the given determinant is more likely to be considered stunted or underweight. An odds ratio that is less than 1 indicates that the variable is decreasing the probability of stunting/underweight. A value of 1 indicates that there is no effect. Table 4.6 presents the coding utilized for the analyses.

Table 4.6 Predictor Variable Coding

Residence (0=urban, 1=rural)
Maternal Education (0=no education, 1=primary, 2=secondary or higher)
Maternal Work Status (0=no, 2=yes)
Radio ownership (0=no, 1=yes)
Sex of child (0=male, 1=female)
Sanitation facilities (0=no, 1=latrine, 2=flush)
Source of drinking water (0=surface, 1=well, 2=piped)
Immunization status (0=no vaccinations, 1=other vaccinations, 2=measles)
Diarrhea (0=no, 1-yes)

Stunting

Generally, there is an increase in the odds ratios for both primary and secondary maternal education between the 1980's and 1990's. Across countries, maternal education consistently has the highest odds ratios, with primary education having higher odds ratios than secondary education. The other variables do not show significant changes in the magnitude of the odds ratios.

Underweight

There appears to be problems with the data because some of the odds ratios are extremely high, interpretation of the models should be done with extreme caution. Maternal education displays a similar pattern to the stunting models in that the odds ratios tend to increase between the first and second survey. Radio ownership, a common variable across countries (except NE Brazil 1986) demonstrates a slight decrease in the magnitude of the odds ratios between the 1980's and 1990's.

Table 4.7 Odds ratios for Stunting

Stunting	Year	Brazil(NE)	Guatemala	Mali	Uganda	Zimbabwe
Residence	80's	-	-	-	0.63	-
	90's	-	0.79	0.61	0.57	-
Education (primary)	80's	3.30	5.22	0.11	-	2.69
	90's	11.96	7.97	7.87	2.86	2.37
Education (secondary)	80's	-	2.90	0.10	-	2.07
	90's	6.28	6.03	5.98	2.35	2.35
Work	80's	-	-	-	-	-
	90's	1.73	-	-	-	-
Radio	80's	-	1.34	2.23	1.33	1.48
	90's	-	-	-	1.20	-
Sex	80's	1.63	-	-	1.21	1.29
	90's	2.49	1.14	-	-	-
Sanitation (latrine)	80's	2.37	2.62	-	-	3.51
	90's	-	2.30	-	-	-
Sanitation (flush)	80's	0.03	2.48	-	0.17	-
	90's	3.46	2.35	-	-	-
Water source (well)	80's	-	-	-	-	-
	90's	6.18	-	-	-	-
Water source (piped)	80's	-	-	-	-	-
	90's	6.93	-	-	0.49	-
Immunization (other)	80's	-	0.52	2.11	0.65	-
	90's	3.00	0.64	0.66	0.64	-
Immunization (measles)	80's	0.53	0.40	0.37	0.69	0.50
	90's	0.26	0.40	0.40	0.53	-
Diarrhea	80's	-	-	0.57	0.81	0.64
	90's	0.63	0.63	0.61	0.72	-

- variable not significant

Table 4.8 Odds Ratios for Underweight Status

Underweight	Year	Brazil(NE)	Guatemala	Mali	Uganda	Zimbabwe
Residence	80's	-	-	-	0.34	38.01
	90's	4.53	0.56	0.82	0.47	-
Education	80's	-	4.81	-	3.04	-
(primary)	90's	-	59.72	2.16	3.77	9.24
Education	80's	-	2.58	-	-	-
(secondary)	90's	-	43.03	1.52	3.01	4.36
Work	80's	-	-	-	0.50	-
	90's	9.24	-	1.14	-	-
Radio	80's	-	1.26	1.52	1.90	10.19
	90's	19.39	1.18	1.28	1.47	0.20
Sex	80's	-	-	-	-	-
	90's	6.41	-	-	1.47	2.42
Sanitation	80's	-	8.62	-	-	-
(latrine)	90's	-	2.40	-	0.32	168.2
Sanitation	80's	-	7.47	-	-	-
(flush)	90's	-	2.23	-	0.23	90.01
Water source	80's	-	-	-	-	-
(well)	90's	-	-	-	4.73	0.11
Water source	80's	-	-	-	-	-
(piped)	90's	9.56	-	-	4.11	0.21
Immunization	80's	9.59	0.71	-	0.63	-
(other)	90's	7.46	0.69	0.62	-	-
Immunization	80's	-	0.41	0.50	0.55	0.09
(measles)	90's	-	0.43	0.61	0.73	0.01
Diarrhea	80's	0.38	-	0.43	0.50	0.20
	90's	0.10	0.70	0.55	0.53	0.35

- Variable not significant

4.6 Summary of Multivariate Results

Findings of the stunting models are more consistent than the underweight models. There appears to be some data problems with the underweight models because some of the odds ratios are extremely high. Both models are examined, but caution should be extended to the interpretation of the underweight models.

Controlling for environmental and health variables, maternal education displays the most consistent pattern of all the socioeconomic variables for stunting, both over time and across countries. Maternal education appears more frequently than any other variable in the models and also has the highest odds ratios among all the statistically significant variables. Although both levels of education are important, primary education is the 'stronger' predictor. These patterns are similar, but not as prominent for the underweight models.

Model 1 for stunting consistently contains place of residence as a significant variable. Place of residence changes, however, with the addition of variables. In some cases residence is removed with the addition of environmental and health variables and in other cases residence remains significant. For the underweight models, place of residence is not displaced with the addition of other variables.

Radio ownership proves to be an important predictor for the stunting models and even more important for the underweight models. There is no meaningful pattern for sex of the child or work status of the mother. The addition of environmental variables indicates that sanitation is a more common predictor than source of drinking water. Source of drinking water, however, becomes significant for some countries during the 1990's. Diarrhea is an important predictor, particularly for the African countries.

Immunization status is often included in the models, with measles vaccinations appearing more frequently than other vaccinations.

Chapter Five: Discussion and Conclusion

In the House of Hunger diseases were the strange irruptions of a disturbed universe

- Dambudzo Marechera, ***The House of Hunger (1975)***

5.0 Introduction

The structure of the final chapter is as follows. The first section discusses the results of the data analyses and places them in context with other studies. The second section integrates the results of the study in the context of health development and examines the role of national governments and the international health community. The final sections provide recommendations for future research and policy directions.

5.1 Discussion of Results

Changes in the Nutritional Status of Children

The first objective of the analysis of the DHS data was to examine the changes in the nutritional status of children over the past decade, and to compare these changes across countries. The aim of the analysis was to determine if there has been progress in decreasing child malnutrition in developing countries. The progress was considered with respect to the goals of the 1990 World Summit for Children which sought a 50 % worldwide reduction of the 1990 PEM levels by the year 2000 (United Nations, 1990). In this study, progress was examined between the mid 1980's to the mid 1990's. UNICEF (1995) states that for nations to achieve the goal of the World Summit, a minimum 20% decrease in malnutrition is required by 1995.

The results of the study indicate that there are significant changes in the nutritional status of children between the 1980's and 1990's for all five countries. The

improvements in child nutrition, however, are modest at best. The one exception is Northeast Brazil which demonstrates an almost 10% decrease in the percent of children undernourished. There is an approximate 50% decrease in children who are both stunted and underweight. This is an important reduction because the Northeast is the most impoverished region in Brazil. It is surmised that national figures would show an even greater reduction in malnutrition.

In Guatemala, there are decreases in the percent of undernourished children, but these changes are very small. This lack of progress is extremely troublesome in Guatemala due to their initially high rates of malnourishment. Over 50% of the children under five sampled during both the 1980's and 1990's are stunted. High rates of undernutrition in Guatemalan children are noted elsewhere (Pebley & Goldman, 1995; de Onis, Monteiro & Clugston, 1993). In Mali, there are obvious signs of deterioration in nutritional status. There is an almost 20% increase in children who are malnourished. There are large increases in all three nutritional indicators. Uganda and Zimbabwe display mixed results. There is a slight decrease in the overall percentage of children undernourished; there is a significant reduction in stunting but an increase in children who are underweight. These results suggest that there has not been adequate progress in the reduction of malnutrition but rather stagnation and even deterioration.

The deterioration of health in Africa has been noted elsewhere (UNICEF, 1998; Thompson, 1996; Stamps, 1993). Three trends of malnutrition have been observed in Africa: (1) static or a slight increase in prevalence; (2) trend appears static but there has been a recent peak in incidence (majority); and (3) clear evidence of increasing prevalence of underweight (Thompson, 1996). The increase in malnutrition follows the

economic decline of the 1980's. Social and health spending have been cut in many government budgets in accordance to the structural adjustment programs that were put in place. There have also been declines in per capita incomes, reducing household food expenditure. Stamps (1993), the Minister of Health in Zimbabwe, has attributed the increase in chronic malnutrition in Zimbabwe to the drought that occurred during the early 1990's, and the explosion of the AIDS virus.

Children under 5 may develop AIDS either by perinatal transmission or through contaminated breast-milk. Malnutrition is linked with infectious disease, including AIDS. One of the main clinical manifestations of AIDS is wasting (Ball, 1998). Patterns of malnutrition cannot be distinguished from patterns of weight loss associated with AIDS. Studies conducted in sub-Saharan Africa found that 25% of children with malnutrition were inflicted with the human immunodeficiency virus (HIV) virus (Ball, 1998). Paediatric AIDS is a growing concern in developing countries. In 1997, over 500 000 children under the age of 15 became infected with the AIDS virus; 95% of the children were under 5 (WHO, 1998).

Many previous studies use one anthropometric indicator to disseminate information with respect to the nutritional status of children at a community, regional or national level. The nutritional status of children, however, depends on the choice of indicator utilized. The results of this study indicate that there are national differences in the prevalence of each of the three nutritional indicators. The results also confirm that there are common patterns of nutritional status among countries. This is consistent with the studies demonstrating global (Sommerfelt & Stewart, 1994; Victora, 1992) and regional variation (de Onis, et al., 1993). Northeast Brazil, Guatemala, Uganda and

Zimbabwe have higher levels of stunted children compared to underweight children with relatively low levels of wasting. Mali has a higher prevalence of children who are underweight than children who are stunted combined with relatively high levels of wasting. These patterns remain constant over time.

There is an increase in wasting for all five countries. This change in wasting is both interesting and troublesome. Wasting is an indication of present, short term nutrition. An increase in wasting may indicate present economic hardships or environmental disasters such as droughts. Increases in this indicator may be an indication of an overall deterioration of nutritional status. There is a possibility that increases in wasting may lead to further long term nutritional deficiencies, which may ultimately lead to increases in the prevalence of stunting and underweight children. The statistical associations between the indicators indicate that there is no correlation between stunting and wasting, which is consistent with the findings of Keller (1983). Increases in levels of wasting, therefore, may not lead to increases in stunting. There is, however, a moderate association between wasting and underweight status. This suggests that perhaps the increase in wasting in these populations may lead to increases in underweight children.

Another possible explanation of the increase in wasting may be the link between malnutrition and AIDS. As noted earlier, wasting is one of the side effects of AIDS (Ball, 1998). DHS surveys did not examine children for the possibility of HIV infection. Although this study is not able to directly link the increase in wasting with an increase in AIDS, there may be a correlation between the two factors.

Changes in nutritional status over time are not necessarily indicative of overall improvement (Shen, Habicht & Chang, 1996). Nutritional status of children was therefore

examined according to place of residence. Rural children have significantly poorer nutritional status compared to urban children. This is true both during the 1980's and 1990's in all countries. The prevalence of wasting, increases more in rural areas compared to urban areas. It appears that the increasing prevalence of wasting in all five countries is predominantly a rural phenomenon.

The debate between sex differences in the nutritional status of children under five is longstanding. The results indicate that there is a slight male bias with respect to nutritional status, these results are similar to other studies (Hill & Upchurch, 1995; Svedberg, 1990). Over time, gender differences are maintained for stunting and underweight status. Wasting increases slightly more in male children compared to female children. Anthropometric indicators, however, are not necessarily capable of determining sex differences (Hill & Upchurch, 1995). The analyses that were performed did not account for the initial female advantage. Girls are biologically less susceptible to infectious diseases and nutritional disorders. Since girls have this advantage, boys *should* have higher rates of malnutrition. The disparities between sexes are small to insignificant. The results cannot conclude that there is a gender bias in nutritional status in this sample, further study is needed for clarification.

Socio-economic Determinants of Growth

The second objective of the data analysis was to examine changes in the socio-economic determinants of growth over time and to determine if there were common determinants for the five developing countries. Victora (1992) suggests that there are possibly different causes for the various indicators, which would explain the variability of

these indicators around the world. Logistic regression models were developed for each indicator to determine if there were differences between stunting and underweight status. The importance of each predictor was determined by their frequencies in the models and by the odds ratios in the full logistic regression model.

The results of the multivariate analyses indicate different patterns in the determinants for stunting compared to underweight models. Frongillo and his associates (1997) found different causes for stunting and wasting. This study indicates that there are also differences in causes of stunting and underweight status in children. Further exploration of the causes of each indicator will illustrate more detailed patterns. This may be determined by using a larger number of countries in the study and including a greater number of variables in analysis.

Maternal education is the most prominent and consistent variable for stunting. After controlling for environmental and health factors, maternal education remains significant. A mother with primary education, in particular, decreases the likelihood of her child being stunted. This supports the notion that maternal education is an important predictor of child health and nutrition (Bicego & Boerma, 1993; Caldwell, 1993; Victora et al., 1992; Cleland & Ginneken, 1988). Over time, all the countries demonstrate an increase in the value of the odds ratios. This suggests that maternal education has become an increasingly important predictor of child nutritional status. A similar relationship is found with respect to underweight status, except in Northeast Brazil where there is no statistical association between maternal education and child nutritional status.

Education is a necessary component of development. Haq (1995) specifically notes that "Education is the true essence of human development. Without education,

development can be neither broad-based nor sustained" (UNICEF, 1999). Of the 9 variables analyzed, this study finds maternal education to be the most important determinant of child stunting, an indicator reflecting social and economic conditions. Education is important for increasing the transferability of health education. Household nutrition is promoted through knowledge of nutritional food, food handling procedures and infant feeding practices. Mata (1988) has labeled this knowledge "maternal technology." Mothers may be raised without the acquisition of this technology, hindering child survival and growth. Women who possess effective maternal technologies often have children who thrive in impoverished areas and poor conditions. The promotion of maternal technologies is necessary for development.

The education of women is repeatedly shown to not only benefit the health of her children, but also to improve family planning choices, decrease violence and abuses against women and increase empowerment of women. UNICEF (1999) states that of 130 million school age children in the developing world without access to primary education, two-thirds are girls. The education of girls is one of the most widely stated strategies for development, cited often by the United Nations and the World Bank. These organizations, however, fail to provide ideas and strategies to promote education of females. The recognition of the importance of female education is not sufficient. There needs to be specific strategies that recognize the social, cultural and economic reasons why female children are not attending school and to provide practical solutions. For example, how does one educate the girl who stays at home to take care of her younger siblings while her parents are both working, or the girl that stays home to care for sick family members afflicted with AIDS? There have been some approaches to these issues

that have proven effective. Leslie and her associates (1988) cite the following examples: increasing the number of schools to reduce traveling distance which often alleviates safety concerns of girls, creating flexible timing of education programs, particularly during agricultural periods, shortening the periods of class on a daily basis and introducing small scholarships and/or stipends to increase attendance. Further examination of these issues and incorporating such strategies in the communities may be one of the greatest contributions to community health.

Radio ownership was used as a proxy for household economic status. The use of radio ownership is not a universally accepted method of measuring socio-economic status, but is appropriate for this particular study. The socio-economic classifications in developed countries typically use income, occupation or literacy, which are inappropriate to use in developing countries due to the "structural and economic heterogeneity between both developing and industrialized countries" (Cortinois, Vella & Ndiku, 1993, p.1087). Cortinois and his associates (1993) constructed a socio-economic index which indicated that radio ownership is one of the most useful variables in the classification of socio-economic status. This study demonstrates an association between owning a radio and nutritional status. Radio ownership is the most consistent variable in the models for underweight status, both during the 1980's and 1990's. Households owning a radio are less likely to have an underweight child than households with no radio. It may be that households with a radio have greater financial and food security. Owning a radio may also be an important medium for health education, which could promote good nutrition (Sommerfelt & Stewart, 1994).

Univariate and multivariate analyses indicate that place of residence is an important determinant of growth. Generally, children living in rural areas are more likely to be undernourished than children in urban areas. In the stunting models, place of residence is modified in the cases of Northeast Brazil, Zimbabwe and Guatemala (1987). Once the environmental variables were controlled, place of residence is no longer significant. This suggests that in these countries, rural residents are disadvantaged through poor sanitation and lack of safe drinking water. For Uganda, Mali and Guatemala (1995) residence remains significant for all three models, indicating there may be other factors accounting for the rural disadvantage such as poor access to health services.

Maternal work status is a significant determinant of underweight status in three countries; Northeast Brazil, Guatemala and Uganda. Over time, the working status of the mother is not consistent for these countries. Work is a significant predictor of underweight status during the 1990's for Northeast Brazil and Guatemala and during the 1980's for Uganda. In the cases of Northeast Brazil and Guatemala, there is a greater likelihood of a child being malnourished if the mother was working, while in Uganda this relationship was reversed.

Although it is possible to ascertain that there are both intra and inter-country differences with respect to maternal work status, no conclusive statements can be made. This is due primarily to the manner in which working status was defined in the study. Women's employment, as defined by DHS, was whether the woman was working at the time of the survey and was working for cash wages. This is an extremely narrow definition of employment. There are many women in the developing world that work outside of the cash economy and would not have been included in the definition of

'working'. In addition, this definition may not include women who have seasonal or casual employment. Dasgupta (1993) claims that the casual work force in developing is predominantly women, ranging between 60 and 90 %. Moreover, the DHS definition does not account for other variables which may affect the nutritional status of the child, such as the number of hours worked by the woman, whether or not she worked at home or away from the household, the effect of maternal income or the quality or type of childcare that was in place (Leslie,1988). DHS took notice of these types of issues and developed more detailed questions concerning maternal work status in recent surveys.

A second problem with using maternal employment as a predictor of child survival involves the income side of the employment equation, the positive income effect. The positive income effect is based on the assumption that acquired resources will benefit the child's health and well being. Intra-household distribution, however, is dependent on the person who controls the income. There is a growing body of evidence that suggests that there are gender differences with respect to the allocation of resources in a household (Dasgupta, 1993). For example, women tend to allocate more money on feeding children than men do. An increase in maternal income, therefore, cannot necessarily be interpreted as an increase in the distribution of food and other items for the well being of her children.

5.2 Linking Study Results with Health and Development

Health is both an essential objective and a condition for development (WHO, 1998). Nutrition is an essential link to social development (MacPherson, 1990). The prevalence of undernourished children in a community or nation is one of the most important indicators of development (UNICEF, 1998). The stagnation of progress of

reducing childhood malnutrition shown in four of these countries is an indication of inadequate development and insufficient health practices during the past decade.

The results of this study illustrates that malnutrition is a complex disorder associated with various socio-economic, environmental and health factors. These issues confirm health promotion ideology, which stresses the importance of examining a multitude of determinants with respect to health status. Strategies should, therefore, focus on integrating all such aspects.

Health researchers often argue whether strategies to combat malnutrition should be promoted through improved nutrition or by the reduction of disease. The results of this study indicate that socio-economic factors are crucial to the nutritional well being of the child. Non-medical factors may in fact have a greater impact on health status than medical factors (Beaglehole & Bonita, 1997). Maternal education and radio ownership (as a proxy for income level), are key determinants of growth even after controlling for environmental and health conditions. Improvements in malnutrition will be greatest if strategies are integrated into social and economic development as delineated by PHC.

A crucial component of PHC, initiated at Alma Ata, was community participation (Asthana, 1994b). The influx of SPHC strategies, however, created confusion and ambiguity, and limited the practical use of community participation. Participation implies "a struggle for the redistribution of power and resources in society." (Asthana, 1994b, p.185) This is closely linked to the thinking of the Brazilian educator Paolo Freire who argues that society is based on inequality and governed by oppressors. The manner to rise above oppression is to "critically recognize its causes, so that through transforming action they can create a new situation." (Freire, 1970, p.29)

The importance of participation is that it serves as a source of empowerment. In the field of health, empowerment is the notion that people have the capacity to increase control over their own health by other people in the community (Grace, 1991). A healthier society can be attained by involving people as a collective group to identify problems, and to develop strategies through influencing 'personal and social spheres' (Wallerstein & Bernstein, 1988). Research, particularly in the psychological field, indicates that gaining greater control and power has a crucial impact on health status. A focus on community participation will help to empower people to gain greater perceived control. Such a focus will also help to create suitable local programs and to encourage people to actively partake in the development process (Ashtana, 1994b).

National governments and the international community should promote and invest in PHC. With limited finances for health expenditures, national governments should incorporate broad-based strategies and refrain from high cost medical interventions. Strategies will vary among nations depending on social and political situations (Abel-Smith, 1990). Abel-Smith (1990) compiled a list of failings in the health services of developing countries, such as a disproportionate amount of money spent for urban health care, concentrated resources on hospitals, rather than PHC and a lack of spending on preventative health as opposed to curative health. The researcher stresses that countries may not be in a position to immediately follow low cost services for the whole population, but moving in this direction will lead to progressive changes.

The ideals of PHC sought to not only distribute health resources nationally, but also internationally. Article II in the Declaration of Alma Ata (1978) includes the following statement: "The existing gross inequality in the health status of the people

particularly between developed and developing countries is politically, socially, and economically unacceptable and is, therefore, of common concern to all countries." Foreign aid agencies should refrain from implementing individual, project type work but rather work jointly with nations to implement wide ranging PHC programs. After structural adjustment in Mozambique, health care policies became increasingly dominated by donor and loan agencies (Cliff, 1991, as cited in Buchmann, 1996). The policies led to a "fragmentation of the primary health care approach" due to the implementation of regional "projects". Action should be taken to help share health resources with developing countries. There should also be action to prevent abuses such as the selling of overpriced, unnecessary, and often out of date pharmaceuticals or the marketing of commercial breast milk substitutes. Without international collectivity, and increases in support of developed countries the strategies of PHC will be futile.

Progress cannot be made through the health sector alone. There needs to be changes in the global economy to improve the situation that many governments in the developing world find themselves in today, namely excessive external debt. The United Nations estimated that Africa requires approximately 9 billion dollars a year to meet basic human needs (Buchmann, 1996). This price is less than the money being spent to repay foreign debts. There are great concerns regarding financial debts voiced by various leaders in the developing world. Mavis Muyunda, Zambian Minister of State for Foreign Affairs, states that this debt "translates into a dehumanizing life of poverty, malnutrition, infant mortality and moral degradation" for people living in developing countries (United Nations, 1990, as cited in Buchman, 1996). Stamps (1992), attributes the general decrease in the quality of life of the people of Zimbabwe to "the tendency of those with

economic power to move the goal posts with depressing regularity." Haq (1995) rejects charitable actions and one-way transfers from developed countries and urges for new partnerships between the North and the South based on justice, equitable sharing and mutual cooperation.

An expansion of thought is needed in the field of health, in particular with respect to maternal-child health strategies. Medical and public health researchers concerned with child survival often view women solely as an 'instrument' to child health (Leslie, 1988). This view trivializes the roles of women in society. Using the example of maternal working status, it is clear that this factor cannot be used as a generalized predictor of child health. Doing so ignores other factors such as the necessity that many low-income families rely on the employment opportunities of women. The status and roles of women need to be clearly integrated into the socio-economic views of health promotion.

Dasgupta (1993) acknowledges the importance of health in development, but cautions solutions based predominantly on the implementation of public health measures. In particular, infants and young children have caught the attention of international organizations and national governments, such as the 'child survival and development revolution' (CSDR) by UNICEF. The narrow focus of the international health community on early child survival and the implementation of specific medical techniques, such as oral rehydration therapy, fail to address underlying causes of ill health, namely poverty and inequality. The health of the child is inextricably bound to the mother and other members of the family. The child will not fare well if the economic providers and nurturers of the family are ill. Sometimes families must make decisions that have a negative impact on child health and development for long term needs of the family,

especially in times of crisis (Thompson, 1996). For example, during distress migration, as seen in Rwanda in 1994, children may be abandoned or placed in orphanages in an attempt to secure a better chance of survival. Furthermore targeting child survival reduces the right to health for other members of society. Researchers in the field of health must be prepared to step back and take a wider lens and to examine development in the entire social constructs instead of using narrow and simplistic (even if it is with good intentions) approaches.

5.3 Policy Recommendations

There are two dominant views in developing nutritional policies (Foster, 1992). One type of policy aims to treat the symptoms of malnutrition, while the other type of policy aims to treat causes. Treating the symptoms involves various nutrition interventions ranging from international food aid, to food-rationing schemes to vitamin supplementation programs. Policies that aim to treat symptoms may be effective at reducing malnutrition, but are more often than not, unsustainable. Treating the causes of malnutrition involves devoting attention to a broad range of social, economic, environmental and health factors. This may help to decrease malnutrition in the long run, but effects may not be reached as quickly as treating the symptoms. Due to limited resources, it may come to a choice between policies. The dilemma, thus, is do we attempt to reduce the immediate suffering of hunger or to alleviate malnutrition over time? The results of this study in conjunction with the emerging field of health promotion indicate that our goal should be for long term, sustained levels of nutrition obtained by addressing the root causes of malnutrition.

The results of this study, in collaboration with other research (Frongillo et al., 1997; Victora, 1992), suggest that nutritional indicators vary with respect to country and region, and there are different socio-economic causes of each indicator. These have implications for nutritional policies, which can be applied to a community, region or nation (Frongillo et. al, 1997). These recommendations include: (1) identifying which nutritional problems are prominent (stunting, wasting, underweight or a combination of these); (2) identifying the factors that are causing the deficits in nutritional status; (3) determining if these factors can be changed and if these changes will lead to improvements in nutritional status. MacPherson (1990) stresses that nutritional surveillance, particularly at the national level, is essential in organizing strategies to combat poverty and to reduce social inequality. Longitudinal studies are also important to observe the factors influencing changes in nutritional status and to assess the functioning of different strategies and policies.

5.4 Recommendations for Future Research

This study illustrates that there are differences in nutritional patterns across countries and over time. Future research should continue to examine global trends in child malnutrition, specifically to examine the potential increase in wasting worldwide. The relationship between wasting and other indicators needs to be investigated to determine if increases in wasting in a region leads to increases in other anthropometric indicators.

Maternal work status should be studied in a more in depth manner that allows an exploration of specific elements such as time, social and cultural factors. This type of study requires more detailed information, which often does not appear in international

health surveys and may require different methodologies, such as qualitative research and case studies. If researchers choose to implement maternal work status as a predictor of child survival, they should be aware of definitional problems and should refrain from making conclusive or causal statements.

Logistic regression is the analysis of choice among public health researchers, due mainly to the simplicity of the procedure and easy interpretation of the odds ratios for determining risk factors. The results of this study are limited by problems attributed to inadequate logistic regression model fits, specifically poor classification of cases. Researchers typically do not report the adequacy of the logistic regression models which raises the question of the appropriateness of models used in analysis. The use of the chi-square as a measure of goodness-of-fit has also been scrutinized and has various disadvantages (Hosmer, Hosmer, Cessie & Lemeshow, 1997). The extensive use of logistic regression should be questioned in the health field. There is a multitude of multivariate techniques available. As the fields of public and community health expand, researchers should explore new statistical techniques.

5.5 Conclusion

This study has demonstrated that, in spite of the goals of the World Summit for Children, there has not been adequate progress in the reduction of childhood malnutrition in 4 of the 5 countries selected in this study. The continuation of widespread malnutrition is a major constraint in the development process. Various economic and political setbacks have led to the implementation of targeted strategies, increased reliance on medical interventions and project type solutions. Malnutrition constitutes a complex array of socio-economic factors, environmental and health determinants. It is therefore imperative

to use comprehensive strategies for the improvement of nutritional status. Such strategies will require national and international cooperation to engage in social change. The essence of international cooperation for social progress and improvements in child health is captured by Stamps (1992, p. 36) "We have to abolish the things which divide us and promote mutual support on the basis of a common destiny…Only uplifting the future prospects for all our children can promote a harmoniously progressive healthy world."

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Appendix A: Description of DHS Surveys

Country	Survey	Date of Fieldwork	Executing Agency	Sample Size
Brazil (NE)	DHS-I	1986	BEMFAM *	644
Brazil (NE)	DHS-III	1996	BEMFAM	2298
Guatemala	DHS-I	1987	INCAP**	2207
Guatemala	DHS-III	1995	Instituto Nacional de Estadistica	4911
Mali	DHS-I	1987	Centre d'Etudes et de Recherches sur la Population pour le Developpement	948
Mali	DHS-III	1996	CPS/MSSPA, DNSI ***	4263
Uganda	DHS-I	1988/89	Ministy of Health	2297
Uganda	DHS-III	1995	Ministry of Finance and Economic Planning	3350
Zimbabwe	DHS-I	1988/89	Ministry of Finance and Economic Planning	1496
Zimbabwe	DHS-III	1994	Central Statistical Office	1907

*Sociedade Civil Bem-Estar Familiar no Brasil
**Instituto de Nutricion de Centro America y Panama
***Centre pour la Population et la Sante, Direction National de la Statistique et de l'Information

Appendix B: Logistic Regression Results

Brazil: Stunting	*Year*	*Coefficient*	*Standard Error*	*p-value*	*Odds Ratio*
Residence	86	.1796	.2967	.5548	1.1968
	96	-.3137	.2548	.2183	.7308
Education					
	86	1.1927	.6124	.0515	3.2958
primary	96	2.4814	.4166	.0000	11.9586
	86	.6334	.5864	.2801	1.8841
	96	1.8366	.3553	.0000	6.2751
secondary					
Work	86	-.2027	.2274	.3726	.8165
	96	.5498	.2380	.0209	1.7329
Radio	86	.0812	.2095	.6982	1.0846
	96	.1273	.2282	.5769	1.1358
Sex	86	.4864	.2060	.0182	1.6264
	96	.9136	.2224	.0000	2.4934
Sanitation					
latrine	86	.8621	.2683	.0013	2.3681
	96	.5280	.4550	.2458	1.6955
flush	86	-3.5874	1.0314	.0005	.0277
	96	1.2403	.4508	.0059	3.4568
Water Source					
well	86	-.1471	.3334	.6590	.8632
	96	1.8215	.3879	.0000	6.1814
piped	86	-.0004	.3584	.9991	.9996
	96	1.9364	.2943	.0000	6.9336
Immunization					
other	86	.3617	.3312	.2747	1.4358
	96	1.100	.3367	.0011	3.0042
	86	-.6277	.2240	.0051	.5338
measles	96	-1.3493	.3108	.0000	.2594
Diarrhea	86	-.0125	.7023	.9537	.9875
	96	-.4666	.6887	.0501	.6271

Guatemala: Stunting	*Year*	*Coefficient*	*Standard Error*	*p-value*	*Odds Ratio*
Residence	87	.0626	.1280	.6249	1.0646
	95	-.2400	.0888	.0069	.7866
Education					
	87	1.6530	.2390	.0000	5.2226
primary	95	2.0752	.1832	.0000	7.9664
	87	1.0662	.2390	.0000	2.9043
	95	1.7962	.1790	.0000	6.0269
secondary					
Work	87	.0128	.1434	.9290	1.0129
	95	.0166	.0793	.8346	1.0167
Radio	87	.2939	.0989	.0030	1.3416
	95	.1090	.0695	.1167	1.1151
Sex	87	.0698	.0927	.4515	1.0723
	95	.1301	.0616	.0348	1.1389
Sanitation					
latrine	87	.9637	.1807	.0000	2.6213
	95	.8322	.1333	.0000	2.2985
flush	87	.9074	.1621	.0000	2.4778
	95	.8561	.1158	.0000	2.3540
Water Source					
well	87	.1700	.1960	.3857	1.1853
	95	.6566	.5595	.2406	1.9283
piped	87	.0805	.1771	.6496	1.0838
	95	.4250	.5560	.4447	1.5295
Immunization					
other	87	-.6631	.1279	.0000	.5153
	95	-.4435	.0986	.0000	.6418
	87	-.9268	.1071	.0000	.3958
measles	95	-.9167	.0729	.0000	.3998
Diarrhea	87	-4.0065	8.2066	.2383	.6254
	95	-.0342	.0705	.6277	.9664

Mali: Stunting	*Year*	*Coefficient*	*Standard Error*	*p-value*	*Odds Ratio*
Residence	87	.0663	.2680	.8047	1.0685
	96	-.4882	.0880	.0000	.6137
Education					
	87	-2.1876	.6344	.0006	.1122
Primary	96	2.0632	.3709	.0000	7.8710
	87	-2.3482	.6456	.0003	.0955
	96	1.7891	.3828	.0000	5.9838
Secondary					
Work	87	4.5665	22.2431	.8373	96.2057
	96	.0953	.0698	.1718	1.1000
Radio	87	.8020	.2150	.0002	2.2300
	96	.1369	.0737	.0634	1.1467
Sex	87	.0272	.1916	.8873	1.0275
	96	.0725	.0692	.2946	1.0752
Sanitation					
Latrine	87	4.6310	9.0239	.6078	102.6197
	96	4.6224	4.0421	.2528	101.7367
Flush	87	4.1180	9.0212	.6480	61.4364
	96	4.4579	4.0415	.2700	86.3082
Water Source					
Well	87	.3277	.6178	.5958	1.3878
	96	-.0826	.2677	.7576	.9207
Piped	87	-.0205	.5975	.9726	.9797
	96	.1599	.1904	.4011	1.1733
Immunization					
Other	87	.7472	.3430	.0294	2.1111
	96	-.4125	.0848	.0000	.6620
	87	-.9938	.3698	.0072	.3702
Measles	96	-.9083	.0884	.0000	.4032
Diarrhea	87	-.5567	.1933	.0040	.5731
	96	-.4991	.0741	.0000	.6071

Uganda: Stunting	*Year*	*Coefficient*	*Standard Error*	*p-value*	*Odds Ratio*
Residence	88	-.4678	.1592	.0033	.6264
	95	-.5580	.1061	.0000	.5723
Education					
	88	.4775	.2073	.0213	1.6120
primary	95	1.0511	.1584	.0000	2.8607
	88	.3799	.1967	.0534	1.4622
	95	.8551	.1434	.0000	2.3516
secondary					
Work	88	-.0528	.1702	.7565	.9486
	95	-.0354	.0814	.6637	.9652
Radio	88	.2830	.1064	.0078	1.3270
	95	.1834	.0828	.0268	1.2012
Sex	88	.1929	.0882	.0287	1.2128
	95	.2847	.0771	.0002	1.3294
Sanitation					
latrine	88	.1058	.1255	.3990	1.1116
	95	-.4974	.4200	.2364	.6081
flush	88	-1.7913	.4936	.0003	.1667
	95	-.5217	.4090	.2021	.5935
Water Source					
well	88	.6415	.6932	.3548	1.8992
	95	-.5379	.2909	.0644	.5840
piped	88	.3513	.6925	.6119	1.4209
	95	-.7210	.2888	.0125	.4863
Immunization					
other	88	-.4373	.1138	.0001	.6458
	95	-.4429	.1095	.0001	.6422
	88	-.3646	.1068	.0006	.6944
measles	95	-.6303	.0887	.0000	.5324
Diarrhea	88	-.2088	.0935	.0255	.8115
	95	-.3292	.0844	.0001	.7195

Zimbabwe: Stunting	*Year*	*Coefficient*	*Standard Error*	*p-value*	*Odds Ratio*
Residence	88	-.6527	.4642	.1597	.5206
	94	-.4229	.3284	.1977	.6551
Education					
	88	.9905	.2649	.0002	2.6925
primary	94	.8629	.2199	.0001	2.3699
	88	.7269	.2390	.0024	2.0686
	94	.8561	.1684	.0000	2.3539
secondary					
Work	88	.0622	.1391	.6551	1.0641
	94	.1903	.1287	.1392	1.2096
Radio	88	.3887	.1488	.0090	1.4751
	94	-.1144	.1372	.4046	.8919
Sex	88	.2540	.1287	.0484	1.2892
	94	.1119	.1282	.3828	1.1184
Sanitation					
latrine	88	1.2562	.4649	.0069	3.5119
	94	.9743	.5239	.0629	2.6493
flush	88	.8521	.4617	.0650	2.3446
	94	.9819	.5193	.0586	2.6696
Water Source					
well	88	-.5573	.7634	.4653	.4653
	94	.0604	.4907	.9020	1.0623
piped	88	-1.2207	.8592	.1554	.1554
	94	-.2193	.4651	.6373	.8031
Immunization					
other	88	.2730	.2749	.3206	.3206
	94	.2221	.2843	.4346	1.2487
	88	-.6881	.1456	.0000	.0000
measles	94	-9.2222	7.4532	.2160	.0001
Diarrhea	88	-.4442	.1376	.0012	.0012
	94	-.1848	.1435	.1978	.8312

Brazil: Underweight	*Year*	*Coefficient*	*Standard Error*	*p-value*	*Odds Ratio*
Residence	86	.5288	.7477	.4794	1.6969
	96	1.5101	.6860	.0277	4.5272
Education					
	86	7.5450	25.1824	.7645	1891.193
primary	96	7.8706	24.8192	.7512	2619.1335
	86	5.7935	25.1824	.8180	328.1715
	96	8.3295	24.8128	.7371	4144.2325
secondary					
Work	86	-.5611	.4734	.2359	.5706
	96	2.2238	1.1193	.0469	9.2427
Radio	86	-.1423	.4829	.7683	.8674
	96	2.9648	.7422	.0001	19.3902
Sex	86	-.7544	.4763	.1132	.4703
	96	1.8574	.7157	.0095	6.4072
Sanitation					
latrine	86	.8576	.6554	.1907	2.3574
	96	.7352	1.0223	.4720	2.0859
flush	86	-6.9156	20.6614	.7378	.0010
	96	-.3572	1.0620	.7366	.6997
Water Source					
well	86	-.8062	.7822	.3027	.4466
	96	-7.6197	58.6430	.8966	.0005
piped	86	-.3914	.8548	.6470	.6761
	96	2.2573	.7762	.0036	9.5570
Immunization					
other	86	2.2608	.5248	.0000	9.5904
	96	2.0095	.8110	.0132	7.4597
	86	-1.0952	.6540	.0940	.3345
measles	96	-.9305	.8481	.2726	.3944
Diarrhea	86	-.9618	.4632	.0379	.3822
	96	-2.2705	.6683	.0007	.1033

Guatemala: Underweight	*Year*	*Coefficient*	*Standard Error*	*p-value*	*Odds Ratio*
Residence	87	.1908	.1378	.1661	1.2102
	95	-.5747	.1059	.0000	.5629
Education					
	87	1.5713	.3968	.0001	4.8131
primary	95	4.0896	.7121	.0000	59.7160
	87	.9460	.3953	.0167	2.5755
	95	3.7620	.7111	.0000	43.0326
secondary					
Work	87	-.1185	.1569	.4498	.8882
	95	-.1581	.0852	.0634	.8537
Radio	87	.2321	.1022	.0232	1.2612
	95	.1681	.0718	.0192	1.1830
Sex	87	-.0835	.0988	.3984	.9199
	95	.0680	.0658	.0192	1.0703
Sanitation					
latrine	87	2.1545	.2949	.0000	8.6232
	95	.8772	.1709	.0000	2.4042
flush	87	2.0107	.2835	.0000	7.4683
	95	.7998	.1580	.0000	2.2251
Water Source					
well	87	.0017	.2065	.9933	1.0017
	95	.2388	.6777	.7246	1.2698
piped	87	-.1239	.1906	.5157	.8835
	95	.3226	.6748	.6326	1.3807
Immunization					
other	87	-.3444	.1288	.0075	.7087
	95	-.3686	.1041	.0004	.6917
	87	-.9030	.1223	.0000	.4054
measles	95	-.3593	.0736	.0000	.4251
Diarrhea	87	3.2557	13.5025	.8095	25.9372
	95	-.3593	.0736	.0000	.6982

Mali: Underweight	*Year*	*Coefficient*	*Standard Error*	*p-value*	*Odds Ratio*
Residence	87	-.1065	.2180	.6253	.8990
	96	-.2017	.0781	.0098	.8173
Education					
	87	-.8746	.5529	.1137	.4170
primary	96	.7684	.1811	.0000	2.1563
	87	-.9837	.5569	.0773	.3739
	96	.4179	.1989	.0357	1.5188
secondary					
Work	87	5.3328	22.2415	.8105	207.0122
	96	.1307	.0645	.0427	1.1397
Radio	87	.4196	.1781	.0185	1.5213
	96	.2466	.0692	.0004	1.2796
Sex	87	.0802	.1550	.6049	1.0835
	96	-.0713	.0640	.2657	.9312
Sanitation					
latrine	87	5.1971	9.6270	.5893	180.7392
	96	.2017	.4432	.6491	1.2234
flush	87	4.6760	9.6250	.6271	107.3349
	96	-.1059	.4370	.8085	.8995
Water Source					
well	87	.1916	.4181	.6468	1.2112
	96	-.0016	.2338	.9945	.9984
piped	87	-.0227	.4017	.9550	.9776
	96	.1579	.1535	.3037	1.1710
Immunization					
other	87	-.1865	.2639	.4797	.8298
	96	-.4678	.0823	.0000	.6264
	87	-.6947	.2444	.0045	.4992
measles	96	-.4933	.0769	.0000	.6106
Diarrhea	87	-.8438	.1570	.0000	.4301
	96	-.5954	.0704	.0000	.5514

Uganda: Underweight	*Year*	*Coefficient*	*Standard Error*	*p-value*	*Odds Ratio*
Residence	88	-1.0935	.2935	.0002	.3351
	95	-.7546	.1364	.0000	.4702
Education					
	88	1.1134	.3482	.0014	3.0447
Primary	95	1.3253	.2178	.0000	3.7634
	88	.5240	.3429	.1265	1.6888
	95	1.1008	.2061	.0000	3.0066
secondary					
Work	88	-.6872	.2209	.0019	.5030
	95	-.0072	.0924	.9380	.9928
Radio	88	.6441	.1552	.0000	1.9042
	95	.3859	.0957	.0001	1.4709
Sex	88	.2087	.1133	.0653	1.2321
	95	.3838	.0880	.0000	1.4679
Sanitation					
Latrine	88	.0334	.1487	.8223	1.0340
	95	-1.1350	.4517	.0120	.3214
flush	88	-1.0814	1.0395	.2982	.3391
	95	-1.4550	.4410	.0010	.2334
Water Source					
Well	88	.5044	1.0823	.6412	1.6561
	95	1.5532	.6103	.0109	4.7265
piped	88	.0311	1.0829	.9771	1.0316
	95	1.4132	.6099	.0205	4.1090
Immunization					
Other	88	-.4558	.1405	.0012	.6340
	95	-.1907	.1217	.1170	.8264
	88	-.5971	.1396	.0000	.5504
measles	95	-.3136	.1002	.0018	.7308
Diarrhea	88	-.6879	.1164	.0000	.5026
	95	-.6397	.0922	.0000	.5275

Zimbabwe: Underweight	*Year*	*Coefficient*	*Standard Error*	*p-value*	*Odds Ratio*
Residence	88	3.6380	1.0445	.0005	38.0148
	94	.7806	.4455	.0797	2.1827
Education					
	88	10.2387	33.3700	.7590	27964.268
primary	94	2.2232	.3613	.0000	9.2367
	88	7.8387	33.3702	.8143	2536.9779
	94	1.4733	.3292	.0000	4.3637
secondary					
Work	88	.5689	.3651	.1191	2536.268
	94	.2798	.1793	.1187	1.3229
Radio	88	2.3216	.6996	.0009	10.1920
	94	.4353	.2049	.0336	1.5455
Sex	88	-.1867	.3095	.5464	.8297
	94	.8854	.1855	.0000	2.4240
Sanitation					
latrine	88	10.5266	23.7896	.6581	37294.937
	94	5.1250	1.0118	.0000	168.1806
flush	88	9.8851	23.7875	.6777	19635.864
	94	4.4999	1.0009	.0000	90.0114
Water Source					
well	88	9.8839	221.3835	.9644	19612.704
	94	-2.2110	.6737	.0010	.1096
piped	88	.9705	223.1783	.9965	2.6393
	94	-1.5467	.6308	.0142	.2129
Immunization					
other	88	.0847	.5740	.8827	1.0884
	94	.3594	.3658	.3285	1.4325
	88	-2.4016	.5593	.0000	.0906
measles	94	-4.4763	1.0041	.0000	.0114
Diarrhea	88	-1.6019	.3272	.0000	.2015
	94	-1.0510	.1833	.0000	.3496