CHILD MALNUTRITION IN NIGER:

AN INVESTIGATION OF PATTERNS OF CHANGE

1992 - 1998

by

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STATEMENT BY AUTHOR

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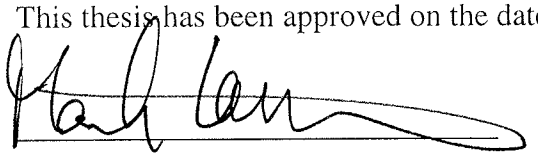

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DEDICATION

Ma Taasu Sama Yaay,

Ku ci am ndey ju rey

Dinga am bes bu rey.

Ku ci am ndey ju sew,

Dinga am bes bu sew ruuc.

Ku ci am ndey ju rey

Dinga am bes bu rey.

Ku ci am ndey ju baaq,

Dinga titero lu raw taaq.

To the children of Niger.

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ABSTRACT

CHAPTER 1

INTRODUCTION

Although considerable progress has been achieved in the reduction of child malnutrition in the developing world as a whole, an estimated 150 million children under five years old are still malnourished (WHO 2000). Malnourished children have lower resistance to infection and are more likely to die from diseases like diarrhea and respiratory infections. Those who survive will suffer from recurring sickness, deficient growth and decreased learning ability (UNICEF 2001). A staggering 49% of under-five child mortality (5.2 million children) in developing countries is associated with malnutrition (WHO/AFRO 2001). Malnutrition is not only medical, but also a social disorder with economic ripple effects that endanger development. It is a true global crisis that deprives million of children of their basic human rights (UNICEF 1998). Malnutrition is the outcome of a long chain of interrelated events that need to be understood and dealt with accordingly.

While over the last decade the underweight prevalence in the developing world as a whole declined on average from 32% to 28%, there has been little or no change (32% to 31%) in Sub-Saharan Africa (SSA) where one third of all children under-five remain underweight. In reality, the actual number of malnourished children in SSA increased. Pervasive poverty, soaring debt burdens, nonexistent or inadequate funding for health and education, poor agricultural productivity, ineffective public institutions and the AIDS

pandemic are, among others, the roots of malnutrition in Sub-Sahara Africa (UNICEF 2001).

Niger is characterized by high poverty, low levels of education, poor access to health services, and low status of women. In addition, over the last decade the country has gone through severe droughts and political instability that exacerbated its economic and social conditions. Niger is among the countries hit worst by malnutrition. Four in ten children under five are underweight and/or stunted, and one in three children dies from long-term starvation before the age of five (UNICEF 2001).[1] Furthermore, malnutrition rates have increased over the 1990's (Onis et al. 2000). There is great need to identify the principal determinants of child malnutrition and to uncover how they have evolved over time. Also, women's nutritional status is so closely linked to child malnutrition (for example, if a pregnant woman is malnourished, the growth of her fetus is compromised) that it is essential that the two be concurrently investigated. This study takes up this challenge. It focuses on the key underlying determinants of child nutritional status using Demographic and Health Surveys data from the early and the late 1990's (1992 and 1998). It looks to appraise the determinants of child malnutrition in order to understand its nature. Its overall objective is to determine where attention and resources can be directed in future efforts to eradicate malnutrition in Niger.

Several key questions will be investigated in this study:

1-Did malnutrition increase significantly between 1992 and 1998, and if so who was affected by the rise?

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[1] Niger is included in the list of countries where chronic malnutrition is highest (tied 22nd with Bhutan).

2-What are the underlying determinants of child nutritional status, and how did they change over the years?

3- Did women's nutritional status change between 1992 and 1998? What are the determinants of women's nutritional status in Niger?

The study is divided into eight chapters. Chapter 2 presents Niger's background characteristics, chapter 3 introduces the conceptual framework for child nutritional status and chapter 4 discusses the data, measures and methodology utilized in the study. Chapters 5, 6 and 7 present the major results of the study, while chapter 8 summarizes the main findings, considers their policy implications and discusses options for improving nutritional status in Niger.

CHAPTER 2

NIGER

BACKGROUND CHARACTERISTICS

As a country with little urbanization and whose economy depends on agriculture, Niger figures among the poorest countries in the world. This chapter introduces some relevant background information about a nation that went through major changes over the 1990's. After the overview presented in the first section, the two following sections briefly review Niger's agricultural policy and its current nutrition conditions. The last section focuses on consumption patterns across Niger.

2.1 Niger Overview

2.1.1 Geography and Climate

Figure 2.1 presents a detailed map of Niger. As a vast landlocked West African country, Niger is bordered North by Algeria and Libya, East by Chad, South by Nigeria and Benin, and West by Burkina Faso and Mali. Niger's land area totals 1,267,000 square kilometers (494,130 square miles), slightly less than twice the size of Texas and about 4.17 percent of Africa. The country has only one permanent body of water, the River Niger, which is Africa's third longest river (500 kilometers) and Niger's only link to the Atlantic Ocean. Apart from the Air Mountains, most of the country is flat and level land. With two thirds of Niger arid, the climate is very hot and dry. Accordingly,

the Saharan north is virtually rainless, while the south, in the Sahel belt, has an unreliable rainy season that is preceded by a period of extreme daytime heat. Also, most of the vegetation grows in grasslands in the south of Niger. Trees such as acacia thorn trees, tamarind, mahogany, baobab and date palms are found in that area, while low olive bushes grow in the desert area. Since water is scarce, animals find it very difficult to obtain moisture. Like two of its neighboring countries, Mali and Mauritania, Niger suffers from desertification, the increasing spread of the desert (World Infozone Limited 2002)[2].

2.1.2 The People of Niger

The population of Niger was estimated at 10.4 million in 2001, with a density of 21 people per square mile. In 1999, the population growth rate was the world's 17th highest. At 2.9%, it largely surpassed the agricultural production growth rate estimated then at 2.2%. If the rate stays constant, the population will double in only 24 years, and the number of food insecure people will dramatically grow. Most people live in the south, with 75% of the population found in 12% of the land area. This enormous disparity in population density generates a big demographic pressure on an agro-pastoral environment known to be fragile (World Statistics and Atlases 2002). Niger's population is very young: 70% is under age 40, 50% under 15 and only 2% over 65.

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[2] Desertification is defined by the International Convention on Desertification as the degradation of the land in arid, semi-arid and sub-humid dry areas caused by climatic changes and human activities. A reduction in the natural potential of the land and depletion in surface and ground water resources accompany it. But above all it has negative repercussions on the living conditions and the economic development of the people affected by it.

The administrative organization divides the country into seven districts, Agadez, Diffa, Dosso, Maradi, Tahoua, Tillaberi and Zinder, and one urban community, Niamey. Urbanization is very low (20^{th} lowest in the world) at only 17%. Apart from Niamey, the capital and largest city, the major cities include Zinder, Maradi, Tahoua, and Agadez.

Figure 2.2 breaks down the ethnic groups found in Niger as a percentage of the total population. Of the nine tribes, the Haoussa, Djerma, Touareg and Peulh represent 95% of the population. The other 5% includes the Kanouri-Manga, Toubou, Arabe, Gourmantche and Mossi. The sedentary farmers include the Haoussa established along the Nigerian border, the Djerma located in the Southwest, and the Kanouri found near Lake Chad. Most Touareg, Peulh and Toubou are nomad herdsmen in the northern arid and desert land. The main languages in use are Haoussa, spoken by 80% of the population, Djerma and French (the official language). Despite the fact that over 80% of the people are Muslim, the Republic of Niger is not an Islamic state (World Statistics and Atlases 2002, PNUD 1997).

2.1.3 Political Conditions

The Republic of Niger is a relatively young country, having won its independence from France only in 1960. Political instability, poor governance and guerilla wars particularly marked the 1990's. A political deadlock between the President, the head of the National Assembly and the Prime Minister (each from a different political party) culminated in a military coup in 1996 that positioned a General, Ibrahim M. Bare as the new president. After three years of poor governance, Bare was assassinated, and a military rule ensured timely political transition. Those few months were distinguished by

deplorable economic and financial performance, resulting in the accumulation of debt payments, including six months of civil services salaries. Mamadou Tandja, elected president in 1999, achieved political stability only in 2000 by successfully implementing peace accords with the rebels in the northern and eastern part of Niger among others (World Bank 2002). However, instability returned in July 2002 when the mutiny in Diffa detained various defense, security and civil officials in an attempt to seize power by force. Without political stability, the extent of government involvement in a country's economy is limited. Hence, it becomes difficult to develop and implement sound and sustained macroeconomic policies, and to provide social amenities and services to the citizens.

2.1.4 Socioeconomic Conditions

Niger is a poor country with few resources, and to add to that, past droughts have been devastating to the economy. Niger is among the least developed countries, ranked 172nd (out of 173) on UNDP's 2002 Human Development Index. After enjoying a short lived period of economic boom in the late 1970's, recording double digit GDP increase due to uranium world demand, Niger went into a slump after demand dropped and two severe droughts hit the country in 1980's. Per capita Gross National Product (GNP) was $170 in 2001, the world's lowest, and Gross Domestic Product (GDP) grew a mere 1.7% on average between 1990 an 1997 (see figure 2.3). Poverty affects about 63% of the population, which includes 34% who are extremely poor. Poverty cut-off points are set to an annual income of 75,000 CFA francs (about $114) and 50,000 ($76) per year in the

cities and rural areas respectively.[3] Rural areas contribute 86% to total poverty. Of the rural population, 66% are poor and 36% are extremely poor. In urban areas 52% and 26% are, respectively, poor and extremely poor. Niamey has the lowest proportion of poor with 42%, which constitutes about 4 percent of all poor. In some aspects, poverty varies according to urban or rural location. In spite of this, in both groups the primary problems for the poor -the *talaka* as they are known in Niger- are malnutrition and food insecurity, and the extended family network is considered the most efficient safety net (World Bank 1996). This severe condition can be explained by an economy that relies heavily on the agricultural sector, which constitutes 41% of GDP and employs 90% of the labor force. Agriculture, on which 80% of households depend, is tremendously susceptible to irregular and declining rainfall and frequent droughts. The industry and service sectors constitute respectively 17% and 42 % of the GDP, and employs 6% of the population; the government employs the other 4%. Income inequalities are extreme in Niger; for example in 1995, the poorest 10% and the richest 10% of the population shared, respectively, 0.8% and 35.4% of the total income (Central Intelligence Agency 2002).

Poverty and inequality may have been worsened by policy responses to the economic crisis that occurred at the end of the uranium boom. In January 1994, the government devalued the currency by 50% along with other CFA countries to restore competitiveness[4]. As part of a larger structural adjustment policy, the government agreed to limit the increase in the wage bill to 10%, to improve tax collection, and to combat

[3] Set by the National Statistical office of Niger (Direction de la Statistique et de la Comptabilite Nationale (DSCN)).

[4] Devaluation refers to reducing the value of local currency relative to major foreign currencies (in this case the French Franc).

fraud in order to raise revenues to 9% of GDP from 7.3% in 1993. It also decided to limit the deficit to 14.4% of GDP, and simplify external tariffs. However, cuts in government recurrent expenditures (and investments) in health, education, agriculture, and infrastructure undermined service delivery, which was particularly disadvantageous to the poor. In order to increase profitability and productivity in the agricultural sector, technological improvements must definitely be accomplished. In addition, appropriate price and fiscal policies that do not discriminate against farmers are needed. In conjunction with stringent labor laws, a regulatory environment biased against the private sector has created an unfavorable climate for private entrepreneurship (World Bank 1996).

There is ample evidence that the purchasing power of the population went down considerably after structural adjustment policies were enforced. Figure 2.4 illustrates how the average consumer price index behaved over 1990-2000 in Niamey. Before devaluation (1994) the average CPI was declining, however a big increase of 35.5% took place in 1994 (127.2), which continued through 2000 (157.9). Since 1994, average food and beverage prices have been higher than the average of all prices. In 2000, the inflation rate was estimated at 2.8%. Evidently, food has gotten increasingly beyond the reach of the poor over the years.

Table 2.1 reports the total and male/female adult literacy rates over 1990 to 1999. Very few adults (i.e. 15 and older) are able to read and write in Niger (15% in 1999), which is a major hurdle in the pursuit of development. When broken down by gender, the proportion of literate men is nearly three times higher than proportion of literate women

(23% vs. 8%) in 1999. The education system, from primary through university levels was not operational for most of the time between 1994 and 1997 due to strikes and political instability (USAID 1998). The expected number of years of schooling was 3 for male students and 2 for female students in 1999 (World Bank-Genderstat 2002).

Table 2.1 continues with gross enrollment rates and the proportion of female students in primary and secondary school in Niger from 1990 to 1999. Gross enrollment rates in secondary and tertiary school stayed virtually constant over the ten-year period, that is around 7 and 1 percent respectively. In contrast, primary gross enrollment rose by 3 percentage points over the same time. Note that the share of female students in secondary school increased by about 31% between 1990 and 1998 (29% to 38%), while the share of female students grew only about 8% in primary school (36% to 39%). Lack of education in Niger increases poverty due to low earning power. Education has been shown to increase returns to labor, upgrade standards of living, improve health and nutrition, and reduce fertility. However, enrollment rates should attain at least 50% for education to have an effect on poverty alleviation (World Bank 1996). Niger is still very far from reaching this level.

Reallocating expenditures towards the education sector is essential and effective for fighting poverty. When a government invests in education, it helps increase the human capital of the poor. Table 2.2 presents government expenditures on education from 1990 to 1997. A net decrease in the proportion of current expenditure budgeted to both primary and secondary education is evident. Also, current expenditure as a percent of GNP per capita sharply decreased from the early 1990's levels. In 1997, the share of

per capita GNP channeled into the education system for each primary student dropped to a low 27.5 % compared to 46% two years before structural adjustment. The same decline took place in the case of total public expenditure on education as a percent of GNP from 1992 to 1997 (4.1% to 2.3%) and as a percent of total government expenditure (19.9% to 12.8%).

Niger's health indicators are especially disconcerting. In 2000, life expectancy at birth in Niger was estimated to be 45.7 years, the world's fifth lowest, while the country's fertility rate was the highest in the world, at 7.2 children on average[5](PRB 2001). Infant mortality rates are extremely high, reaching 114 deaths per 1,000 births, well over the average for Sub-Saharan Africa (91/1,000). The under-five mortality rate is 248 per 1,000 births (World Bank-WDI 2002). In a country where only 18% of births are attended by skilled health staff, it is certainly unsurprising that 120 women out of 10,000 die giving birth. Furthermore, it is estimated that 41% of pregnant women are anemic (World Bank 2002).

Table 2.2 continues with information on the number of physicians in the country, government expenditure on health, and the rates of immunizations against major diseases. In 1999, there were more medical doctors than ever in the history of Niger (274), still an extremely low number. Health expenditure as a percent of total public expenditure is also very low, at 6.6 % down from a high of 8% in 1992. The "Programme Elargi de Vaccinations," an immunization program targeting children less than 12 months countrywide, does not seem to be a success given the lack of sustained growth in the

proportion of children vaccinated (BCG, DTCP3, Rubella and Tuberculosis) over the years. The percentage of vaccinated children exceeded 50% only five times in nine years. In perspective, the above numbers can be explained by the fact that about 70% of the population of Niger does not have access to medical care (Afrol News/Afrol.com 2002). Modern health care services have become even less accessible as a result of incessant public sector strikes and drug shortages (USAID 1998).

Despite the Constitution's provisions for women's rights, traditional courts still regulate most women's living conditions. Except among the Touareg, there is a deeply rooted belief in submission of women to men in the society. Women are yet to be allowed the title and rights of head of household. In practice, they do not hold true rights to inheritance, land tenure, child custody and divorce, and they have very limited economic and political opportunities. Among the Haoussas and the Peulhs in the east, some women are not even allowed to leave home during the day, let alone unaccompanied. (Afrol News/Afrol.com 2002). Niger placed last (146^{th}) on the Gender-Related Development Index ranking in 2002 (UNDP 2002).

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[5] According to the Population Reference Bureau (2001), the total fertility rate increased from 7.4 to 7.5 over 1992 to 1998 despite the fact that the percent of currently married women of reproductive age practicing family planning increased from 4.4% in 1992 to 8.2% in 1998.

2.2 Agriculture

2.2.1 Policy

The growth of the agricultural sector in Niger has been handicapped by several factors, namely irregular and unstable rains, the lack of basic infrastructure in rural areas, and the fact that the country is landlocked. Adding to the above factors are considerable socioeconomic, financial and institutional constraints. In January 2001, the government decided to redirect its agricultural policy. Four major points are emphasized in the new policy: (1) improvement of food security for Nigeriens; (2) development of commercial/industrial agriculture to increase export earnings; (3) upgrading of the rural agricultural system; and (4) improvement of cultural techniques by promoting mechanization and re-organizing the seed market.

Niger's arable land was estimated at 3.9% of total land area in 1998, in conjunction with zero tractors per 1,000 agricultural workers and 7 grams of fertilizer per hectare of arable land (Newafrica.com 2002). Over the last ten years the political and institutional volatility in Niger did not facilitate a coherent agricultural policy, which contributed to the escalation of poverty. Traders hold significant power over the fixing of prices and hold a monopoly on transport. Farmers are organized into co-operatives, groups of several villages, but most of them do not have the financial, material and human means to fulfill their role in storage and marketing. In view of that, a recent co-operative statute reform was created with the goal to facilitate management within established rural organizations.

2.2.2 Production

Less than 4% of the country is arable, 9% is permanent pasture and only 2% is forest and woodland (Geesing and Djibo 2001). Most of the farms in Niger are small-scale, family-owned, and traditional in their methods of cultivation. Millet, sorghum and cowpea (niebe) constitute, the major staple foods produced. Niger's millet and sorghum production, mostly in the south, is among the highest in West Africa (Geesing and Djibo).

Table 2.3 lists the production, in thousands of tons, of key agricultural products from 1990 to 1999. Cereal production is very volatile, varying sometimes greatly from one production year to the other. Production was relatively extremely low in 1997 due to the food crisis that hit the country. Bean production is also high in Niger, with a total production of about 420,000 tons in 1999. However, most of it does not find its way into Nigerien's pots but is exported to neighboring Nigeria. Maize imports have sharply increased in the 1990's. In 1990, 11, 438 tons of maize came into the country compared to 68,000 tons in 2000, roughly 6.3 and 4.5 times more than the amount produced (FAO 2002). Cereal imports mainly come from the West African countries of Benin (maize) and Nigeria (millet, sorghum) and from Asian rice growing countries (Geesing and Djibo 2001). It was most recently estimated (1999) that food imports represented 39% of the total merchandize imported to Niger (Newafrica.com 2002). Table 2.4 presents Niger's food balance sheet for 1990-2000. On average, cereal availability reached 2,516 thousand tons, of which 1,920 thousand tons went to human food consumption. Millet,

sorghum and rice constituted the bulk of cereal food utilization. They amounted to 152.6, 35.2 and 10.9 kilograms, respectively, per person per day.

More than one million people work full-time in livestock production, which is the largest export after uranium. Livestock production is based on extensive grazing, but is limited by an irregular climate, the low quality of pastures and some sanitary and economic constraints. Two kinds of livestock are produced: (1) camels, which adapt the best to the dry environment are considered a long-term investment, and (2) small ruminants, which have a higher productivity are considered a short-term investment. Beside milk, the sector markets hides, skins and leather. Most animal sales by producers are destined for export to Nigeria (Geesing and Djibo 2001).

2.3 Food Security and Nutrition Conditions

The 1996 World Food Summit defined food security as "a situation in which all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO 1996). To attain food security, three conditions must be met: availability of food, access to food and utilization of food. Food insecurity is described as the opposite of food security.

In Niger, food insecurity can result from three different types of food shortages. Food insecurity is acute when food shortages originate from a natural disaster such as drought (for example the famines of the 1931s, 1953-1955s, 1966-1969s, 1973/74s, 1983/84s, 1997/98s (CNEDD/PNEDD 2000). It is transitory but severe during the

"periode de soudure" (hungry season) between June and September, when farmers run out of grains, and food prices are high. Food insecurity is chronic when food is in short supply on a continuous basis, causing stunting among children.

Table 2.4 continues with information on per capita daily supply of calories, protein and fat averaged over 1990-2000. Calories from cereals available per day and per person averaged out 1,452, of which nearly 71% comes from millet. Table 2.5 presents yearly calorie availability for the four major cereals consumed in Niger from 1990 to 2000. Over the years, their availability dropped (1.1%), thus reducing their supply of calories per caput per day. Between 1992 and 1998 calorie availability from cereals dropped 2.7%, probably reflecting the food crisis of the 1997/98-production year. Overall, daily per capita calorie availability in Niger averaged out to 2,006 kilocalories, of which 1,890 came from vegetable products and 116 from animal products. Millet and sorghum were the main source of calories (63%), followed by vegetables and fats.

It is well recognized that the availability of food is a necessary but not sufficient condition for food security. People need sufficient food access, which is largely determined by their income. As mentioned in section 2.1.4, food prices increased considerably after the 1994 devaluation of the local currency. Also, few people in urban areas can afford to buy food all year-round due to a high rate of poverty. Even in the cereal-producing departments of Maradi, Zinda and Tahoua, many poor farmers have a tendency to sell their crops before the harvest so that they can buy food. Consequently, the same farmers find themselves lacking both money and cereals after the harvest (FEWS/NIGER 1999). There were three consecutive years of below-average harvest

(1996-1997) that caused cereal prices to reach very high levels. When prices are too high in Niger, the most vulnerable populations deplete their assets to buy food, consume more wild food than usual, and reduce the number of meals that they consume.

Food must not only be available and accessible, but also must be properly utilized to fulfill nutritional requirements to the human body. Constraints to food utilization include, for example, nutrient losses associated with poor health (e.g., through diarrhea, vomit) and food preparation, inadequate knowledge and practice of health and nutrition techniques, and cultural practices that restrict consumption of a nutritionally adequate diet for certain groups or household members. One consequence of ineffective food utilization in Niger is Iodine Deficiency, which has become a public health problem of significant magnitude. Iodine is an essential nutrient required in small amounts by the body and controls metabolism growth and development. In 1994, it was estimated that 38.5% of the population had goiter, the physical manifestation of the deficiency. The small amounts of iodine found in the soil are certainly the principal reason for such a high prevalence in Niger. The highest percentages of people living with goiter were located in the departments of Dosso (10%), Tahoua (9%) and Maradi (8%) (FAO 1998). Iron Deficiency Anemia (IDA) in pre-school children and Vitamin A Deficiency (VAD) are also a public health problem in Niger.

UNICEF (2001) estimates that in 2000 about 39.6% of children under five in Niger were underweight, while 14.3% were severely underweight. Stunted and severely stunted children constituted, in order, 39.8% and 19.5%. There were 14.1% wasted children, and 3.2% were severely wasted. As for adult malnutrition, it was shown using

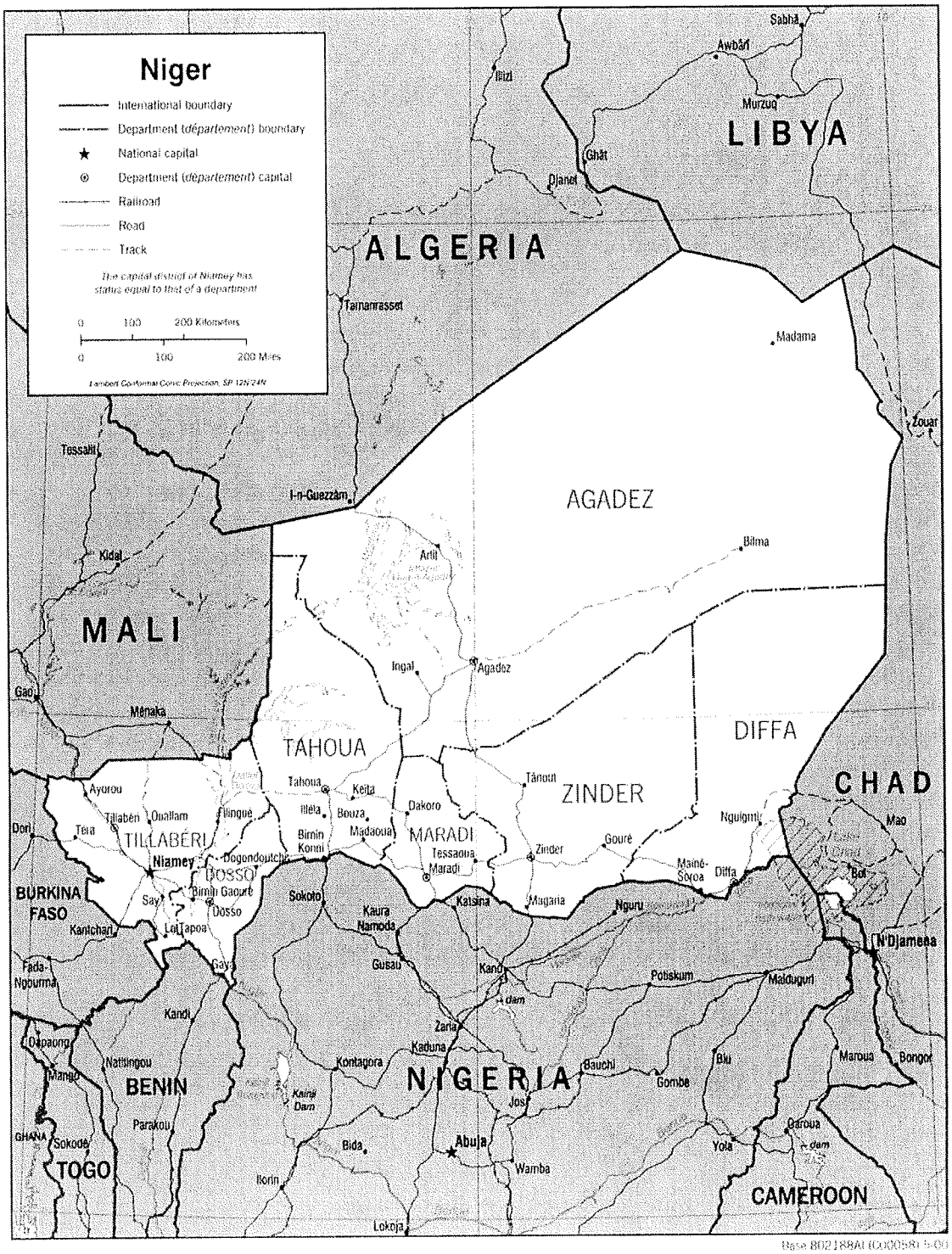
Body Mass index (BMI), an anthropometric indicator for adults, that in 1998 the highest incidences of undernourishment were found in Agadez, Diffa and Zinder, where over one third of adults were affected (FAO 1998).

2.4 Consumption Patterns

Cereals provide about 85% of the calories of sedentary Nigeriens in rural areas, while they supply 65% of the calories of non-sedentary and urban populations (FAO 2001). However for districts such as Agadez, where only 10% of the cereal is produced, market prices and food flows dictate the distribution of the sources of calories. Touareg and Peulh nomadic herders essentially consume milk and millet, one more than the other depending on the season[6]. Over time the urban consumption patterns have dramatically shifted, with rice consumption reaching 40 kilograms per person per year in Niamey compared to 5.6 kg in rural areas. In addition, more and more urban people get their calories from outside their home (10%) (FAO 1998). In 1993, the National Household and Budget and Consumption Survey (ENBC) estimated that urban non-poor consumed, respectively, over 3 and 1.5 times more vegetables and meat/fish than their rural counterparts (World Bank 1996).

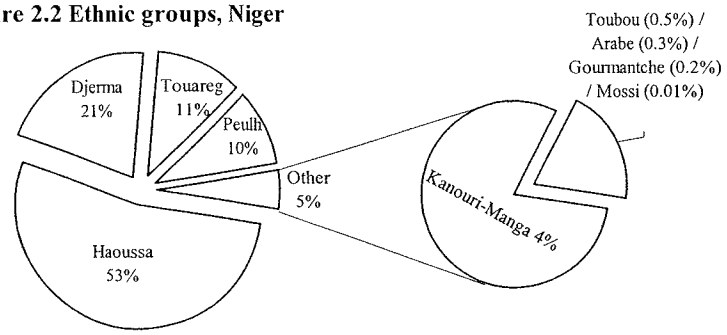
[6] Milk is more valuable during the rainy season, while millet is of high demand during the dry season.

Figure 2.1 Map of Niger



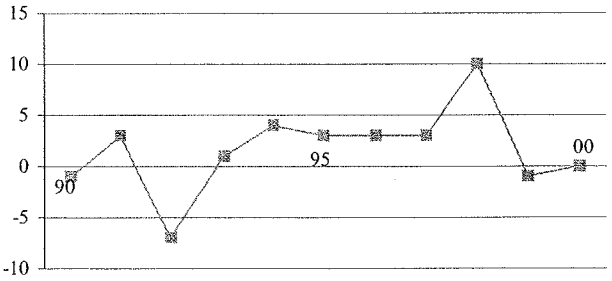
Source: University of Texas Library Online

Figure 2.2 Ethnic groups, Niger



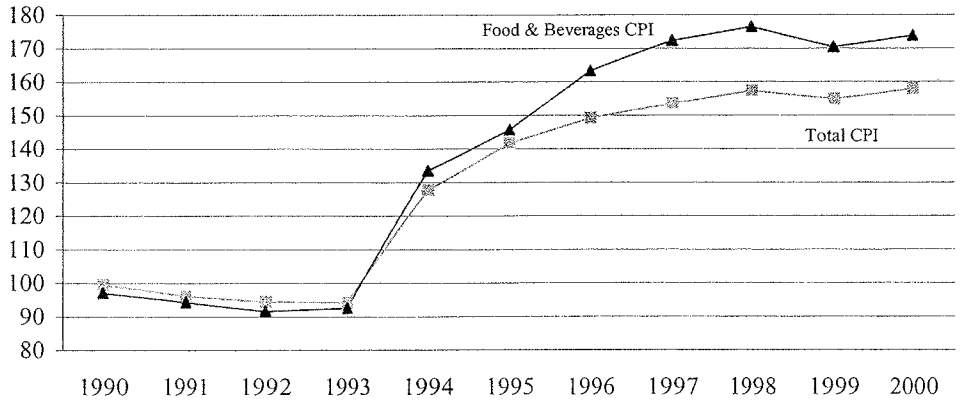
Source : United Nations Development Programme

Figure 2.3 GDP growth (annual %), 1990-2000



Source: WDI database, 2002

Figure 2.4 Average Consumer Price Index (base=1989) Niamey, Niger 1990-2000



Source : Direction de la Statistique et des Comptes Nationaux

Table 2.1 Literacy and education , Niger 1990-1999

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Adult literacy rate										
Literates as % of adult population (estimated)	11	12	12	12	13	14	14	14	15	15
Literates as % of adult population, Female (estimated)	5	5	6	6	6	7	7	7	7	8
Literates as % of adult population, Male (estimated)	18	18	19	20	20	21	21	22	22	23
Ratio Female, Male	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Education										
Gross enrollment rate (%) primary	29	28	28	29	29	29	29	29	31	32
Gross enrollment rate (%) secondary	7	6	6	7	7	7	7	n/a	7	7
Gross enrollment rate (%) tertiary	1	1	1	1	1	1	1	1	n/a	n/a
Girl's enrollment share										
% of female students in primary school	36	37	37	36	37	38	38	39	39	n/a
% of female students in secondary school	29	30	33	n/a	34	34	35	37	38	n/a

n/a = not available

Sources: USAID, Economic and Social Data Service (ESDS) (data compiled is from UNESCO)
Ministère de l'Education Nationale, Niger
World Development Indicators (WDI) database, 2002

Table 2.2 Social support: Education and Health, Niger 1990-1999

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Education expenditures										
% of Public Current Expenditure on Pre-Primary and Primary Education	60.6	n/a	54.1	62.1	60.6	62	59.7	59.7	n/a	n/a
% of Public Current Expenditure on Secondary Education	33.1	n/a	29.6	31.6	33.1	31.6	32.3	32.3	n/a	n/a
Current Expenditure Per Primary Student as % of GNP Per Capita	40.0	n/a	45.9	n/a	35.2	37.0	31.3	27.5	n/a	n/a
Total Public Expenditure on Education as % of GNP	3.2	3.1	4.1	2.9	2.9	2.9	2.6	2.3	n/a	n/a
Total Public Expenditure on Education as % of Total Government Expenditur	18.6	18.4	19.9	14.7	14.6	16.4	15.2	12.8	n/a	n/a
Health expenditures										
Number of physicians	84	118	108	135	139	135	135	n/a	n/a	274
Total Public Health Expenditure as a % of Total Public Expenditure	5.9	7.3	8	6.5	5.7	7.2	5.9	6.6	6.6	6.6
Immunizations 1/ (%)										
BCG	53	36	37	33	32	50	61	44	43	n/a
DTP3	22	18	20	20	20	23	32	28	26	n/a
Rubella	25	23	21	20	27	43	58	42	n/a	n/a
Tuberculosis	40	41	43	35	36	36	32	33	52	n/a

n/a = not available

1/ Immunization coverage (in percent) at 11 months under the "Programme Elargi de Vaccinations"

Bacillus of Calmette and Guerin (BCG)

Diphtheria Tetanus and Pertusis (DTP)

Sources: USAID, Economic and Social Data Service (ESDS) (data compiled is from UNESCO)

Direction de la Statistique et des Comptes Nationaux, Niger

Ministère de la Santé, Niger

Table 2.3 Agricultural production (thousand tons), Niger 1990-1999

Crop	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Sorghum	281.2	464.0	383.8	421.0	399.6	265.7	410.4	289.7	533.3	476.0
Millet	1,428	1,844	1,787	1,658	1,972	1,769	1,762	1,352	2,441	2,295
Maïze	1.8	1.9	1.0	0.1	1.8	1.3	3.6	3.0	0.7	15.3
Fonio	0.6	0.6	0.5	0.7	0.8	0.9	1.4	1.0	1.0	1.0
Rice (paddy)	9.8	6.7	20.6	9.0	0.6	52.7	83.2	50.7	53.5	60.5
Wheat	11.2	10.4	8.4	4.4	7.2	3.1	1.7	0.6	6.2	12.7
Potatoe/Sweet Potatoe	119.0	22.5	37.9	20.2	27.9	48.0	39.1	30.1	39.1	n/a
Beans	223.6	461.2	402.3	162.8	424.8	184.4	295.2	192.5	214.7	419.9
Peas	7.4	8.3	14.8	25.8	36.8	72.8	26.4	17.7	20.7	15.3
Groundnuts	15.7	45.8	57.1	25.5	67.4	111.1	196.0	87.9	99.0	103.8
Cassava	141.9	126.3	76.3	116.5	65.4	77.7	96.1	129.5	156.1	100.8
Onions	220.0	168.8	172.4	149.7	152.2	185.7	183.4	181.1	183.4	n/a
Tomatoes	49.2	79.4	82.5	48.2	47.8	47.8	96.3	64.1	62.0	n/a
Cotton	4.9	9.4	3.1	2.4	4.5	7.8	6.8	n/a	n/a	3.3
Sugar Cane	97.1	78.9	97.4	60.9	56.8	104.3	139.0	173.6	139.0	n/a

n/a = not available

Sources : Direction de la Statistique et des Comptes Nationaux, Ministère du Développement Rural

Table 2.4 Food balance sheet, average 1990-2000

	Domestic supply					Utilization		Per caput supply		
	Production	Imports	Stock change	Exports	Total	As food	Kg/year	Calories/day	Protein grams/day	Fat grams/day
			(in thousand tons)							
Cereals - excluding Beer	2274	159	83	0	2516	1920	209.3	1452	32	12
Wheat	8	47	1	0	56	55	6.0	45	1	0.1
Rice (milled equivalent)	42	62	2	0	106	100	10.9	104	2.0	0.1
Barley - excluding beer		1	0		1	0	0.0	0	0.0	
Maize	5	26	3	0	34	32	3.5	30	0.8	0.3
Millet	1842	5	18	0	1865	1400	152.6	1030	20.2	8.8
Sorghum	375	10	59	0	444	323	35.2	233	7.2	2.2
Cereals, other	2	8		0	10	10	1.1	10	0.2	0.0
Grand total								2006	54.5	32.5
Vegetable products								1890	45.7	25.0
Animals products								116	8.7	7.5

Source: FAOSTAT Database, 2002

Table 2.5 Calorie availability from cereals 1990-2000

Cereal	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Maize	13.0	6.5	11.0	10.4	8.6	18.3	14.6	45.8	87.4	35.2	59.2
Millet	1,184.4	1,077.7	1,049.7	1,025.3	994.0	993.6	960.7	1,027.0	933.1	1,071.7	1,049.9
Rice (paddy)	98.3	101.4	96.9	99.4	85.6	78.1	89.4	140.4	121.9	110.3	110.5
Sorghum	259.4	202.6	270.4	194.1	261.7	280.2	279.1	206.2	247.3	222.9	157.1
Wheat	66.2	54.9	56.6	71.5	56.3	18.0	40.1	25.8	38.0	39.1	41.2
Total	1,621	1,443	1,485	1,401	1,406	1,388	1,384	1,445	1,428	1,479	1,418
Growth rate (%)		-0.110	0.029	-0.057	0.004	-0.013	-0.003	0.044	-0.012	0.036	-0.041

Source: FAOSTAT Database, 2002

CHAPTER 3

CONCEPTUAL FRAMEWORK:

THE DETERMINANTS OF CHILD NUTRITIONAL STATUS

The first section of chapter 3 discusses the conceptual framework guiding the empirical analysis of this study, and explores the link between women's and child nutritional status. In the second section, the nutrition production function is combined with a collective model of household decision-making in order to derive a reduced-form demand function for child nutritional status. The function supplies a consistent statistical framework within which socioeconomic determinants of children's nutrition can be identified and factored into policy interventions accordingly.

3.1 Conceptual Framework

Malnutrition is a complex problem because it results from a long chain of interrelated events. More than just a science to be learned, it is also a crisis to be resolved. It is therefore crucial that it be understood before attempting to fight it. The conceptual framework underlying this study is adapted from the United Nations Children's Fund (UNICEF) framework for the determinants of child malnutrition and death (UNICEF 1998). The organization's framework not only includes biological and socioeconomic causes, but also incorporates causes at both the micro and macro levels, making it the most comprehensive framework of nutritional status. In the framework, the problem of malnutrition is looked at from a more holistic perspective instead of relying on one simple explanation directed on the food or health sector. The framework reveals

three levels of causality: immediate, underlying and basic determinants of child nutritional status. Figure 3.1 details the stages in the framework.

3.1.1 The Immediate Determinants

The immediate determinants of child's nutritional status are the child's dietary intake, including energy, protein, fat and micronutrients, and health status. The two immediate determinants are themselves interrelated making it complex to actually determine which one occurred first in some cases. It is often easy to identify a malnourished child or a high incidence of malnutrition in a community because deficient dietary intake and poor health directly manifest themselves at the individual level. Although malnutrition can be reduced based on an obvious recognition of its immediate causes, long term improvements can only be assured if the analysis is extended to another level, that is if the underlying determinants are also investigated.

3.1.2 The Underlying Determinants

The immediate causes of malnutrition are affected by household level underlying determinants. The underlying determinants are various and interrelated. They are also mostly associated with the under-fulfillment of children's specific basic needs. They are grouped into three main sectors: household food security, health environment and services, and maternal and child care. Although the first two precondition adequate dietary intake and the control of common diseases among children, they do not satisfactorily ensure them. There must be in addition a system that guarantees that foods and health services are appropriately used for the benefit of the children. Some of these

essential services are included in the maternal and child care sector. In that effect, all three underlying determinants are equally important.

The 1996 World Food Summit defined food security as "a situation in which all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO 1996). As opposed to simple availability of food, household food security is determined by financial, physical and social access to food and by its effective utilization. Thus, it is essential to acknowledge that an increase in national food production does not guarantee household food security. Likewise, food availability at the household level does not ensure access for an individual on account of factors that include intra-household allocation and culture. For more on food security and its concepts see Maxwell and Frankenberger (1992). Food security as the main solution of malnutrition has been a central paradigm for years, but while food is crucial, it is not the only factor.

The health environment and services are also important underlying determinants of child nutritional status. Water unavailability indirectly affects nutrition because it increases the workload of women thus reduces time available for care. Also, lack of safe water and sanitation directly affects health, food preparation, and general hygiene. Curative and preventive health services are needed to guarantee good health for all community members. It is often the case that countries incorporate their nutrition service in the Ministry of Health not conscious that malnutrition is not only the responsibility of the health department.

Care is defined as "the provision in the household and the community of time, attention, and support to meet the physical, mental, and social needs of the growing child and other household members" (INC 1992). Caring practices include care and support for mothers during pregnancy and lactation, child breastfeeding and complementary feeding, psychosocial care (cognitive simulation for children), health seeking behavior, food processing, hygiene practices, and home health practices. The caregiver must also have sufficient education, time, and support to be able to offer care to a child. The resources for good care include (1) education, knowledge and belief (measures capacity to provide proper care); (2) physical and mental health (translate capacity into behavior); and (3) autonomy, workload and social support (facilitate conditions in the family and community) (Engle, Menon and Haddad 1999). The concept of care was emphasized more than ever at the 1992 International Conference on Nutrition in Rome (Engle 1992), when efforts were made to comprehend the reason why malnutrition persists even with enough food and the presence of an adequate health environment.

Most underlying causes of child malnutrition are the result of inequality in society. The World Bank's most recent definition of poverty includes not only material deprivation (measured by income and consumption) but also low achievements in education and health (World Bank WDR 2002). The notion of poverty is also extended to include vulnerability, exposure to risk and powerlessness. Poverty has severe consequences for child nutritional status. Poor people's condition is associated with lower levels or constrained use of key assets and with low quality housing and access to basic services. The poor are unable to attain food security and do not have the resources for

care. While caused by poverty, malnutrition also perpetuates an inter-generational cycle of poverty. In fact, malnourished girls tend to later give birth to malnourished children, who in turn will most likely be intellectually deficient, thus have diminished productive and creative capacities (UNICEF 1998). The poor, the ones most affected, cannot be ignored in the fight against malnutrition.

3.1.3 The Basic Determinants

The underlying determinants of child malnutrition are in turn affected by basic determinants, a group of factors that relate to resources, their control and use. The three major types of resources taken into account are human, economical and organizational. Human resources consist of people and their skills, motivation, knowledge and time. Economic resources include among others land, assets and income. Organizational resources can be made up, for example, of formal and non-formal institutions. The availability and control of these resources are connected to both the historical processes of a country or community and to other outside processes such as economic dependency or imposed structural adjustment programs. These processes can be classified into four groups of basic determinants of malnutrition:

(1) ecological and technical conditions of production (e.g., environment, levels of technology and people skills);

(2) social conditions of production (e.g., power structure, division of labor);

(3) political factors (e.g., structure, function, policies, legal system of the state);

(4) ideological factors (e.g., cultural preferences, beliefs).

The level and interaction of these various factors explain the existing availability and control of resources in a country or community. In turn, the availability and control of these resources explain the extent of realization of the three necessary conditions (food, health and care) for good child nutrition.

3.1.4 The Links Between Child Nutritional Status and Women's Nutritional Status

It is essential to give attention to women's nutrition because, above all, women have a basic right to food and good health. In addition, women play a crucial role in maintaining household food security (Quisumbing et al. 1995). However, women's role is not limited to the area of production, but extends to their reproductive, nurturing, and caring responsibilities. The well being of a newborn significantly depends on the health of the mother during pregnancy and birth. Also, a mother's poor health and nutritional status can seriously affect a child's survival and development by diminishing the caring ability of the mother (Engle, Menon and Haddad 1999).

As shown in Figure 3.2, nutrition problems continue throughout the life cycle. A baby faces a higher risk of disease and premature death if his/her mother is malnourished, sick or received inadequate prenatal and delivery care (Tinker and Ransom 2002). The nutritional status of girls and women significantly affects first and foremost the development of the fetus, which, for up to 9 months, depends entirely on its mother for nourishment (Ramakrishnan et al. 1999).[7] Maternal malnutrition leads to childhood malnutrition as underweight and/or anemic mothers are more likely to give birth to

intrauterine growth retarded (IUGR) or low-birth weight infants (Adair 1987; Scholl and Hediger 1994). Children with low birth weight start life at a disadvantage because they are likely to suffer cognitive impairments and developmental retardation. They are predisposed to remain underweight as children, even with partial catch up with their adequate-birth-weight-peers (Martorell et al. 1998). Their poor nutritional status, which may be characterized by protein-energy malnutrition, iodine deficiency disorder, vitamin A deficiency and iron deficiency anemia among others, continues through childhood and adolescence. When malnourished female adolescents enter their adult years and pregnancy, they often fail to gain enough weight, which puts their babies at risk of low birth weight. Thus, the cycle of malnutrition continues.

Tackling women's malnutrition has also another aspect that is key to child survival and development. Better-nourished women are healthier in later years. Healthier elders, particularly in Sub-Saharan Africa, translate into improved quality of care for children and reduced burden of women in caring for sick elders. Investing in maternal and child nutrition has both short-term and long-term benefits of enormous economic and social magnitude such as reduced health care costs throughout the life cycle, increased intellectual capacity and higher adult productivity (ACC/SCN 2000).

The major factors contributing to women's malnutrition in Sub-Saharan Africa include inadequate food intake (quantity and quality), infections (HIV/AIDS), reproductive factors, heavy physical labor, poor access and utilization of social services

[7] Near one quarter of newborns in the developing world suffer from some extent of growth and micronutrients deficiency (UN/ACC/SCN 2000). More than 20 million infants in the developing world are born every year with low birth weight (Save the Children 2001).

such as health and education, and cultural and social factors such as low status (FANTA 2001).

3.2 The Model

The UNICEF conceptual framework can be effectively set in terms of a mathematical model. Mathematical models of household decision-making are an essential tool in understanding how power gaps within a household can affect the process of child nutrition provisioning, and what internal and external forces to the household shape the decision-making process. Thus, they facilitate the identification of the appropriate variables to be included in empirical analysis.

3.2.1 Economic Models of Household Decision-Making

Becker (1965, 1974), Becker and Lewis (1973) and Becker and Tomes (1976) were the first attempts to include the household in economic theory. A major assumption in their models is that the household as a decision-making unit is characterized by a single utility function that is maximized subject to a single budget constraint. Although this approach simplifies the analysis by equating the household decision process to an individual decision process, it poses theoretical problems.[8]

There is also much evidence in current economic literature that households with more than one member do not make decisions according to the unitary model (Haddad, Hoddinot and Alderman 1997).

---

[8]The requisite for a unique household utility function is to aggregate the utility functions of all members of the household. However Arrow's theorem shows that this does not produce an aggregate utility function with all the desirable characteristics: asymmetry, negative transitivity, Pareto efficiency, independence from irrelevant alternatives and absence of a dictator.

A collective model acknowledges the existence of several decision-making units, with possibly different preferences, in the household. The allocation of resources in the household depends on the power of each member. Power in turn is related to a person's potential welfare outside the sphere of the household (outside marriage). Thus, the higher the welfare that each member can obtain outside the family, the more credible is her threat of leaving the family, the higher is her bargaining power, and the higher is her utility within the household. In short, each member looks to secure through resource allocation at least the same welfare as the one to be achieved upon leaving the household. The collective model implies that decision-making power depends greatly on the current conditions in the labor market and also on the potentials in the marriage market taking into account traditional values. For example, the acceptance of divorced people, especially women, can be an important determinant of how marriageable one can be in a traditional society. Haddad and Reardon (1993) showed how women's low decision-making power resulted in resource allocation biased toward adult males in Burkina Faso.

Collective models include cooperative and non-cooperative game-theoretic models, or some blend of the two. In cooperative models, household members are assumed to pool their resources and make decisions over resource allocation jointly (McElroy and Horney 1981). In non-cooperative models, members control separate sets of resources and make decisions separately (Ulph 1988). A blend of the two models could take the form in which resource allocation decisions are modeled as a non-cooperative game but resource control decisions as a cooperative game (Carter and Katz

1997; Smith and Chavas 1997). For the purpose of this study, a cooperative game-theoretic model is developed.

3.2.2 Collective Decision-making and Resource Pooling

In the context of a simple static model of a multi-member household, overall household welfare, W, depends on the utility U^i of each household member. The household members are classified into three groups: caregiver, M, (assumed to be the mother), other adults, Ad, and children, Ch. The welfare function is written as

$W = (U_M, U_{Ad}^1, ..., U_{Ad}^D, U_{Ch}^1, ..., U_{Ch}^J)$.

At this point, assume that income from wage employment rather than home-based self-employment constitutes adults' income and that goods are all purchased on the market rather than home produced. Consider a household is made up of a woman, f, a man, husband or live-in partner, m, and their child. The husband and wife spend their time in three activities: (1) income generation, T_{iw}, for which wage w_i is received; (2) care for household members, $T_{ic;}$ and (3) leisure, T_{il}. Household income is the aggregate of income earned and income accrued from other exogenous sources (denoted E_i). It is allocated between two types of goods: (1) those directly consumed, X_O, having prices p_O; and (2) those used in the provisioning of nutrition for household members, X_N, having prices p_N.

Let the couple's preferences be defined over child nutritional status, N, goods directly consumed, and their leisure time as follows[9]:

[9] The utility and nutrition provisioning functions are assumed to be continuously differentiable, increasing in all arguments, and strictly quasi-concave.

$$U^i(N, X_O, T_{fl}, T_{ml}) \qquad i = f, m. \tag{1}$$

Though the man and woman's preferences are defined over the same set of variables, they may have different preferences over them and indeed may not be involved in choosing some of them.

Nutritional status is considered a household provisioning process with inputs of purchased goods, such as food and medicines, and the couple's time in caring practices, such as newborn care and feeding practices. This process is denoted:

$$N(X_N, T_{fc}, T_{mc}, \Omega) \tag{2}$$

where

$$\Omega = (\Omega_{ch}, \Omega_{hh}, \Omega_{co})$$

is a vector of child characteristics (Ω_{ch}), characteristics of the household and caretaker(s) (Ω_{hh}), and characteristics of the community in which the household is located (Ω_{co}). Child characteristics include age, sex, and genetic endowment. Characteristics of the household may include household size, age-sex composition, health environment, and the ethnic origin, age and education of the woman and man. Characteristics of the community may include its location and infrastructure.

In a model of joint decision-making and resource pooling, all resource allocation decisions are made jointly conditional on overall household income. However, the man and woman may have different levels of power in the shaping of a final decision. The endogenous choice variables of the model are

$$\xi = (X_O, X_N, T_{fw}, T_{fc}, T_{fl}, T_{mw}, T_{mc}, T_{ml}).$$

The man and woman together choose ξ to maximize a Nash objective function

$$[U^f(N, X_O, T_{fl}, T_{ml}) - \phi^f(p, w^f, E^f, \alpha^f)] \times [U^m(N, X_O, T_{fl}, T_{ml}) - \phi^m(p, w^m, E^m, \alpha^m)], \quad (3)$$

subject to the nutrition provisioning function (2) and

$$T_w^f + T_c^f + T_l^f = T^f \quad (4)$$

$$T_w^m + T_c^m + T_l^m = T^m \quad (5)$$

$$p_O X_O + p_N X_N = w_f T_w^f + w_m T_w^m + E^f + E^m \quad (6)$$

$$(U^i - \phi_i) < 0, \qquad i = f, m. \quad (7)$$

Equation (3) is the product of the gains the man and woman get from being members of the household; the gains must be positive (equation 7). To derive the fallback positions, the utility functions of the woman and man are maximized given the time and income constraints they would face in the event of divorce. The fallback positions are thus functions of the prices, wages, and exogenous incomes they would face, which are assumed to be those faced in the current circumstances. They are also functions of other non-monetary factors influencing the agents' fall-back positions, denoted α_i, including their human capital (e.g., education) and social capital (e.g., ability to rely on their close relatives).[10]

Equation (4) and equation (5) establish that the woman's as well as man's time endowment (24 hours a day) is allocated among work, care and leisure. Equation (6) is

[10] While these are often referred to as "extra-household environmental parameters" (EEPs) (McElroy 1990), they may also include the characteristics of individuals.

the household budget constraint. It equates the household's expenditures to the sum of employment incomes and exogenous incomes of the woman and man.

When substituted into equation (2), the reduced-form equations for the inputs into the nutrition provisioning function give the following reduced-form equation for child nutritional status:

$$N^*(p_O, p_N, w^f, w^m, E^f, E^m, \alpha^m, \Omega). \qquad (8)$$

This is a function of the prices faced, the woman's and man's income generating potentials as embodied in their wages, their exogenous incomes, factors influencing their situation in the event of divorce, and child, household and community characteristics. It is important to note that the estimation of the reduced-form function N in equation (8) does not supply information on the biological mechanisms responsible for children's growth deficiencies. Nevertheless, the function provides a consistent statistical framework within which the impact of household and community exogenous variables on children's health and nutrition can be estimated and consequently, factored into policy intervention.

The decision-making power of a woman relative to her husband influences child nutritional status in this model by affecting the degree of influence the woman has over (1) the allocation of her time and her husband's time to care, and (2) the allocation of household income to purchased goods that enhance the child's nutritional status. The first order necessary condition for optimal allocation of household income to purchases of goods that are inputs into child nutrition provisioning, for example, is obtained by maximizing the following Langrangian function:

$$
\begin{aligned}
Max\, L = & [U^f(N, X_O, T_{fl}, T_{ml}) - \phi^f(p, w^f, E^f, \alpha^f)] \\
& \times [U^m(N, X_O, T_{fl}, T_{ml}) - \phi^m(p, w^m, E^m, \alpha^m)] \\
& + \mu_1(T^f - T_w^f - T_c^f - T_l^f) + \mu_2(T^m - T_w^m - T_c^m - T_l^m) \\
& + \lambda(w_f T_w^f + w_m T_w^m + E^f + E^m - p_O X_O - p_N X_N) \\
& + \gamma_1(0 - U^f + \phi) + \gamma_2(0 - U^m + \phi) \qquad ,
\end{aligned}
$$

and deriving

$$
\frac{\partial L}{\partial X_N} = -\lambda P_N + \frac{\partial U^F}{\partial N}\frac{\partial N}{\partial X_N}(U^m - \phi^m) + (U^f - \phi^f)\frac{\partial U^m}{\partial N}\frac{\partial N}{\partial X_N} = 0 \quad .
$$

This can be written as

$$
-\lambda P_N + \frac{\partial N}{\partial X_N}\left[\frac{\partial U^f}{\partial N}(U^m - \phi^m) + \frac{\partial U^m}{\partial N}(U^f - \phi^f)\right] = 0 \qquad ,
$$

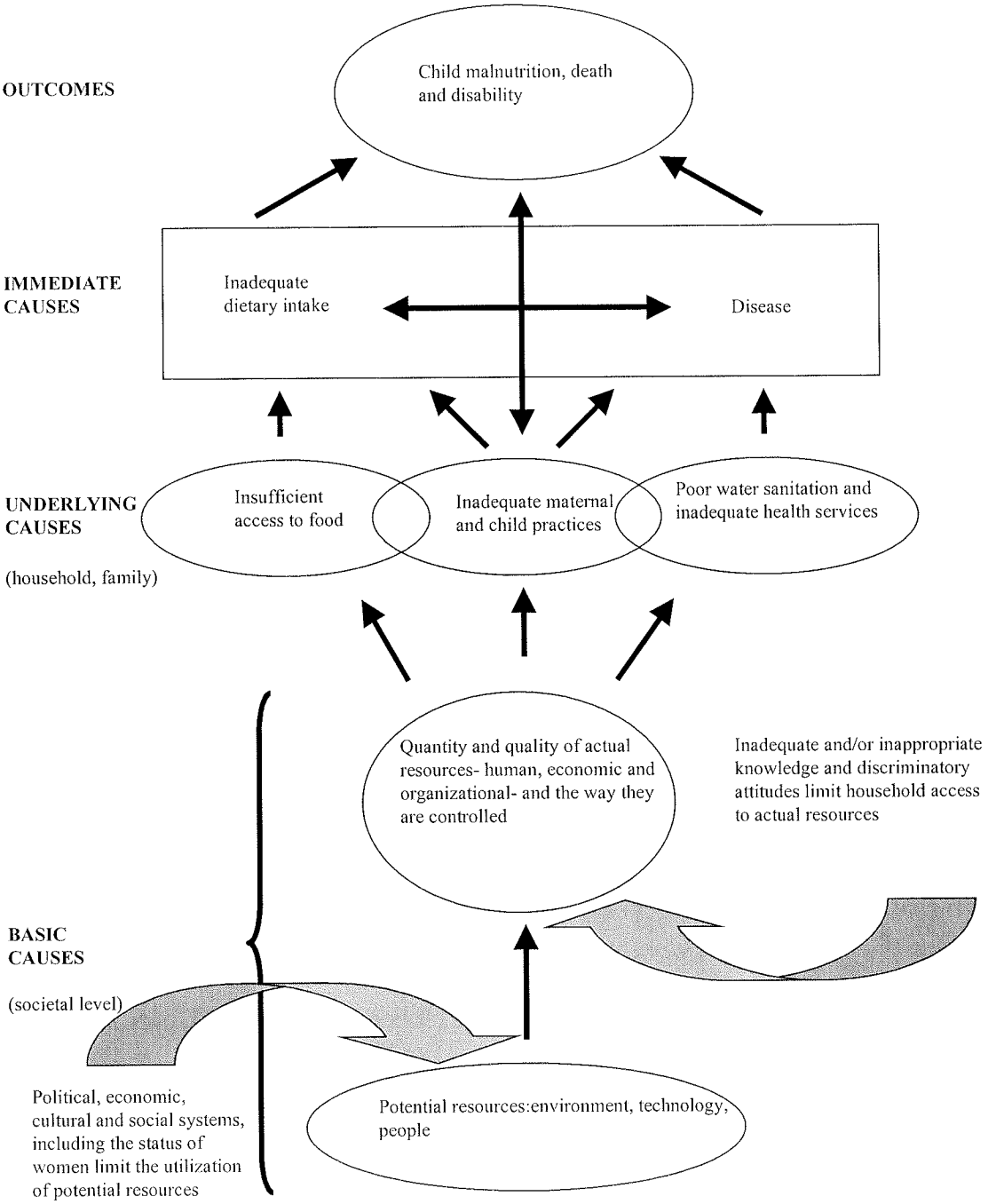
and reduced to:

$$
\frac{\partial N}{\partial X_N}\left[\frac{\partial U^f}{\partial N}(U^m - \phi^m) + \frac{\partial U^m}{\partial N}(U^f - \phi^f)\right] = \lambda p_N \qquad (9)
$$

where λ is the household's shadow value of income.

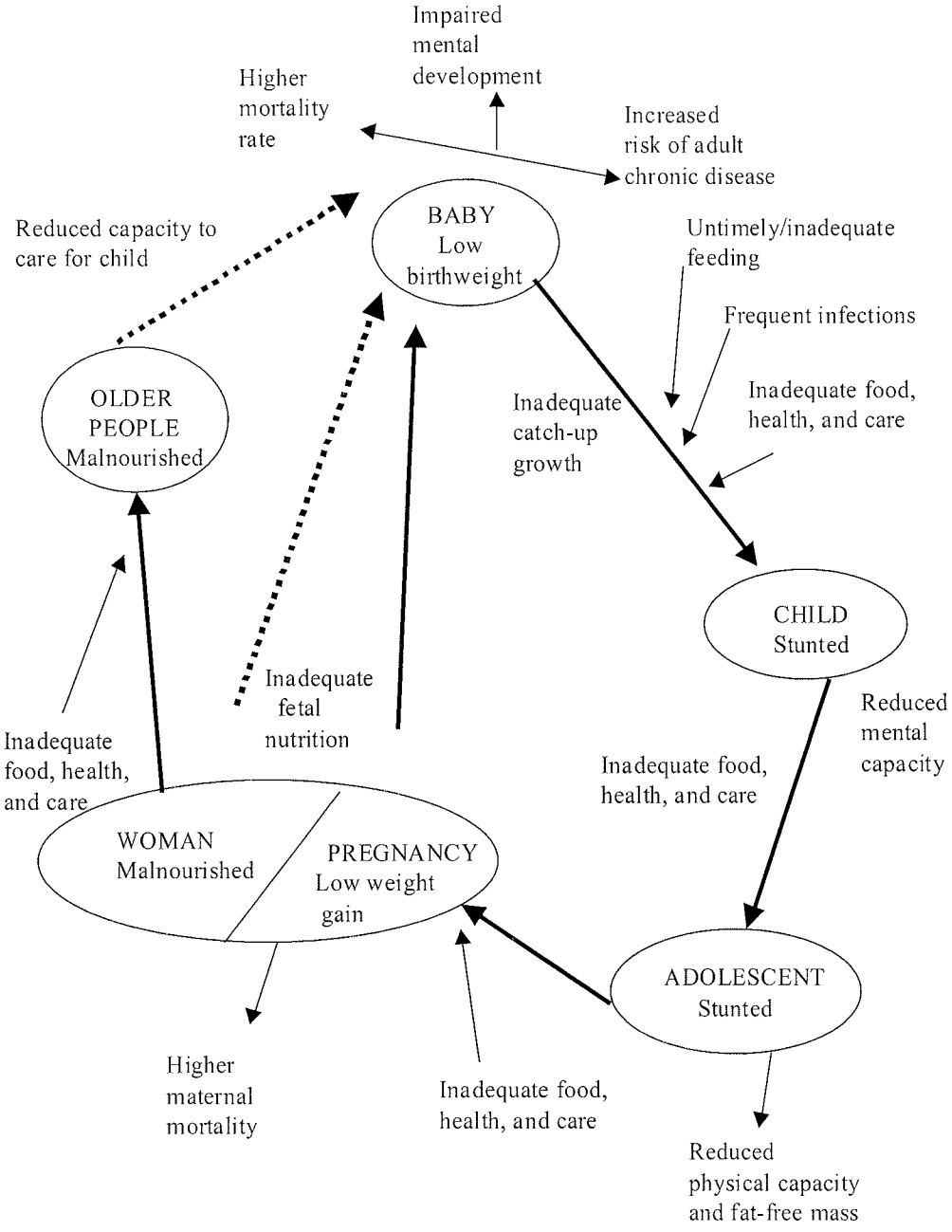
At the optimum, the household member with the most favorable fallback position, specifically the one having the least to gain from membership in the household (U^i-ϕ^i is lowest), has the most influence over how income is allocated among the purchase of nutrition inputs and other goods. If the woman is more concerned about child nutrition than the man ($\partial U^f/\partial N > \partial U^m/\partial N$), then a balance of power in favor of the latter implies that less of household resources will be allocated to nutrition provisioning than if there were an equal balance of power.

Figure 3.1 The causes of child malnutrition



Source: UNICEF (1998)

Figure 3.2 Nutrition throughout the life cycle



Source: Adapted from the ACC/SCN-appointed commission on the Nutrition Challenges of the 21st Century

CHAPTER 4

DATA, MEASURES AND METHODOLOGY

Section 1 of chapter 4 describes the data employed in the study. Sections 2 and 3 introduce, respectively, the dependent variables and the measures of selected determinants of child nutritional status. Sections 4 and 5 describe the construction of indexes of women's status and economic status that will be employed. Finally, section 6 presents the estimation strategy utilized in the study.

4.1 Data

The Demographic and Health Surveys (DHS) are a worldwide program designed to collect data on maternal and child health, fertility, and family planning. The program is funded by the United States Agency of International Development (USAID) and is executed by the Macro International Inc, Calverton, USA, in collaboration with the appropriate institutions of the host countries. DHS are nationally representative surveys with two-stage sample designs conducted in single rounds. The first stage consists of selecting clusters from regional units within a given country. In the second stage, households are randomly selected within each cluster. The DHS surveys have two main survey instruments: a household schedule and an individual questionnaire for women of reproductive age (i.e. 15 to 49). The household schedule collects basic household demographic information including the list of household members. It is subsequently

used to select eligible respondents for the individual surveys that provide information such as household assets, reproductive histories, and the health and nutritional status of the respondent and all her children born during the three or five-year period preceding the survey.

For the purpose of this study, the data utilized are taken from the 1992 and the 1998 Niger DHS surveys. The 1992 survey was conducted in collaboration with the Finance Ministry of Niger, while Care International, Mali executed the Niger 1998 survey.[1] Even though the design of the two surveys is not entirely uniform, there were clear efforts to standardize them so that they are practically comparable.[2]

Table 4.1 describes the data sets employed and the sample sizes[3]. The sample analyzed in the study includes 5,674 children under the age of three and 5,166 women, their mothers. The number of children in 1992 is 2,334 (2,110 women); it is 3,338 (3,056 women) in 1998. In total 4,525 households are included. The above sample was selected taking into account the need for best quality data on child nutritional status (i.e. height, age, and weight) and on explanatory variables including the characteristics of women and their partners and household socio-demographic characteristics.

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[1]The executing agency in 1992 is the Direction de la Statistique et des Comptes Nationaux, Direction General du Plan, Ministere des Finances et du Plan. The executing agency in 1998, Care International, Mali is one of the local offices that the international relief and development agency has throughout the world.

[2] Apart from the fact that two different executing agencies were involved in the two phases, the major differences rest in the time of collection within the year, a change in the application of sampling weights, and some variations in the availability of certain variables. In 1992 the collection of data took place between March and June, while in 1998 between January and July.

[3] Both data sets are weighted to be nationally representative. All sample weights are normalized such that the weighted number of cases is identical to the unweighted number of cases when using the full data set with no selection.

Several steps were taken in choosing the sample. First, only children aged 0-36 months are included in the analysis since only this age group is found in both data sets (only children born during the three-year period preceding the survey were included in 1998). Second, all children with missing or implausible data on weight, height, or age according to DHS standards were not included.[4] Third, children whose mothers claimed not to have a male partner were excluded. This was a prerequisite for the construction of an index of women's relative decision making power, one of the main independent variables, and for studying the impact of male education on nutritional status. The women without partners constitute 5.35% and 3.72% of the women whose children aged 0-36 months do not have missing or implausible anthropometric data in 1992 in 1998 respectively. Fourth, all children with missing data for most of the independent variables controlled for in the regression analysis were excluded.[5] Finally, for each dependent variable of the study, an additional data cleaning process was performed, which led to the exclusion of few more cases.[6]

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[4] Weight-for-age and height-for-age z scores less than –6 or greater than +6 are considered illogical. A plausible weight-for-height is considered to be between –4 and +6.

[5] For some of the variables (i.e. household age-sex composition and ethnicity), an "eyeballing" of the household schedule was used to replace missing values. Each household data was directly and extensively investigated in order to determine the age bracket (i.e. < 15, between 15 and 55, and over 55) and the ethnicity of a member missing the relevant data. However in regards to household age-sex composition, there was no judgment of an age bracket if the members per se were also the partners of the sampled women. The children of those women were to subsequently be dropped out of the sample since they were missing data on an essential independent variable and measure of the women's status index.

[6] For height-for-age, weight-for-height, and body mass index, regression diagnostics i.e. graphs of leverage-versus-squared residual plot (Statacorp 2002) were used to detect and exclude influential observations with high errors. Also, outliers for height-for-age and weight-for-height z scores that fell inside the World Health Organization (WHO 1995) flexible exclusion range were considered potential data entry or reporting errors. Cases of probable inaccurate high *haz*, *whz* and low *haz* were specifically dropped. The percentage of cases dropped because of suspected influential observations and outliers for the anthropometry data is less than 0.001% for both 1992 and 1998.

It is additionally important to point out that information on child health is only collected in the detailed questionnaire of women 15-49 who were present at the time of the survey. Thus, the sample of children is not fully representative of the national sample of children less than three years in the Niger DHS surveys. Furthermore, although the sample leaves out children born of mothers younger than 15 or older than 49 and children whose mothers have died, fertility rates are normally so much lower outside the selected age range that the restriction does not critically compromise the representativeness of the sample.

4.2 Nutritional Status Measures

4.2.1 Child Nutritional Status

Anthropometry is an economical and non-invasive measure of the general nutritional status of an individual or a population group that have been extensively employed. Anthropometry can in fact be used for numerous objectives depending on the indicators selected. The three measures used to undertake anthropometric assessment of children are age, height, and weight. Each of these measures supplies information about an individual. Once two of the variables are used together as an index, they provide valuable information about a person's nutritional status. Three indices are commonly used to assess the nutritional status of children: height-for-age, weight-for-height, and weight-for-age. The reference standards come from North American multi-ethnic data from the US National Center for Health Statistics (NCHS). The World Health

Organization recommends the reference standards for international use (WHO 1995). The z score or standard deviation unit is defined as the difference between the anthropometric value for an individual and the median value for the reference population divided by the standard deviation for the reference population. The formula is:

$$Z_i = (A_i - \overline{A}_{rp}) / \sigma_{\overline{A}_{rp}} \quad ,$$

where A is a given anthropometric measure for child *i*, and $\overline{A}_{rp}$ is the median value of the anthropometric measure for the reference population. Z scores are regularly used in child nutritional status studies because they (1) allow the use of a fixed point in the distributions of different indices and across different ages; (2) enable the computation of useful summary statistics (i.e. mean and standard deviation) for a group of children (Cogill 2001).

Table 4.2 lists the dependent variables that are analyzed in the study. Height-for-age z score (*haz*) is commonly interpreted as indicative of chronic malnutrition and/or frequent sickness and disease. It therefore cannot be used to measure short-term changes in malnutrition. Indeed, *haz* reflects linear growth achieved before birth and during childhood. Stunting, which is defined as standardized height-for-age of less than –2 z scores is an indicator of past growth failure and reflects long-term malnutrition. Given the cumulative effects and that complete catch-up linear growth may not occur, the prevalence of stunting tends to increase with child age.

Weight-for-height z score (*whz*) is indicative of current or acute malnutrition and is more sensitive to current periods of sickness and short-term food shortages. It is

independent of the age variable since a child's weight should be about the same for a given height regardless of how old she is, making it a useful indicator in conditions where reported age is either unknown or unreliable. Wasting occurs if a child's *whz* falls below –2 standard deviations from the international reference.

Weight-for-age z score (*waz*) is the most commonly used indicator to measure malnutrition because weight measurement is the least error prone with non-professionals as measurers. *Waz* is a summary measure reflecting aspects of both acute and chronic influences on nutritional status and is recommended as an indicator to assess changes in the magnitude of malnutrition over time. A child with low *waz*, –2 standard deviations below the international reference, reflects the condition of being underweight for a specific age (Cogill 2001).

4.2.2 Women's Nutritional Status

Body Mass Index (BMI) is generally used to assess adult nutritional status and is considered a good measure of body fat and protein stores. Independent of age, BMI measures body weight corrected for height. It is defined as:

$$B_i = w_i /(h_i)^2 \ ,$$

where B refers to BMI, w to weight in kilograms, and h to height in meters for an individual i. There are no internationally accepted standards of classification but a BMI below 18.5 is generally regarded as indicating undernourishment (Collins, Duffield and Myatt 2000). It is important to note that BMI changes during pregnancy, thus it is

essential to separate pregnant women from non-pregnant women when evaluating women's BMI.

4.3 Operational Measures of the Determinants of Child Nutritional Status

This section presents the operational measures of the relevant determinants of child nutritional status explored in this study. The first part concentrates on the selected explanatory variables included in the reduced-form regression analyses. The second part focuses on caring practices for women and children, which will be examined using descriptive techniques. Tables 4.3 and 4.4 provide a list and a description of the variables.

4.3.1 Explanatory Variables for Regression Analysis

The variable that measures child age is a three-step dummy variable. The group of children aged 0-1 year is acting as the reference category and the two indicators variables include, respectively, children that are older than 1 year but less than 2 years and children older than 2 years but less than 3 years. Age also reflects the typical deterioration of linear growth in children that is believed to occur between the age of one and three.

The sex of the child is indicated by a dummy variable that takes the value of 1 if the child is female and 0 otherwise. Sex may indicate the importance a household gives to different children when allocating resources (Sahn and Stifel 2002), or may show a genetic difference in linear growth between boys and girls (Agnihotri 1999).

Parental characteristics consist of women and men's age and women and men's education measured as continuous variables (in years). Mothers play a key role in

household activities concerning childcare. Mother's age typically serves as proxy for experience in caring for a child. Maternal education has been considered one of the principal determinants of child health in poor countries. Caldwell (1979) contended that the schooling process creates a less fatalistic attitude towards life, and that it ultimately causes parents to be more conscious and more effective in combating their children's illness. Cleland (1990) showed that maternal education reveals the bargaining strengths of the adult female in her household. Thomas, Strauss and Henriques (1991) reported that the impact of maternal education on child height is almost entirely explained in Brazil by indicators of access to information such as watching television, reading papers, and listening to the radio. Amar-Klemesu (2000) shows that maternal education is the principal predictor of good care practices. Strauss (2001) pointed out the income effect of parental education: it increases resources available for rearing children. As for paternal education, it is believed that it affects child anthropometry through the distribution of resources and the ability to use different types of health services more effectively (Schultz 1984).

An additional characteristic of women is their ethnicity, with Haoussa as the reference category and Djerma, Kanouri, Touareg, Peulh and "other ethnic groups" the indicator variables.[7] Ethnicity may reflect the effect of traditional beliefs, discrimination and dietary habits on child health.

A polygynous marriage is defined as a union in which a man has several wives. Polygyny may have an ambiguous effect on child nutritional status. There is a strong

emphasis on reciprocity among wives in providing childcare for one another's children. It is generally accepted that children benefit from having other women take care of them (Oppong 1987). However, Oni (1996) found among Yoruba of Nigeria, that husbands favor the children of the junior wives over the children of senior wives in terms of medical care. Besides, if there is another woman in the household who is involved in the bargaining process of resource allocation, her relative status or education, for example, may have a spillover effect (positive or negative) on how a woman's children are cared for. To account for this effect, a dummy variable is used to indicate if a woman is in a polygynous union (1 if yes, 0 otherwise).

The final characteristic of women is women's status, which is measured as an index of women's decision making power relative to her husband. Women's status is defined as "women's power relative to men's in the households, communities, and nations in which they live" (Smith et al. 2002). Women's status directly affects the quality of care for children. It also indirectly affects it by influencing the quality of care women themselves receive. Women with low status relative to men are likely to have little control over resources within the household, experience difficult time constraints, have little knowledge or inappropriate beliefs, suffer from poor mental health, and lack confidence and self-esteem. Under these circumstances, women have difficulties adopting appropriate caring practices for their children. They are also kept from providing adequate care to themselves, which in turn undermines their ability to give

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[7] "Other ethnic groups" include Gourmanthe, Mossi, Toubou, other and foreigners. They represent 2.53 % of the women in the sample.

proper care to their children (Smith et al. 2002). Refer to Section 4.4 for a discussion about the construction of the index of women's status.

The household characteristics include household size, household age-sex composition, drinking water and sanitation utilization, urban or rural area location, economic status, and region of residency. Household size is a continuous measure of the number of people who typically live and eat together. It reflects the number of people among which household resources need to be allocated. Sahn (1988) found that economies of scale in nutrient intake have a propensity to favor the nutritional status of children from larger families. Household composition variables affect nutrient requirements of the household and demand for food. The selected variables include the percentage of males and females in the age groups of 0-15, 15-55 and greater than 55 that constitute the household.

The type and quality of drinking water and sanitation available to household members capture the health environment of a household. The reference category for drinking water is the use of surface water, and indicator variables for safe drinking water use include well water and pipe water. No use of latrine is the reference category for sanitation, and two indicator variables establish the existence of increasingly sanitary facilities, pit latrine and flush latrine. Children from households that lack proper health environments such as water supply and adequate sanitation facilities are at greater risk of diarrheal diseases, malaria and cholera (World Bank 2000). Every one of these conditions seriously contributes to malnutrition. Gwatkin, Guillot and Heuveline (1999) discovered that the two biggest causes of death among the poorest 20% of the world's developing

countries (as classified by national GDP per capita) are respiratory infections and diarrheal diseases. The importance of household health environment variables is stressed in Strauss and Thomas (1995) and UNICEF (1998).

Zinder/Diffa is used as the reference category for region of residence, with dummy variables for Niger (the capital city), Dosso, Maradi, Tahoua/Agadez and Tillaberi.[8]

The measure of economic status is included to represent household real income, taking into consideration prices faced. Higher income is expected to affect household resources as well as child health more directly. For example, higher earnings increase household's access to food as well as medical care during illness, thus improving the health situation. However, economists do not agree with the type of effect household economic status has on child height, often used to measure nutritional status. Sahn (1994) used instrumented consumption expenditures as a proxy for permanent income and found that it is an important determinant of chronic malnutrition (height-for-age) in Cote d'Ivoire, but conversely Barrera (1990) did not find any indication of such importance in a study of child nutrition in Philippines. Thomas and Strauss (1992) and Sahn and Alderman (1997) found significant income effects in Brazil and Mozambique, respectively, only for older children. In Pal (1999), ordered probit estimates of nutritional status suggested that higher per capita current income improves the nutritional status of preschool children in rural India. However, the effect of income disappears

[8] Zinder, Diffa, Tahoua, Agadez, are officially distinct regions of Niger (departments). However it was necessary in the context of this study to bracket Zinder and Diffa, and Tahoua and Agadez together, because the DHS survey had only six categories of regions (with the above grouping) in lieu of the eight regions delineated in the 1992 survey.

when instruments of longer-run income (per capita landholding and expenditure) are employed instead.

In this study, the measure of economic status employed orders households into three groups: poor (the reference category), middle and rich. This categorization is based on an index created using principal component analysis, as explained in Section 4.5 below.

4.3.2 Measures of Caring Practices for Women and Children

As discussed in chapter 3, the quality of care for women is related to child nutritional status, particularly during pregnancy and child birth. A mother's well being during pregnancy is not only important for herself, but also for her child. The World Health Organization recommends at least four routine prenatal care visits. Also, doctors, midwives or nurses should supervise labor and delivery with the midwifery skills to handle deliveries safely (UNICEF Statistics). Intrauterine growth retardation as well as maternal death can be avoided by following these recommendations. Women who receive prenatal care are screened and treated for diseases such as anemia, provided with nutritional supplements such as iron foliate and iodine if needed, and vaccinated against tetanus to which their child and themselves are exposed during child birth. Also, it is during prenatal care that women are able to identify skilled birth attendants to help with labor, delivery and newborn care, and to receive counseling on newborn and child nutrition (Save the Children 2001).

As determined by the United Nations Children's Fund framework for the determinants of child malnutrition and death (UNICEF 1998), quality feeding for

children is critical to their nutritional status. The benefits of breastfeeding for infant health and survival, child growth and development and maternal health are well documented. Lutter (1998) provides a good summary of these benefits. Immediate and exclusive breastfeeding is strongly recommended for most infants. Immediate breastfeeding initiation takes advantage of vital nutrients found in a mother's breast milk, fosters mother-child bonding and provides the infant the enhanced anti-bacterial, anti-viral, and nutritional properties of colostrum (first milk) (The LINKAGES Project 1999). The World Health Organization recommends six months of exclusive breastfeeding and sustained breastfeeding to the second year. An exclusively breast-fed child is at much lower risk of infection from diarrhea and pneumonia (The LINKAGES Project 1999). Also, it is crucial to introduce high quality complementary food from the sixth month as part of good nutrition (WHO 1998).

Health seeking practices incorporate both preventive and curative elements. In the developing world, infectious diseases are the biggest killers, and preventive measures such as immunization and proper treatment are indispensable. According to the World Health Organization, children in developing countries should receive eight basic vaccinations in their first year of life. The recommended vaccinations include one dose of BCG vaccine to resist tuberculosis, three doses of polio vaccine to prevent poliomyelitis, three doses of DPT to protect against diphtheria, whooping cough, and tetanus, and a vaccination against measles. The DPT and the polio vaccines are to be given at 6, 10, and 14 weeks after birth, while the measles vaccine is due 9 months after birth.

One important type of social support the primary caregiver can find is alternate child care. The abilities of the substitute caregiver are particularly important when it comes to complementary feeding and psychosocial care practices such as responsiveness. The level of care needed, however, may vary depending on the stage of development a child is in. According to Engle (1992), care by anyone other than the mother or a competent adult is associated with higher infant mortality for children less than one year of age. The consequences are less dramatic by the second and third year. Glick and Sahn (1998) found that despite the large estimated benefits of maternal income, maternal work overall did not appear to improve child nutrition in Guinea. The result suggests that negative time allocation effects are likely to be stronger than positive income effects in societies where gender bias in earnings, education, credit markets...etc are found. Also, it is known that quality of care is likely to be very poor if offered by children (McGuire and Popkin 1990).

Table 4.4 lists the caring practice variables employed in this study. Four variables related to prenatal and birthing care for women are employed. For children, there are three categories of caring practices, which include determinants associated with breastfeeding and complementary feeding, health seeking behaviors, and quality of substitute childcare takers.

Of the three variables employed to measure prenatal care for mothers, two are dummy variables that indicate respectively whether the mother received any prenatal care and whether she had at least 3 visits if she did receive prenatal care (1 if yes, 0 otherwise). The third variable is continuous and measures the number of months before

birth a woman had her first prenatal care visit. Birthing care is represented by a dummy variable that indicates whether a woman gave birth in a medical facility (public or private).

Three dummy variables indicate in order whether breast-feeding was initiated within one day of birth, a child less than 4 months is exclusively breast-fed, and child less than 4 months is not given the bottle (1 if yes, 0 otherwise). A continuous variable is used to measure the number of months a child has breast-fed.[9] Complementary feeding is measured with a dichotomous variable indicating whether a child between six and twelve months receives any food other than milk (1 if yes, 0 otherwise).

Health seeking behaviors are indicated by four dummy variables (1 if yes, 0 otherwise). The first two are whether a child with diarrhea was taken to medical facility, and whether the child was treated (curative aspect). The last two are whether a child received any vaccinations, and whether a child received the recommended vaccinations for her/his age (preventive aspect).[10]

The quality of substitute childcare providers is represented by a dummy variable that indicates whether a child has an adult caretaker while her/his mother works (1 if yes, 0 otherwise).

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[9] Only measured if child has finished breastfeeding.

[10] Given WHO recommendations and a three month grace period, children less than 3 months are considered to have received the recommended vaccinations if they have received at least one vaccination, children in their 3rd month if they have three vaccinations, children in their fourth month if they received five vaccinations. Children between 5 and 9 months are expected to have received at least seven vaccinations, and children 10 months and older eight vaccinations. The recommended vaccinations are solely based on number of vaccinations received as opposed to type of vaccinations received.

4.4 Index of Women's Relative Status

Though women's status can be measured at different levels, such as intra-household or extra-household, only one measure is employed in this study. It is a measure of women's decision making power relative to their male partners, usually their husbands. Hence, it captures wife-man relative power in a household. Because the data sets used in this study do not have evidence of direct power (e.g., control over resources, degree of influence in decisions), the measure is based on a number of indicators chosen for their conceptual relevance and validity as demonstrated in previous studies. The indicators are combined into an index by way of factor analysis. For a review of women's decision making power indicators in current usage and more on the validity of the chosen indicators see Smith et al., 2002[11].

The sample utilized to construct the index included women with partners whose children are less than five (rather than less than three) years old, that is 5,227 women from the combined 1992 and 1998 data sets. Three indicators of women's decision making power relative to their partners are chosen taking into account the multi-dimensionality of the concept itself. The first indicator involves employment, the second

[11]Smith et al. (2002) undertook a validation of candidate indicators selected in DHS data sets for several developing countries. Four categories of validation variables are included (1) decision making over money, (2) decision making over reproduction, (3) mobility, and (4) other types of decisions. The goal of the validation was to determine with the help of probit regressions (with validation variables as dependent variables, and with candidate indicators as explanatory variables) whether the candidate indicators as a group are significant and positive predictors of each validation variable while controlling for household characteristics. Following the regressions, a test of joint significance is undertaken to judge the validity of the indicators. In summary, the results for the sample countries suggested that the indicators used to compose the women's relative decision making index are positively associated with all four categories of validation variables.

is in the area of marriage, and the third is affiliated with human capital (i.e. experience).[12] The selected indicators are:

(1) Whether the woman works for cash income (*cashwk*)

(2) The woman's age at first marriage (*agemar*)

(3) The percent difference in the woman's and her partner's age (*agedif*)

The indicators are constructed such that higher values represent greater decision making power of a woman relative to her partner. Table 4.5 compares the variables across the two years.

The first indicator reports ***whether the woman works for cash income*** (denoted *cashwk*). It is equal to 1 if the woman declares that she works to increase resources coming in the household and additionally receives cash in exchange for that work; it is zero otherwise. To determine the employment status, two questions are asked in sequence in the survey: (1) "Aside from your own housework, are you currently working?" If the answer is no, a follow up question was asked to confirm the occupation status. (2) "As you know some women take up jobs for which they are paid in cash or kind. Others sell things, have a small business or work in the family farm or in the family business. Are you currently doing any of these things or any other work?" Women who answer negatively to both questions are considered not employed. Women, who answer yes to at least one of the questions, are then asked if they receive a salary or any money

[12] Note that in Smith et al. (2002) an additional indicator, the difference in the woman's and her partner's years of education, was selected. After running factor analysis for this study sample in order to construct the index of status, it was found that the high incidence of an education difference of zero (0) between partners caused the indicator to give a negative factor score. In other words, partners' educational difference was found to be negatively contributing to the extent of a woman's relative decision making power.

for their work. About 38% of the sampled women work for cash, that is, about 36% in 1992 and 39% in 1998.

Women's employment is considered an important factor in enhancing the status of women (Hogan, Berhanu, and Haillermariam 1999). The positive effects of earning cash income may result in an increase of total household income, which can translate into a more obvious contribution to her household's economic status. Also, cash income from independent sources (i.e. not own family-run business) may help a woman get more bargaining power in the household's decision making process (Ghuman 2001). Other positive effects include knowledge development through greater contact with other working individuals, social capital expansion outside of the sphere of kinship groups to be used to enhance a fallback position, improved capabilities, and a clearer awareness of individuality and welfare (Sen 1990; Gage 1995; Mason 1987; Riley 1997).

The second indicator, ***woman's age at first marriage*** (denoted *agemar*), is a continuous variable measured in years. The minimum and maximum values in the sample are, respectively, 8 and 31.

Women's age at first marriage is generally lower on average than men's and varies greatly from country to country, culture to culture and from developed areas to underdeveloped areas. For example the average age at first marriage is estimated at 15.9 years in Chad, 19.7 in Egypt, 20.8 in Haiti, and 25.1 in the United States of America (DHS 1991-1999; Haub and Cornelius 2000). The age at which a woman first marries is in essence highly associated with power because early marriage is not only a strategy used by older generations to control the sexuality of unmarried females, but also the

demands of childbearing are automatically higher. Since women who marry at an early age have a higher fertility rate (Sen 1993), they are less likely to complete a formal education, thus less likely to obtain necessary skills to take part in income generating activities. They are also less mobile and hence less effective in building up social capital outside of their kinship spheres. As a result, these women's economic dependence on men is considerably higher, and their role in household decision-making is weakened (Mason 1993; Riley 1997).

Percent difference in the woman's and her partner's age (denoted *agedif*), as opposed to the difference in age in absolute value, controls for age of the partner so that a given difference in age carries more weight for younger couples than for older couples. For example, the percent age difference between a 15 years old woman and her 20 years old partner is equal to -25 percent, whereas it comes to -16 percent between a 25 years woman and a 30 years old man. The average percent age difference is –28.1% in 1992, and -26.6% in 1998. Age difference between partners is an important indicator of decision making power because in households where husbands are considerably older, wives have a weaker ability to exercise power (Jejeebhoy 1991; Dharmalingam 1996).

Table 4.6 presents the correlation coefficients of the three selected indicators. The indicators *agemar* and *agedif* are moderately but significantly correlated (p-value< 0.01). *Cashwk* is also significantly associated with *agedif* (p-value< 0.01) and with *agemar* (p-value< 0.05).

The three indicators are combined into an index based on a linear combination of their standardized values using factor analysis (Smith et al. 2002).[13] Factor analysis is a statistical method used to analyze interrelationships among a set of correlated variables and to express these variables in terms of their common factors (i.e. underlying characteristics). The method summarizes the information contained in a number of indicators into a smaller set of dimensions with a minimum loss of information (Hair et. al 1992). The smallest number of unobservable factors that best account for the correlation among the indicators is identified first, then for each factor the weight of the indicators is chosen based on the share of their specific variance to the total variance. In this study, only the first identified factor (i.e. the one that accounts for the most common variance among the variables) is selected.

Table 4.7 contains the factor analysis output. Only one of the three factors identified contributes positively to the total variance of the indicators (i.e. its eigenvalue is positive, see panel A). Thus it is the factor retained. Each factor loading (panel B) represents the correlation between the indicator and the overall factor. Like Pearson correlations, loadings range from –1 to 1. Based on the factor loadings, the scoring coefficients are reported in panel C. The relative decision making power index (dm_index) is calculated as follow:

$$\begin{aligned} dm\_index = \quad & 0.1335 * cashwk \quad + \\ & 0.2144 * agemar \quad + \\ & 0.2353 * agedif, \end{aligned}$$

[13] Standardized values are used so that the indicators' ranges do not affect their relative weights.

where the values of the indicators are standardized values. The indicator *agedif* is given the greatest weight. It is followed by *agemar*, and *cashwk*. The resulting index is set up on a 0-100 scale to ease the interpretations of the regression analysis of the study. The unweighted sample mean is 38.63. For a more detailed descriptive analysis of the index women's relative decision making power, see the following chapter.

4.5 Index of Household Economic Status

Information on household income and expenditures is not collected in the DHS surveys. However, data are collected on ownership of various assets and characteristics of households' dwellings. In the absence of variables that would allow for a direct measure of households' economic status, several approaches have been employed to determine economic status using these surveys. One way to estimate the impact of economic status on an outcome is to directly enter one or more of the above variables into multivariate regression equations (Montgomery et al. 1997; Desai and Alva 1998). Although this approach indeed allows a control for wealth in estimating the impact of other variables in multivariate regression equations, it does not identify the wealth effect. It is, in other words, impossible to conclude from the coefficients on the assets variables the impact of an increase in wealth. For example owning a car may indicate a high income but also may affect nutrition by making it easier in accessing more diversified food that in turn may possibly increase nutritional status. Combining several household or/and individual attributes as indicators into an index is another way that has been utilized to measure economic status when using DHS data or similar survey data

(Timaeus and Lush 1995; Filmer and Pritchett 1999; Filmer and Pritchett 2001). [14] Difficulty arises when assets and housing quality indicators are combined with variables pertaining to the quality of accessible sanitary drinking water and toilet facilities because they are known to have an effect on child health that goes beyond their association with economic status. See Morris et al. (2000) for a discussion about the validity of proxy measures of wealth and income in rural Africa. Montgomery et al. (2000) also discuss the issues associated with the use of proxy variables to measure living standards. Finally, Bollen, Glanville and Stecklov (1999) extensively review the use of socioeconomic status and class in studies of fertility and child's health.

For this study, an index based on a linear combination of variables capturing household ownership of consumer durables and some characteristics of the household's dwelling is created. Variables such as water and sanitation quality are not included because they are direct determinants of health and nutritional status. The sample utilized to construct the index includes data from all women (even those without partners and those with children up to 59 months). The method employed to create the index is principal components analysis (Filmer and Pritchett 1999; Gwatkin et al. 2000; Filmer 2002). Filmer and Pritchett (2001), using instrument variables, reverse regression and other procedures, demonstrate that the first principal component is a robust proxy measure of living of standards.

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[14] The National Family Health Surveys (NFHS) are an example of surveys that do not collect information on either household income or consumption expenditure. The NFHS surveys are directly modeled on DHS surveys.

To a large extent, principal components analysis is similar to factor analysis. Principal components analysis is also a method that helps reveal simpler patterns within a complex set of variables. The main objective of principal components analysis is to reduce the dimensionality of a data set, and to identify new meaningful underlying variables. It is a technique that transforms a number of possibly correlated variables into a smaller number of uncorrelated variables called principal components. The first principal component accounts for the largest variability in the data, and each succeeding component accounts for as much as of the remaining variability as possible.

Column 1 of Table 4.8 presents the eight variables used to construct the index. They are dummy variables that indicate whether the household owns a radio, a television, a bicycle, a motorcycle, a refrigerator and a car, whether the household has access to electricity, and whether the dwelling's floor is made of finished material (1 if yes, 0 otherwise). Columns 2 and 3 of Table 4.8 present descriptive statistics for the indicators, in particular the unweighted proportions and standard deviations.

Column 4 lists for each asset the scoring factor for the first principal component. These are used to construct the linear index of variables with the largest amount of information common to all variables. In effect, the first principal component, with an eigenvalue of 3.4, explains 42.5% of the total variability in this analysis. These factor scores represent the weights that indicators hold in the constructed index. The scores are all positive as expected (richer households are more likely to own the selected assets, have access to services and have better housing quality).

The formula for the asset index for any household *j* is:

$$A_j = f_1 \times (a_{j1} - a_1)/(s_1) + ... + f_N \times (a_{jN} - a_N)/(s_N),$$

where $f_1 \ldots, f_N$ are the factor scores for assets 1 through N, $a_{j1} \ldots a_{jN}$ are the asset values for household *j* and $a_1 \ldots a_N$ and $s_1 \ldots s_N$ are the means and standard deviations of the asset variables taken over all sampled households. Therefore, the household asset index is computed using the standardized form of the indicators (mean 0, variance 1). Given that all indicators take the value one or zero, it is quite easy to interpret their weight in the index. Column 5 of the table displays the index marginal change (f_i/s_i) caused by a move from a 0 to 1 value for each indicator. A household that owns a refrigerator has an asset index higher by 1.95 than one that does not. However, owning a bicycle increases the index by only 0.42. The actual scores for each level are reported in columns 6 and 7. A household that owns all selected consumer durables, has access to electricity, and has finished surface floors, scores the maximum (8.66), that is the aggregate of all eight asset scores in column 6. Similarly, a household without access to any of the listed assets scores the minimum (-1.01), the sum of all asset scores in column 7.

Women in the sample are classified according to the value of their household index in order to create economic status groups. Cutoff values for the different categories are then derived, and each household is assigned a group based on its index value. The groups are labeled poor (bottom 40%), middle (40%) and rich (top 20%). The word "poor" here does not relate to the common notion derived from being below a poverty line. In this study, it refers to the population who lives in households with low values of

the asset index. The last three columns of Table 4.8 display the percentage of households in each economic status group that own a particular asset.

Table 4.9 presents the cut-off points applied in the creation of the economic status groups, and displays the respective percent of the population falling into each category.

4.6 Estimation Strategy

As stated earlier, this study sets out to answer three key questions:

1-Did malnutrition increase in Niger significantly between 1992 and 1998, and if so who was affected by the rise?

2-What are the underlying determinants of child nutritional status, and how did they change over the years?

3-Did women's nutritional status change between 1992 and 1998? What are the determinants of women's nutritional status in Niger?

Several techniques are employed to answer these crucial questions.

4.6.1 Tests for Significant Differences in Levels

In order to answer question 1 and the first part of question 3, the levels of the child anthropometric variables and body mass index have to be compared across the two years.[15] Also, the child anthropometric variable levels must be evaluated across 1992 and 1998 by some key characteristics in order to determine which children the increase of malnutrition affected, if in fact an increase is confirmed. To do so, tests for significant

[15] All tabulations produced are weighted using the sampling weights provided by each data set.

differences in levels of the anthropometric variables are employed. For the anthropometric z scores (*waz*, *haz* and *whz*) and body mass index (BMI), two-sample t tests of the hypothesis that each z score or BMI has the same mean within two groups are performed. For the dichotomous variables indicating whether a child is malnourished (underweight, stunted and wasted) or a woman is underweight, two-sample z tests of the hypothesis that each variable has the same proportion within two groups are carried out. To test if the mean of group x is equal to the mean of group y ($\mu_x = \mu_y$) when the variance of for groups x and y (σ_x, σ_y) are unknown but assumed to be identical ($\sigma_x = \sigma_y$), we use the formula given by

$$t = \frac{\bar{x} - \bar{y}}{\sqrt{\frac{(n_x - 1)s_x^2 + (n_y - 1)s_y^2}{n_x + n_y - 2}} \times \sqrt{\frac{1}{n_x} + \frac{1}{n_y}}} \quad ,$$

where n_x and n_y are the number of observations in group x and in group y respectively. The result is distributed as Student's t with ($n_x + n_y - 2$) degrees of freedom.

The test statistic for a two-sample z-test for proportions is:

$$z = \frac{\hat{p}_x - \hat{p}_y}{\sqrt{\frac{(x+y)}{(n_x + n_y)}\left(1 - \frac{(x+y)}{(n_x + n_y)}\right)} \times \sqrt{\frac{1}{n_x} + \frac{1}{n_y}}} \quad ,$$

where $\hat{p}_x = x/n_x$ and $\hat{p}_y = y/n_y$ (Statacorp 2002).

The key characteristics by which the child nutritional status variables are evaluated are the child's sex, urban/rural location, regional residency, parental educational level, and household economic status.

Question 2 needs to be resolved in two stages. Section 4.6.2 below is the subject of the first stage. In stage 2, the levels of seven socioeconomic and thirteen caring practices variables are evaluated across the years and tested for significant differences. For a continuous variable, a two-sample t test of the hypothesis that the variable has the same mean within the two years is performed. For a dichotomous variable, a two-sample z test of the hypothesis that the variable has the same proportion within the two years is carried out.

One key assumption must be made before attempting to explain which caring practices are accountable for a decline in child nutritional status: the magnitude of impact of these determinants does not vary across time. It is understood that unlike the other underlying determinants the significance of these determinants in child's health stays more or less the same across time because of their relationship with basic human biology. For example, the importance of breastfeeding is not going to vary in the "short" run unless the biological makeup of the human body undergoes extreme transformations, which is highly unlikely.

4.6.2 Estimation of Determinants' Effects and Differences in the Effects Across the Years

The first part of question 2 is answered using multivariate regression analysis with a 1992 and 1998 pooled sample. The regression is specifically a region fixed-effects model. The dependent variable, child nutritional status (Y_{ir}), is hypothesized to be

determined by K explanatory variables indexed k=1…K denoted X. The basic cross sectional model takes the form

$$Y_{ir} = \alpha + \sum_{k=1}^{K} \beta_k X_{k,ir} + \mu_r + \vartheta_{ir}, \qquad \vartheta_{ir} \sim N(0, \sigma^2) \qquad i = 1,...,n \qquad r = 1,...R$$

where i represents children, and r the relevant regions in this study. The μ_r are unobservable region specific, household-invariant effects and the ϑ_{ir} are stochastic. If the error term is exclusive of correlation with any explanatory variable, then the Ordinary Least Square (OLS) method will produce unbiased and consistent β_k estimates. A region fixed-effects specification is chosen to eliminate any parameter bias caused by region-specific factors that may be correlated with one or more of the explanatory variables.[16]

Since the DHS surveys follow a two-stage sample design, more than one household is sampled from each cluster, which introduces the likelihood that the error term will not be independently and identically distributed within clusters. If so, the nutritional status variables for households located in the same cluster will be influenced by unobserved cluster-specific characteristics in the same way. Therefore a robust covariance matrix is used to compute standard errors in place of the traditional calculation. Also, a Breusch-Pagan test shows strong heteroskedasticity warranting the use of the Huber/White/sandwich estimator of variance for robust standard errors (Statacorp 2002).

Before moving forward and identifying the determinants of child nutritional status for each year, a test for parameter stability is completed to determine whether there are

[16] A cluster fixed effects could not be specified because sampled clusters are not identical across the years.

indeed significant differences in the parameter estimates across the 1992 and 1998 years. A general Chow-F test establishes whether the null hypothesis that the parameter estimates are the same over 1992 and 1998 is rejected. The formula for the F test is

$$F = \frac{SSR_F - (SSR_{1992} + SSR_{1998})}{k} \Big/ \frac{SSR_{1992} + SSR_{1998}}{N_{1992} + N_{1998} - 2*k} \quad ,$$

where SSR_F is the sum of square residual of a regression that include the pooled data from both years, SSR_{1992} and SSR_{1998} the sum of square residual of regressions for each individual year. The Chow-F test rejected the null hypothesis and concluded that there were significant differences in the parameter estimates across the years for all three measures of child nutritional status.

In order to detect the determinants of child nutritional status and to assess any change in their effects from 1992 to 1998, a dummy variable technique is used. While an alternative method would be to estimate regressions using similar models and two separate samples (one for each year), the dummy variable approach results in more efficient estimates. It also allows an easier manipulation of the variables because information from both samples is used (Kennedy 1992).[17] The estimation of the nutritional status models is handled in three steps. In step 1, a regression model containing all the independent variables and their interactions with a dummy variable indicating the 1998-year is run, and the significance of each interaction term is tested. In step 2, if any interaction variable is insignificant (i.e. p-value$\geq$ 0.100), it is dropped from the equation after which the final model is estimated. Hence, differences in the effect of

[17] Note that the single constrained regression analysis incorporates the additional assumption of a common error variance for both years.

the independent variables across the years are allowed, but only if they are statistically significant. In step 3, a separate regression analysis containing only data for the 1998-year is run. The main goal of this step is to detect whether the computed 1998 parameters from step 2 are effectively significant.

With regards to mothers' nutritional status be included, the test for parameter stability determined that there were no significant differences in the parameter estimates of women's nutritional status across the years (F= 1.00, p-value=0.4611). Therefore, the 1992 and the 1998 data are joined and treated as one sample, and a cluster-fixed effect OLS regression model for body mass index is run using appropriate explanatory variables including the characteristics of women, their partner and household. The dependent variable, BMI is hypothesized to be determined by K explanatory variables indexed k=1…K denoted X. The cross sectional model takes the form

$$BMI_{ic} = \alpha + \sum_{k=1}^{K} \beta_k \mathrm{X}_{k,ic} + \mu_c + \vartheta_{ic}, \qquad \vartheta_{ic} \sim N(0,\sigma^2) \qquad i = 1,...,n \qquad c = 1,...C$$

where i represents women, and c the appropriate cluster where she resides. The μ_c are unobservable cluster specific, household-invariant effects and the ϑ_{ic} are stochastic.

4.6.3 Tests of Specification and of Mis-Specification

Two specification tests are performed in this study, namely a test for detection of heteroskedasticity and one for multicollinearity.

Breusch-Pagan derived in 1979 a Lagrange Multiplier (LM) test for heteroskedasticity. The steps in the Breusch-Pagan test can be summarized as follows:

Consider the linear model:

$$Y_t=B_1 +B_2 X_t +B_3 X_t + u_t \qquad (t = 1,\ldots, N) \qquad (1).$$

First, estimate model (1) by OLS and obtain the residuals, e_t.

Second, run the following auxiliary regression:

$$e^2_t=A_1 +A_2 X_t +A_3 X_t + v_t \quad , \qquad (2)$$

which is a regression of the squared residuals on all the original variables. To test if the variables have an explanatory power in regression (2), compute the LM statistic

$$LM=N * R^2 \qquad (3).$$

The LM statistic for heteroskedasticity is the sample size N times the R-squared from (2). Under the null hypothesis, LM is asymptotically distributed as chi-squared (χ^2) with degrees of freedom equal to the number of independent variables excluding the intercept term (Greene 2000). If the χ^2 value exceeds the critical value of the chosen level of significance (p-value>=0.10), then the null hypothesis of homoscedasticity is rejected.

To detect multicollinearity, the inverse correlation matrix of the independent variables is used. Variance inflation factors (VIF), the diagonal elements of the correlation matrix, are given by $(1-R_i^2)^{-1}$ where R_i^2 is the R^2 from regressing the *i*th independent variable on all the other independent variables. If the mean VIF is considerably greater than 1 or the largest VIF is greater than 30 (Statacorp 2002) or 10 (Kennedy 1992), there is then evidence of multicollinearity.

The test of mis-specification employed in this study is the Ramsey-Reset Test for omitted variables, which looks for omitted variables by including in the original model powers of the fitted values of the dependent variable.

Suppose the model first estimated is:

$$\hat{Y}_t = \hat{B}_1 + \hat{B}_2 X_{2t} + \hat{B}_3 X_{3t} \qquad (t = 1,\ldots, N) \qquad (1).$$

The Reset test proceeds by estimating,

$$\hat{Y}_t = \hat{G}_1 + \hat{G}_2 X_{2t} + \hat{G}_3 X_{3t} + \gamma_1 \hat{Y}_t^2 + \gamma_2 \hat{Y}_t^3 + \gamma_3 \hat{Y}_t^4 \qquad (t = 1,\ldots, N) \qquad (2).$$

Therefore, two regressions are estimated where (2) is (1) with the addition of powered fitted values obtained from (1). The null hypothesis is that no variable was omitted from the first regression model ($\gamma_1 = \gamma_2 = \gamma_3 = 0$), and the alternative hypothesis is that there are omitted variables. To test for specification error, the F test statistic is formed as:

$$F = \frac{SSR_M - SSR / M}{SSR / (N - K - 1)} .$$

where SSR_M is the sum of squared residuals in the restricted equation (without the powered fitted values), SSR is the sum of squared residuals in the unrestricted equation, M is the number of restrictions, N is the number of observations, and K is the number of parameters estimated in the unrestricted equation. If the F test statistic is greater than the F critical value (p-value>=0.10), we reject the null hypothesis that no variable is omitted in the regression model (Johnston and DiNardo 1997).

4.6.4 Endogeneity Issues

Since the study employs a reduced-form estimation framework, caution is necessary in treating household demographic variables as exogenous. Parents may in fact decide to have fewer and healthier children, consequently making household size and household composition endogenous. In the short run, however, the endogeneity of these variables should not be considered a problem. Endogeneity is nevertheless addressed in this study by estimating the models with and without the demographic variables since there are no practical instruments to deal with it. The results suggest that their exclusion does not affect the other parameters in the models.

Another potential endogeneity problem emerges with the economic status variables. Given that consumption, leisure and time allocation decisions are jointly determined with child health, household resource availability can conceivably be endogenous. For example, a woman with undernourished, and hence vulnerable, children might allocate more time for their care and less time for work that brings in additional income. In other words, the line of causation between household resources and nutritional status goes both ways. Because the household economic status index is constructed using some dwelling characteristics and asset ownership, the usual problem of endogeneity when money income measures are used is however expected to be less of an issue. John Gibson (2002) discusses this issue in detail.

Table 4.1 Description of data sets employed and sample sizes

Year of collection	DHS phase	Number of children	Number of women/partners	Number of households	Number of clusters
1992	2	2,336	2,110	1,871	232
1998	3	3,338	3,056	2,654	266
Total		5,674	5,166	4,525	498

Table 4.2 Child and woman's nutritional status variables of the study

Variables	Type
Child nutritional status	
Child's weight-for-age z score	continuous
Whether child is underweight	dichotomous
Child's height-for-age z score	continuous
Whether child is stunted	dichotomous
Child's weight-for-height z score	continuous
Whether child is wasted	dichotomous
Woman nutritional status	
Woman's body mass index	continuous
Whether woman is underweight	dichotomous

Table 4.3 Independent variables of the study: child, woman/partner and household characteristics

Variable	Type
Child characteristics 1/	
Child aged 0-1 (reference category)	dichotomous
Child aged 1-2	dichotomous
Child aged 2-3	dichotomous
Male child (reference category)	dichotomous
Female child	dichotomous
Characteristics of woman and partner	
Woman's age	continuous
Index of women's relative decision making power	continuous
Woman's education in years	continuous
Monogamous union (reference category)	dichotomous
Polygynous union	dichotomous
Woman's ethnicity	
Haoussa (reference category)	dichotomous
Djerma	dichotomous
Kanouri	dichotomous
Touareg	dichotomous
Peulh	dichotomous
Other	dichotomous
Partner's age	continuous
Partner's education in years	continuous
Household characteristics	
Household size	continuous
Percent females 0-15 (reference category)	continuous
Percent females 15-55	continuous
Percent females 55+	continuous
Percent males 0-15	continuous
Percent males 15-55	continuous
Percent males 55 +	continuous
Surface water used (reference category)	dichotomous
Well water used	dichotomous
Piped water used	dichotomous
No latrine used (reference category)	dichotomous
Pit latrine used	dichotomous
Flush latrine used	dichotomous
Rural location (reference category)	dichotomous
Urban location	dichotomous
Poor (reference category)	dichotomous
Middle	dichotomous
Rich	dichotomous
Regions Niamey	dichotomous
Dosso	dichotomous
Maradi	dichotomous
Tahoua/Agadez	dichotomous
Tillaberi	dichotomous
Zinder/Diffa (reference category)	dichotomous
Years 1992 (reference category)	dichotomous
1998	dichotomous

1/child characteristics are only included in the child nutritional status models

Table 4.4 Caring practices for women and children

	Type
Prenatal and birthing care for mother	
Whether woman received any prenatal care	dichotomous
Whether woman with any prenatal care had at least three visits	dichotomous
Number of months before birth woman had first prenatal visit	continuous
Whether woman gave birth in a medical facility	dichotomous
Child feeding practices	
Whether breastfeeding was initiated within one day of birth	dichotomous
Whether child 0-4 months is exclusively breast fed	dichotomous
Whether child 0-4 months receives no bottle	dichotomous
Number of months breastfeeding	continuous
Whether child 6-12 months has received complementary foods	dichotomous
Health seeking behaviors for children	
Whether child with diarrhea was taken to a medical facility	dichotomous
Whether diarrhea was treated	dichotomous
Whether child received any vaccinations	dichotomous
Whether child received recommended vaccinations	dichotomous
Quality of substitute child care takers	
Whether child has adult caretaker while woman works	dichotomous

Table 4.5 Means of indicators of women's decision making power relative to men's, by year 1/

	Whether woman works for cash (1 if true)	Woman's age at first marriage (years)	Age difference of woman and partner (percent)	Valid cases
1992	0.364	14.7	-28.25	2,136
1998	0.391	15.1	-26.55	3,091
Change	0.027*	0.5***	1.7***	Total: 5,227

1/The means are unweighted.

* Significant at the .10 level. ** Significant at the .05 level. *** Significant at the .01 level.

Table 4.6 Correlations among indicators of women's relative decision making power

	Women's age at first marriage	Age difference of woman and partner	Whether woman works for cash
		(means)	
Women's age at first marriage	1		
Age difference of woman and partner	0.1137***	1	
Whether woman works for cash	0.0282**	0.0612***	1

Total women = 5,228

* Significant at the .10 level. ** Significant at the .05 level.

Table 4.7 Index of women's relative decision making power: Factor analysis output

Panel A

Factor	Eigenvalue
1	0.1554
2	-0.0169
3	-0.1046

Panel B

	Factor Loadings
Work for cash	0.1539
Age at first marriage	0.2449
Percent age difference	0.2678

Panel C

	Scoring Coefficients
Work for cash	0.1335
Age at first marriage	0.2144
Percent age difference	0.2353

N = 5,227

Table 4.8 Assets, factor scores and other summary statistics for first principal component (to be used in index of economic status groups)

1	2	3	4	5	6	7	8	9	10
							Percent in ES group with asset		
Asset variable	Mean 1/	Sd	Asset scoring factors	Index marginal change	Score with asset	Score without asset	Poor	Middle	Rich
Whether has radio	0.436	0.496	0.265	0.53	0.301	-0.233	0.00	69.0	89.4
Whether has electricity	0.109	0.312	0.459	1.47	1.310	-0.161	0.00	0.00	53.8
Whether has television	0.094	0.292	0.466	1.60	1.442	-0.150	0.00	0.00	47.1
Whether has bicycle	0.076	0.266	0.111	0.42	0.386	-0.032	0.00	11.0	19.1
Whether has motorcycle	0.059	0.235	0.257	1.09	1.033	-0.064	0.00	0.00	31.6
Whether has refrigerator	0.048	0.214	0.417	1.95	1.847	-0.094	0.00	0.00	23.8
Whether has car	0.037	0.188	0.327	1.74	1.679	-0.064	0.00	0.00	19.4
Whether floor is made of "finished" surface	0.245	0.430	0.378	0.88	0.663	-0.215	0.00	17.7	87.2
					8.66	-1.01			
Summary statistics									
Percent of variation explained by the first component			42.5						
Value of first eigenvalue			3.40						
Number of households	5,313								

1/The means are unweighted.

Table 4.9 Cut-off points for the economic status groups of the sample

	Total asset index value		
ES group	Lowest	Highest	Percent of women
Poor	-1.013	-1.013	40
Middle	-1.013	0.399	40
Rich	0.399	8.669	20

CHAPTER 5

RESULTS: PATTERNS OF CHANGE IN CHILD NUTRITIONAL STATUS

This chapter is the first of two chapters that report the results on the main variable investigated in this study, child nutritional status in Niger. First, child nutritional status is compared across 1992 and 1998 in conjunction with a test of significant difference between the two years in order to evaluate if indeed malnutrition increased over that period. Subsequently, using the same method, changes in child nutrition are assessed across the years for five variables related to child, parent and household characteristics in order to determine who was affected by the changes.

5.1 Comparison of Child Nutritional Status Across 1992 and 1998

The first two columns of table 5.1 list the means and standard deviations of child weight-for age, height-for-age and weight-for-height z scores (*waz*, *haz* and *whz*), while the third column gives the percentage of underweight, stunted and wasted children by year. The changes in all three measures of nutritional status between 1992 and 1998 were considerable. In fact, mean z scores decreased significantly (p-value< .01 level) over the period studied.

Weight-for-age z score, the summary measure reflecting both acute and chronic malnutrition, decreased by 11.8% between 1992 and 1998 (-1.70 to -1.90). Height-for-age z score, the measure for chronic malnutrition, underwent a 12.1% decline, that is a

decrease from -1.49 to –1.67. Weight-for-height, the measure for acute malnutrition, dropped by the same rate.

The decline in *waz* translated into a significant increase of underweight children in Niger, from an already high 44.5% to a soaring 50.2%, that is a 5.7 percentage point rise over the period. In 1998, 41.3% of children under three were stunted compared to 36.2% in 1992, a significant increase of 5.1 percentage points. The wasting rates, though relatively lower, are still alarming given that they characterize the worst form of malnutrition. The prevalence of wasted children significantly increased by 3.1 percentage points, from 18% to 21.1%. In Niger, acute malnutrition increased at a higher rate than chronic malnutrition over the study period (17.2% vs. 14.1%). Figure 5.1 provides a comparative illustration of malnutrition rates in Niger for 1992 and 1998.

5.2 Who Are the Malnourished in Niger and How Did Their Status Change?

5.2.1 Boys' and Girls' Malnutrition

Table 5.2 shows the mean z scores and standard deviations for boys and girls under three in Niger. All three measures of nutritional status dropped significantly (p-value<0.01) for both male and female children. *Waz* fell by about the same for boys and girls during the study period, that is 11.2% and 11.1% respectively. *Haz* dropped 11% for boys compared to 14% for girls. The decline in *whz* was larger for boys (12.4%) than for girls (10.8%).

Table 5.2 also lists the malnutrition rates by sex. The proportion of underweight girls (14.3%) increased at a higher rate than the proportion underweight boys (11.3%) did. Also, the increase in stunting percentages was higher for girls (6.2 points, 18.3%) than boys (4.4 points, 11.3%). However, while there was a significant increase of 3.9 percentage points (21.8%) in the prevalence of wasting among boys in Niger, there was no significant increase for girls. Overall, there is no consistent evidence that the increase in malnutrition was higher among boys than girls, or vice versa, over the study period.

5.2.2 Urban-Rural Malnutrition

It is evident after examining the urban/rural differences in nutritional status that urban children are by far better nourished. In 1998, over one half of the children living in rural Niger were underweight against slightly over one-third in urban communities. The same year, stunting and wasting rates were, respectively, 12 and 17 percentage points higher in rural areas (43% vs. 31.2%, 22.1% vs. 14.7%).

Table 5.3 shows that the means for the three child nutritional status measures significantly decreased (p-value<0.01) from 1992 to 1998 in rural areas, while only *haz* significantly dropped (p-value<0.05) in urban communities. Malnutrition rates significantly increased in rural areas over the study period. Rates of stunted and wasted children significantly rose by 4.8 and 3.5 percentage points respectively, while the rate of stunted children in rural areas rose by 5.3 percentage points. However, the rate of increase in stunting was over 1.5 times higher in urban areas than in rural areas (20.5% vs. 12.6%). Overall, the deterioration of child nutritional status occurred in rural areas of

Niger in the case of stunting and wasting, and in urban areas in the case of stunting only over the study period.

5.2.3 Regional Malnutrition

The regional variations in mean z scores in Niger are listed in Table 5.4. Except for Niamey, the capital city, and the region of Maradi, *waz* significantly decreased from 1992 to 1998. Dosso registered the biggest decline (-0.36, p-value<0.01), about 80% greater than the national average drop. Tillaberi also experienced a significant and above national average drop for *waz* (-0.22, p-value<0.10). In Tahoua/Agadez and Zinder/Diffa[18], the decline was slightly less (–0.16, p-value<0.05). Mean *haz* dropped everywhere but in the pooled regions of Tahoua/Agadez and Zinder/Diffa. Niamey, as well as Dosso and Tillaberi, posted significant and above national average mean z score declines. In the case of acute malnutrition, Dosso again was hit the worst. Its mean *whz* declined by 22.8%, a little under twice the percent change at the national level, over the study period. Tahoua/Agadez and Zinder/Diffa also showed an above average percent change in mean *whz*.

Table 5.5 lists the underweight, stunting and wasting rates in 1992 and 1998. The prevalence of underweight children increased by 10 percentage points (26.4%) in Dosso, that is twice as much the national percentage point increase, and by 6.6 points (15.4%) in Tahoua\Agadez (p-value<0.01). Chronic malnutrition in Dosso and Maradi also

[18] It is important to note that the results for Tahoua/Agadez and Zinder/Diffa are ambiguous given that they represent 4 distinct regions in Niger with distinctive characteristics (ex: weather, agriculture, population). Unfortunately, the grouping of the regions in such a manner is necessary in order to allow for the data collected in 1998.

significantly rose by 26% and 19.5%, respectively. Only the urban community of Niamey and the department of Tillaberi did not register a significant rate increase in acute malnutrition. In Dosso, acute malnutrition increased 54% from its 1992 level (p-value<0.01%), that is over three times the national percentage increase. Wasting rates also significantly increased 32.3% and 30.8% in Tahoua/Agadez and Zinder/Diffa respectively, that is slightly under twice the national percentage rise. Maradi is the only region in Niger where wasting decreased (17.2%). The region of Dosso, situated southeast of the country, was the hardest hit by increases in child malnutrition between 1992 and 1998.

5.2.4 Parental Characteristics: Education

Table 5.6 presents child nutritional status z scores by mother's educational level. Evidently, child nutritional status improves with higher education in Niger. In 1998 for instance, mean *haz* rose at an increasing rate with each level of women's education, that is 14% if mothers had some primary education (compared to none) and 24.5% if mothers added at least some secondary education.

The weighted average of each measure of nutritional status significantly dropped for children with uneducated mothers over the study period. Mean *waz, haz* and *whz* fell 11.6%, 12.5% and 13% (p-value<0.01) respectively. However, the biggest declines in mean *waz* and *haz* were recorded, in order, among children whose mothers received secondary or higher education, and some primary education. For the first group, the z scores moved down 61.5% and 131.3% respectively, while for the second group they dropped 11.8% and 15.7% respectively.

Table 5.7 shows that the changes in the underweight rate were significant for all educational levels, with the percent increases found, from highest to lowest, among children whose mothers received the most education (68.9%), some primary education (25.4%), and no education (12.1%). Stunting rates significantly increased for children whose mothers received no education (4.9 points or 13.1%) or did no reach secondary school (9.1 points or 33.3%). As expected, wasting rates grew significantly by 3.1 percentage points (17.5%) in the group of uneducated mothers. The two-sample proportion test performed did not find that the difference in stunting rates between the two years was significantly different from zero in the group secondary school educated mothers.[19]

In general, child malnutrition rates are extremely high when fathers are uneducated. In 1998, over 6 in 10 children whose fathers received no education were underweight in Niger. Stunting and wasting rates were 42.6% and 21.9% respectively among the same children.

Table 5.8 shows the children's mean z scores by the educational level of their fathers and year. All three z scores, *waz, haz* and *whz,* significantly dropped from 1992 to 1998 among the children with uneducated fathers (p-value<0.01). For the children whose fathers received some primary education, *waz* and *haz* significantly shrunk by 0.11 and 0.21 respectively. The biggest drop in *haz* happened among children whose fathers

[19] However, the two-sample proportion test found that the difference in stunting rates between the two years was significantly less than zero (one tail test) with a p-value<0.05. Note that because of the low number of observations in the groups of women with secondary education, the z statistics produced by the test are very low, consequently not showing strong evidence of significant difference in the levels of malnutrition by year.

received secondary or higher education. Those children's *haz* fell 43.1% from 1992 to 1998.

Table 5.9 summarizes malnutrition rates by fathers' educational level. As expected, the decline in mean z scores was accompanied by a significant increase in malnutrition rates. Percent underweight, stunted and wasted children of uneducated men rose 6.3, 5.5 and 3.5 points (p-value<0.01) respectively. A high and significant underweight rate increase of 7.8 points (21.9%) took place among children found in the group of fathers with some primary education. Additionally, stunting rates went up significantly (p-value<0.10) by a soaring 53.5% among children whose fathers attended secondary school or college.

5.2.5 Household Characteristics: Economic Status

It is important to underline that malnutrition rates for children included in the rich group were relatively lower than the rates from the two other economic status groups (but still extremely high) in both years. The descriptive statistics in Table 5.10 demonstrate the existence of a socioeconomic gradient in child health and nutrition.

Table 5.10 displays child z scores by household economic status. There is evidence that *waz* significantly decreased among the poor and middle groups. The same pattern is true for *whz*. However, mean *haz* significantly declined for all children, regardless of the economic status of their parents.

Table 5.11 shows that high and significant increases in underweight rates occurred in 1998 in all groups, with rates of increase of 10.8%, 18.6% and 16.8% for poor, middle and rich respectively. Stunting rates increased significantly for all groups

(5.5, 5.2 and 6.7 points), but the rate of increase among children who live in rich households was the highest at 29.3%. The increase in wasting involved only children from the poor group, with a 4.4 percentage point rise over the 1992 rate.

5.3 Summary

In this chapter, it is demonstrated that child nutritional status, as measured by weight-for-age, height-for-age and weight-for-height, significantly deteriorated in Niger between 1992 and 1998. Furthermore, the results show that acute malnutrition increased the most over the period.

The percentage of underweight and stunted girls increased at a higher rate than the percentage of underweight and stunted boys did. However, the prevalence of wasting only increased significantly among boys. On the whole, it is not clear that the increase in malnutrition was higher among boys than girls, or vice versa.

The extent of deterioration in child nutritional status differs greatly according to place of residence. Malnutrition, as measured by weight-for-age, increased significantly in rural areas of Niger. While chronic malnutrition rose at a higher rate in urban communities, acute malnutrition was found to have increased only in rural areas of Niger. The percent of children from Dosso suffering from all forms of malnutrition grew at an alarming and higher than national average rate. The rates of growth of stunted, wasted and underweight children were the highest in that region. Stunting increased greatly in Maradi as well, whereas wasting among children grew considerably in the united regions of Tahoua/Agadez and Zinder/Diffa. Maradi is the only region where wasting decreased.

Furthermore, the changes in child nutrition vary across parental educational level in Niger. In effect, children of educated women were the worst hit by the increase of chronic malnutrition. In contrast, acute malnutrition increased only among children of uneducated women.

After analyzing malnutrition by economic status, another socioeconomic characteristic, it was found that child nutritional status deteriorated following a noteworthy pattern: the rate of chronic malnutrition increased the most among children living in "rich" households, while acute malnutrition went up only among children living in "poor" households.

Table 5.1 Child nutritional status by year

	Weighted mean	Standard deviation	Percent	Valid cases
Child's weight-for-age z-score			**Underweight**	
1992	-1.70	1.41	44.5	2,336
1998	-1.90	1.32	50.2	3,338
Change	-0.20 ***		5.7 ***	
Child's height-for-age z-score			**Stunted**	
1992	-1.49	1.56	36.2	2,336
1998	-1.67	1.52	41.3	3,338
Change	-0.18 ***		5.1 ***	
Child's weight-for-height z-score			**Wasted**	
1992	-0.99	1.14	18.0	2,336
1998	-1.11	1.11	21.1	3,338
Change	-0.12 ***		3.1 ***	

* Significant at the .10 level. ** Significant at the .05 level. *** Significant at the .01 level.

Figure 5.1 Percent increase of child malnutrition levels

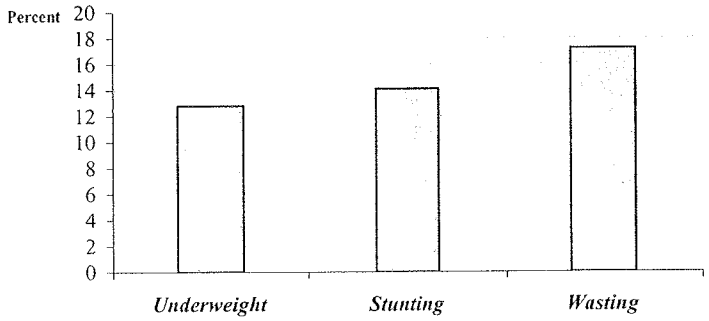

Table 5.2 Child nutritional status by sex and year

	Weighted mean	Standard deviation	Percent	Valid cases
Child's weight-for-age z-score			**Underweight**	
Boys				
1992	-1.70	1.42	44.4	1,226
1998	-1.89	1.29	49.4	1,761
Change	-0.19 ***		5.0 ***	
Girls				
1992	-1.71	1.41	44.7	1,110
1998	-1.90	1.36	51.1	1,577
Change	-0.19 ***		6.4 ***	
Child's height-for-age z-score			**Stunted**	
Boys				
1992	-1.54	1.56	38.2	1,226
1998	-1.71	1.50	42.6	1,761
Change	-0.17 ***		4.4 ***	
Girls				
1992	-1.43	1.55	33.8	1,110
1998	-1.63	1.54	40.0	1,577
Change	-0.20 ***		6.2 ***	
Child's weight-for-height z-score			**Wasted**	
Boys				
1992	-0.97	1.15	17.4	1,226
1998	-1.09	1.11	21.2	1,761
Change	-0.12 ***		3.8 ***	
Girls				
1992	-1.02	1.13	18.7	1,110
1998	-1.13	1.11	20.9	1,577
Change	-0.11 ***		2.2	

* Significant at the .10 level. ** Significant at the .05 level. *** Significant at the .01 level.

Table 5.3 Child nutritional status by urban/rural and year

	Weighted mean	Standard deviation	Percent	Valid cases
Child's weight-for-age z-score			**Underweight**	
Rural				
1992	-1.76	1.44	46.9	1,424
1998	-1.97	1.32	52.5	2,595
Change	-0.21 ***		5.6 ***	
Urban				
1992	-1.40	1.24	32.2	912
1998	-1.47	1.24	36.1	743
Change	-0.07		3.9 *	
Child's height-for-age z-score			**Stunted**	
Rural				
1992	-1.55	1.58	38.2	1,424
1998	-1.74	1.53	43.0	2,595
Change	-0.19 ***		4.8 ***	
Urban				
1992	-1.16	1.40	25.9	912
1998	-1.28	1.40	31.2	743
Change	-0.12 **		5.3 ***	
Child's weight-for-height z-score			**Wasted**	
Rural				
1992	-1.01	1.15	18.6	1,424
1998	-1.15	1.12	22.1	2,595
Change	-0.14 ***		3.5 **	
Urban				
1992	-0.89	1.10	14.8	912
1998	-0.88	1.07	14.7	743
Change	0.01		-0.1	

* Significant at the .10 level. ** Significant at the .05 level. *** Significant at the .01 level.

Table 5.4 Child z scores: mean, standard deviation by region and year

	Weight-for-age z-score		Height-for-age z-score		Weight-for-height z-score		
	Mean	SD	Mean	SD	Mean	SD	Valid cases
Niamey							
1992	-1.24	1.21	-0.87	1.32	-0.91	1.04	400
1998	-1.34	1.19	-1.11	1.28	-0.83	1.07	262
Change	-0.10		-0.24 **		0.08		
Dosso							
1992	-1.50	1.40	-1.24	1.48	-0.92	1.01	272
1998	-1.86	1.21	-1.56	1.30	-1.13	1.06	506
Change	-0.36 ***		-0.32 ***		-0.21 ***		
Maradi							
1992	-1.97	1.51	-1.79	1.56	-1.07	1.25	370
1998	-2.03	1.31	-1.97	1.45	-1.04	1.11	813
Change	-0.06		-0.18 ***		0.03		

Table 5.4 Child z scores: mean, standard deviation by region and year (continued)

	Weight-for-age z-score		Height-for-age z-score		Weight-for-height z-score		
	Mean	SD	Mean	SD	Mean	SD	Valid cases
Tahoua/Agadez							
1992	-1.68	1.32	-1.52	1.48	-0.93	1.13	507
1998	-1.83	1.33	-1.56	1.47	-1.12	1.06	587
Change	-0.15 **		-0.04		-0.19 ***		
Tillaberi							
1992	-1.68	1.30	-1.33	1.45	-1.12	1.10	316
1998	-1.90	1.28	-1.58	1.53	-1.19	1.07	591
Change	-0.22 *		-0.25 **		-0.07		
Zinder/Diffa							
1992	-1.79	1.51	-1.67	1.74	-0.97	1.20	471
1998	-1.94	1.41	-1.69	1.70	-1.16	1.20	579
Change	-0.15 **		-0.02		-0.19 **		

* Significant at the .10 level. ** Significant at the .05 level. *** Significant at the .01 level.

Table 5.5 Child malnutrition levels by region and year

	Underweight (%)	Stunted (%)	Wasted (%)	Valid cases
Niamey				
1992	26.5	19.8	13.3	400
1998	31.7	24.0	14.1	262
Change	5.2	4.2	0.8	
Dosso				
1992	37.9	28.8	13.7	272
1998	47.9	36.3	21.1	506
Change	10.0 ***	7.5 **	7.4 ***	
Maradi				
1992	53.0	43.6	22.1	370
1998	54.0	52.1	18.3	813
Change	1.0	8.5 ***	-3.8 *	
Tahoua/Agadez				
1992	42.1	35.8	15.5	507
1998	48.6	38.3	20.5	587
Change	6.5 ***	2.5	5.0 **	
Tillaberi				
1992	45.4	32.0	21.5	316
1998	51.7	36.7	22.9	591
Change	6.3	4.7	1.4	
Zinder/Diffa				
1992	48.3	42.9	18.5	471
1998	51.5	42.4	24.2	579
Change	3.2	-0.5	5.7 ***	

* Significant at the .10 level. ** Significant at the .05 level. *** Significant at the .01 level.

Table 5.6 Child z scores by women's educational level and year

	Weight-for-age z-score		Height-for-age z-score		Weight-for-height z-score		
	Mean	SD	Mean	SD	Mean	SD	Valid cases
No education							
1992	-1.73	1.41	-1.52	1.57	-1.00	1.15	1,993
1998	-1.93	1.31	-1.71	1.52	-1.13	1.12	2,898
Change	-0.20 ***		-0.19 ***		-0.13 ***		
Some primary education							
1992	-1.52	1.34	-1.27	1.42	-0.93	1.08	245
1998	-1.70	1.36	-1.47	1.55	-1.01	1.13	334
Change	-0.18 *		-0.20 **		-0.08		
Some secondary education or more							
1992	-0.78	1.32	-0.48	1.26	-0.64	1.16	98
1998	-1.26	1.24	-1.11	1.35	-0.75	0.89	106
Change	-0.48 **		-0.63 ***		-0.11		

* Significant at the .10 level. ** Significant at the .05 level. *** Significant at the .01 level.

Table 5.7 Child malnutrition by women's educational level and year

	Underweight (%)	Stunted (%)	Wasted (%)	Valid cases
No education				
1992	45.6	37.3	18.3	1,993
1998	51.1	42.2	21.5	2,898
Change	5.5 ***	4.9 ***	3.2 ***	
Some primary education				
1992	37.4	27.3	16.3	245
1998	46.9	36.4	20.5	334
Change	9.5 ***	9.1 ***	4.2	
Some secondary education or more				
1992	17.7	13.8	7.1	98
1998	29.9	25.0	8.2	106
Change	12.2 *	11.2	1.1	

* Significant at the .10 level. ** Significant at the .05 level. *** Significant at the .01 level.

Table 5.8 Child z scores by men's educational level and year

	Weight-for-age z-score		Height-for-age z-score		Weight-for-height z-score		
	Mean	SD	Mean	SD	Mean	SD	Valid cases
No education							
1992	-1.73	1.41	-1.52	1.56	-1.00	1.15	2,027
1998	-1.95	1.32	-1.71	1.53	-1.14	1.12	2,880
Change	-0.22 ***		-0.19 ***		-0.14 ***		
Some primary education							
1992	-1.58	1.32	-1.31	1.54	-0.93	0.99	170
1998	-1.69	1.26	-1.52	1.51	-0.95	1.06	272
Change	-0.11 *		-0.21 **		-0.02		
Some secondary education or more							
1992	-1.05	1.35	-0.72	1.26	-0.77	1.18	139
1998	-1.18	1.18	-1.03	1.25	-0.72	0.99	186
Change	-0.13		-0.31 **		0.05		

* Significant at the .10 level. ** Significant at the .05 level. *** Significant at the .01 level.

Table 5.9 Child malnutrition by men's educational level and year

	Underweight (%)	Stunted (%)	Wasted (%)	Valid cases
No education				
1992	45.6	37.1	18.4	2,027
1998	51.9	42.6	21.9	2,880
Change	6.3 ***	5.5 ***	3.5 ***	
Some primary education				
1992	35.6	31.6	15.0	170
1998	43.4	36.4	18.3	272
Change	7.8 ***	4.8	3.3	
Some secondary education or more				
1992	25.4	15.7	11.2	139
1998	27.6	24.1	8.7	186
Change	2.2	8.4 *	-2.5	

* Significant at the .10 level. ** Significant at the .05 level. *** Significant at the .01 level.

Table 5.10 Child z scores by economic status and year

	Weight-for-age z-score		Height-for-age z-score		Weight-for-height z-score		
	Mean	SD	Mean	SD	Mean	SD	Valid cases
Poor							
1992	-1.78	1.44	-1.53	1.62	-1.05	1.13	782
1998	-1.99	1.29	-1.75	1.47	-1.18	1.10	1,520
Change	-0.21 ***		-0.22 ***		-0.13 ***		
Middle							
1992	-1.65	1.33	-1.46	1.51	-0.96	1.06	991
1998	-1.86	1.23	-1.65	1.48	-1.06	1.03	1,314
Change	-0.21 ***		-0.19 ***		-0.10 **		
Rich							
1992	-1.31	1.26	-1.03	1.39	-0.86	1.10	563
1998	-1.43	1.23	-1.23	1.38	-0.87	1.02	504
Change	-0.12		-0.20 **		-0.01		

* Significant at the .10 level. ** Significant at the .05 level. *** Significant at the .01 level.

Table 5.11 Child malnutrition by economic status and year

	Underweight (%)	Stunted (%)	Wasted (%)	Valid cases
Poor				
1992	47.3	39.0	19.2	782
1998	52.4	44.5	23.8	1,520
Change	5.1 **	5.5 **	4.6 **	
Middle				
1992	42.0	34.0	16.0	991
1998	49.8	39.2	18.5	1,314
Change	7.8 ***	5.2 **	2.5	
Rich				
1992	29.7	22.9	15.8	563
1998	34.7	29.6	14.1	504
Change	5.0 *	6.7 **	-1.7	

* Significant at the .10 level. ** Significant at the .05 level. *** Significant at the .01 level.

CHAPTER 6

RESULTS: PATTERNS OF CHANGE IN THE EFFECTS AND LEVELS OF UNDERLYING DETERMINANTS OF CHILD NUTRITIONAL STATUS

This chapter is the second of two chapters that report the results on child nutritional status. In section 1, the determinants of child nutritional status in Niger are identified in a multivariate econometric analysis. In this section, not only do we gain a better understanding of what the determinants of child nutritional status are, but we also are able to discern the difference in their effects between 1992 and 1998. Directly following, we investigate the patterns of change of various underlying socioeconomic determinants by comparing them across the years. In section 2 and 3 the levels of socioeconomic and caring practices determinants of child nutritional status are evaluated for 1992 and 1998. The results summarized in section 4 are discussed in section 5 in order to help explain, to a certain extent, why child nutritional status deteriorated. Table 6.1 displays the mean and standard deviation of each of the variables that enters into the models of the regression analysis. These descriptive statistics will be discussed in more detail in section 2.

6.1 Determinants of Malnutrition and Differences in their Effects Between 1992 and 1998

Tables 6.2 to 6.4 present the region fixed effects regression results for child nutritional status (*waz*, *haz* and *whz*) for 1992 and 1998. The second column in each table reports the coefficients of the explanatory variables employed. The number of

stars placed at the right of the coefficients reveals their level of significance (see notes at the bottom of the tables). Since the Brush-Pagan tests indicate the presence of heteroskedasticity (listed at the bottom of tables), robust standard errors were used to calculate the t-statistics, which are reported in the third column of the tables. For the explanatory variables for which the 1992 and 1998 coefficients are different, i.e. the interaction term with the year 1998 dummy variable was significant (p-value < 0.10), the coefficients for 1998 were calculated separately. They are presented in the fourth column of each table, with corresponding t-statistic in the fifth column. The last column in each table reports the p-value (i.e. level of significance) of the interaction term with the year 1998 dummy. The R^2s (listed at the bottom of tables) are relatively low and similar to those found in other child nutritional studies. Also, Ramsey-Reset tests (Statacorp 2002) reveal possible omitted variable bias in the regressions of all three measures of child malnutrition. The variance inflation factor (VIF) test indicates the presence of weak multicollinearity. The largest VIF is equal to 11, which is well below 30. The mean VIF is 2.65, which is not far above the cut-off of 1.

The regression results suggest several variables in the models have a significant effect on child nutritional status in Niger. The independent variables are arranged into three groups: child, parent and household characteristics. As mentioned above, controls for regional effects were added in all estimations.

The regression results are consistent with the finding of past studies that child nutritional status declines significantly with age, reflecting the typical deterioration of linear growth in children aged 1 to 3 years, the most vulnerable age category. In 1998,

the effect of child's age on short-term nutritional status (*whz*) significantly changed from the effect in 1992. *Whz* still declined with age in 1998, but at a lesser degree than in 1992, perhaps reflecting increased immunization coverage over the study period to protect against infectious diseases, such as tuberculosis and diphtheria. Additionally, the effect of age became more negative for 2-3 year old children. Sex, the second child characteristic, does not reveal any particular vulnerability of boys or girls for *waz* or *whz*, but does show that girls' long-term nutritional status, *haz*, is expected to be slightly better than boys' by 0.085 z scores. The finding is consistent with other research from Africa (Svedberg 1990). As mentioned, the greater vulnerability of boys could find an explanation in the distinctive biological makeup of the male and female human bodies (Agnihotri 1999).

With reference to parents' characteristics, women's decision making power relative to men's has a significant and non-linear effect on *waz* and *whz*. The effect is negative at status index levels lower than 47 for *waz*, and is positive at higher status index levels (the unweighted mean is 38.62 for the full sample). In other words, for women who score an index higher than 47 (22.8%), the effect of relative decision making power on child *waz* is positive, though small, and increases at an increasing rate. However, the effect is negative when women score below. The effect of relative decision making power on child *whz* follows the same pattern, with the turning point being 44.5 (29.2% of women scored higher than this). Smith et al. (2002) found that when women's relative decision making power increases, women in Sub-Saharan Africa breast-feed for shorter periods of time. The cutback in the duration of breast-feeding was found to be

unassociated with women's participation in the labor force, but to be indeed something preferred by women. Although reduced breast-feeding negatively affects child nutritional status, as status increases other care practices improve (e.g., immunization of children, prenatal and birthing care…etc), and are after a point apparently able to mitigate the negative effect that lack of adequate breast-feeding creates.

Mother's age, which serves as a proxy for experience in caring for a child, is not significant for either *waz* or *haz* but is negatively associated with acute malnutrition, a relationship that was established for Sub-Saharan Africa as a whole in Smith et al. (2002). The negative relationship with short-term malnutrition may be due to a possible decrease in quality care for more recent children. As a woman gets older, she is more likely to have more children, and likely to devote less effort caring for the newer ones.

There is strong evidence that children of better-educated parents in developing countries are healthier, and our results are consistent with this evidence. Mother's education has a significant positive effect on all three measures of nutritional status in Niger. One year of maternal education adds 0.027 z scores to a child *waz*, that is 0.162 z scores if a mother fulfilled the required six years of primary schooling and 0.351 if she completed secondary school. In the case of chronic malnutrition, a woman needs at least three years of education for schooling to start positively affecting *haz*. After that, the effect increases at an increasing rate. However, the effect of maternal education on *haz* stays relatively small. Four years of college education increases *haz* by just 0.179 z scores. With respect to acute malnutrition, *whz* substantially increases by 0.195 z scores if a woman completed high school. Since the model controlled for economic status, the

effect of maternal education most likely reflects better caring practices such as timely prenatal care, appropriate complementary feeding and enhanced health seeking behaviors.

Whether or not a woman is in a polygynous union does not seem to affect nutritional status in Niger. Given that the variable was included in the model to capture the spillover effect of having another woman who would care for a child in the household, there is suspicion that the effect may become more important as children grow older and depend less on their own mothers for care. To explore this issue, regression for 2-3 years old children only was run. Polygyny was found to be significantly and negatively associated with weight-for-age (-0.140, p-value < 0.05). This result confirms that as children grow older, reciprocity among wives in providing childcare for one another's children has a negative spillover effect on child nutritional status.

Mother's ethnicity had a significant effect in child nutritional status in 1992. Children of Touareg mothers were smaller (*waz)* and slimmer (*whz)* by 0.236 and 0.196 z scores, respectively, than children of Haoussa mothers. In 1998, ethnicity was no longer a significant determinant of either of the two nutritional status measures. This result concurs with the ongoing move to sedentary life of the Touareg people that has been accompanied by a modification of the type of food they consume (i.e. less of the milk and millet diet) (FAO 1998). While transhumance still exists, families from the east are staying at their fields more and more frequently. The Touareg in the western departments of Niamey and Dosso have lost their mobility and are now in an agropastoral economy

(FAO 2001). Drought episodes increasingly compel nomads (Touareg and to a lesser extent Peulh) to sedentary life.

Father's education is a significant determinant of child nutritional status in Niger. One year of paternal education improves the child's *waz* by 0.025 z scores, which adds up to 0.325 z scores if secondary education was completed. As expected, the effect of paternal education is generally smaller than maternal education. For example, the marginal effect of father's schooling on *whz* is 0.011 compared to 0.015 z scores for mother's education, which translates to 0.143 compared to 0.195 z scores if secondary school is completed.

Household size does not seem to affect nutritional status in Niger. The finding on household size is consistent with Sahn's (1994) study of nutritional status in Cote d'Ivoire. Demographic composition of the household also appears to play little role in child nutritional status. A greater proportion of men fifty-five or older in the household negatively but weakly affects *waz*. This may be explained by the fact that elderly males are poor substitute care providers for pre-school aged children. An alternative explanation may be that care of elders undermines care for children. Additionally, a relatively higher rate of male adults (15-55) in a household negatively affects *whz*. This may imply that when food is scarce, adult male high energy and protein requirements affect resource allocation patterns within households, which ultimately do not favor younger children.

The results show that household health environments, such as quality of drinking water and use of sanitary latrines play a considerable role in child nutritional status in

Niger. Drinking well water and piped water, as opposed to surface water, improves child *waz* by 0.264 and 0.300 z scores, respectively. The quality of drinking water was not a factor for *whz* in 1992. However, it had become an important determinant of acute malnutrition by 1998. The regression shows that the effects of well water and piped water on *whz* became large and positive, estimated at nearly one half of a z score (0.476 and 0.495). These results likely indicate the effect of cuts in government health expenditures and, consequently, of lesser access to modern health care over the study period. Indeed, lack of safe water increases the risk of a child contracting diseases such as malaria, cholera and diarrhea, which, in turn, hinder the proper utilization of food necessary to fulfill nutritional requirements to the child's body. Therefore, such diseases require immediate medical attention in order to lower the effects they have on child health, thus child nutritional status. As far as chronic malnutrition is concerned, there is no evidence that access to adequate drinking water affects *haz*.

Use of sanitary latrines such as pit latrines demonstrates significant and positive benefits to child nutritional status. The use of a pit latrine over no latrine increases *waz* by 0.105 z scores. However, when a household has a flush latrine instead, *waz* is not significantly affected. The use of a pit latrine over no latrine raises *haz* by 0.129 z scores, while the use of a flush latrine over no latrine does not significantly affect it. Although availability of a flush latrine in a household was not significant in 1992, it turned out to be significant in 1998 increasing by more than half a child's *whz* (0.567). Again this result most likely indicates the effect that deteriorating health services had on acute nutritional status. Children who suffer from respiratory infections, for example,

must be effectively treated because profoundly weakened health leads to poor food utilization (i.e. nutrient losses), thus malnutrition.

As expected after reviewing the descriptive results in chapter 5, living in urban areas enhances child nutritional status (*waz* and *haz* only) in both years. Various studies have demonstrated that children from urban areas are likely to be better nourished than their rural counterparts (Ruel et al. 1998; Ruel, Haddad and Garrett 1999), which, therefore, may help improve their nutritional status. Niger's level of urbanization is particularly low. Therefore problems associated with high urbanization such as overcrowding and disease contagion are not a serious issue in this context.

Economic status, as measured by the constructed asset index, does not have a strong influence on nutritional status. In the case of acute malnutrition, children from "middle" economic status households are significantly less thin (+0.06 z scores). Other studies have shown that the effect of maternal education on child health outcomes often exceeds the income effect. There is also indication that mother's education may be the principal determinant of nutritional status among younger children (<24 months) but income may become more significant as children grow older and have greater daily requirements of nutrients and other basic needs (Sahn and Alderman 1997). To look into this matter, an age specific regression for 2-3 year old children was run. Economic status turned out to be a significant determinant of weight-for-age. A move from the "poor" to the "middle" economic status group improved *waz* by 0.114 z scores.

The combined effect of the region dummy variables was significant at the 1% level for the *waz* and *haz* models and at the 5% level for the *whz* model (statistics

available at the bottom of Tables 6.2- 6.4), showing great variability across regions. There is evidence that local-level variation in basic determinants such as the food supply, political stability, economic infrastructure, food prices, regional policy (or a biased national policy) and environment played a role in child nutritional status. Living in Niamey had a significant and strong effect on child's *haz* in 1992, probably because then, most of the health services were concentrated in the capital city. However, Niamey lost its advantage in 1998. Low height-for-age is commonly interpreted as indicative of frequent sickness and disease, and this outcome may reflect the degradation of the health care system over the 1990s.

The significant and strong positive effect that residing in Tillaberi also had on *haz* in 1992 had significantly diminished by 1998. Indeed, residing in Tillaberi over Zinder/Diffa reduces *haz* by 0.183 z scores.

6.2 Differences in the Levels of Socioeconomic Determinants

Table 6.5 shows statistically significant differences in the level of socioeconomic determinants across 1992 and 1998. Although some of the determinants improved in level, many worsened over the study period.

6.2.1 Women's Status and Education

In 1998, women had a significantly higher relative decision making power in Niger than in 1992 (p-value < 0.01). In section 6.1, we saw that women's status positively affected nutritional status only when mothers reached a certain level of relative

status. Despite women's status improvement over the study period, relative decision making power on average still negatively affected child nutritional status. In 1998, 25% of women in the sample (against 19% in 1992) scored high enough in the index of decision making power for it to positively affect *waz*. Mothers' and fathers' average years of education remained low and statistically the same over 1992-1998.

6.2.2 Health Environments

There is some indication that the quality of households' health environments in Niger deteriorated a bit with time. A smaller proportion of people in Niger had access to piped drinking water in 1998. They turned instead to water extracted from the ground (well water). Further, a slight percent increase of households that lack toilet facilities took place over the study period. Conversely, the percentage of households with sanitary pit latrines slightly but significantly dropped.

6.2.3 Place of Residence

Urbanization significantly declined, with a greater percent of people in 1998 living in rural areas of Niger than in 1992. Percent of urban population dropped from about 16% to 14%.

6.2.4 Poverty

The percent of households classified as poor substantially and significantly increased from an already high 43.2% in 1992 to 50.4% by 1998, while the proportion of households in the "middle" and "rich" groups shrunk, from 45.2% to 38.9% and from 11.6% to 10.7% respectively.

This section shows that although women's relative status improved to a certain extent, other socioeconomic conditions in Niger deteriorated between 1992 and 1998. Poverty increased considerably and household health environments worsened, with relatively fewer people drinking safe water and using adequate sanitation facilities. Also, a greater portion of the population lived in rural Niger in 1998, where the health care system is the most underdeveloped.

6.3 Differences in the Levels of Caring Practices Determinants

Table 6.6 reveals some differences across the six-year study period in the means of caring practices associated with child nutritional status.

6.3.1 Prenatal and Birthing Care

Four variables pertaining to care for woman, namely prenatal and birthing care, are compared across the years. In 1998, more women received prenatal care in Niger, a rise from 32.7% to 39.5% (difference is substantial but its significance could not be established). The reasons for the low rates in prenatal care and medical facility utilization range from ignorance regarding the importance of care for pregnant women, to poverty, and to low availability of health services in rural areas, where most of the people live. It is important to be aware that, although the test of significance difference determines that fewer women had at least three prenatal visits in 1998, the decline is certainly negligible.

6.3.2 Child Feeding Practices

Breast-feeding initiation was significantly higher in 1998, with about 42% women breast-feeding their children within one day of birth in 1998 compared to 30% in 1992. Although the rate of children 0-4 months old exclusively breast-fed significantly increased by 3.5 percentage points, it was still very low in 1998. Niger has one of the lowest rates in Sub-Saharan Africa (Smith et. al. 2002). It must be called to attention that the rate of children 6-12 months who did *not* receive complementary food as recommended by WHO decreased by almost 5 percentage points from 1992 to 1998 (82.5% to 77.7%).

6.3.3 Health Seeking Practices

Illness prevention and treatment improved considerably over the study period. In 1998, a significantly larger percent of children with diarrhea were taken to a medical facility than in 1992 (+7.6 percentage points). Also, more children with diarrhea received treatment in 1998 (+12.6 points). Vaccination rates were still very low but 5 in 10 children received at least one vaccination in 1998 as compared to nearly 4 in 10 in 1992. This increase might indicate that the government vaccination program was successful in improving, to some extent, immunization coverage in the country.

6.3.4 Alternative Child Caretakers

One very important caring practice is the quality of substitute caretakers secured for children while their mothers are working outside the home. There was a big drop in the percentage of children left with an adult caretaker. In 1992, approximately 9 in 10

children of women working for cash had adult supervision whereas in 1998 only three fourths of the children were under the same supervision.

6.4 Summary of Results

The results from the nutritional status models concur in part with other research results (e.g., Smith and al. 2002). It was found that the primary determinants of malnutrition for children under three in Niger are the child's age and sex, maternal and paternal schooling, household health environments, economic status and place of residence.

The strength of the effects of some determinants has changed considerably over the study period. The oldest age group in the sample was expected to have significantly worse short-term nutritional status in 1998 than their counterparts in 1992. While in 1992 Touareg ethnicity significantly affected child's *waz* and *whz*, it was no longer a determinant of nutritional status in 1998. Health environment factors, as measured by safe water drinking water and use of sanitary latrines, turned out to be significant determinants of acute child malnutrition in 1998, but not in 1992. Finally, for reasons to be explored living in the region of Tillaberi exerted a larger positive effect on *haz* in 1992 than in 1998.

Four socioeconomic variables significantly changed over the study period: (1) women's relative decision making power rose, (2) the quality of household drinking water and (3) sanitary facilities worsened, and (4) poverty considerably increased.

Most caring practices improved over 1992-1998 but the levels of two determinants substantially declined. A higher percentage of women received prenatal care and delivered their infants in a medical facility. Also, a larger proportion of children were initiated to breastfeeding within one day of birth, and were exclusively breast-fed in the first four months of their life. Health seeking behaviors for children improved as well over the study period, with relatively more children taken to a medical facility when suffering from diarrhea. A higher percent of cases of diarrhea were also treated. However, a lower percentage of children were given timely complementary feeding. In addition, a larger percentage of children received substitute care of inferior quality.

6.5 Why Did Child Nutritional Status Decline in Niger?

The deterioration of child nutritional status can be partly explained by the significant changes of two key socioeconomic variables between 1992 and 1998. Poverty considerably increased and household health environments, captured by quality of water supply and sanitation, slightly but significantly worsened.

This study has found that economic status significantly affects acute malnutrition among preschool children in Niger. The growing inability to access economic resources that accompanied increased poverty over 1992-1998 translated into more people being unable to secure food for their families and to invest resources in acquiring proper care for children including paying for health services and securing competent substitute caretakers. It was found that economic status particularly affected the nutritional status of children aged 2-3 years who have greater daily requirements of nutrients.

Consequently, with the intensification of poverty these children are more likely to become food deprived, and parents have increasingly greater difficulties tending to their other basic needs.

Although the deterioration of the health environment over 1992 and 1998 was slight, it may still help explain why child nutritional status declined. One must first consider how terrible the conditions of household health environments in Niger are, especially the widespread lack of sanitation facilities. When combined with the suddenly *large* and *significant* effect these conditions have on acute child malnutrition in 1998, it becomes evident how even a slight decline of health environment quality over the period can be detrimental to child nutritional status.

As discussed before, children who live in urban areas have better short-term, long-term and overall nutritional status than their rural counterparts. Since the proportion of people living in urban areas significantly dropped over 1992-1998, it is therefore safe to state that "de-urbanization" led to higher levels of malnutrition in Niger.

We can hypothesize that growing poverty in Niger affected child nutritional status through two caring practices. First, children were given complementary food at a later period than recommended by the WHO. Second, a greater percentage of children were left with inexperienced children in the role of substitute caretakers while their mothers worked.

To verify if the decline in complementary feeding is associated with the increase in poverty in Niger, the proportion of children 6-12 months introduced to complementary

feeding is compared across economic status groups. The results confirm that the introduction of complementary feeding to children 6-12 months old is indeed connected to the economic status of a household. Only 76.4% of these children are given solid food in poor households, compared to 81.2% and 89.5% in middle and rich economic status households respectively.

One way to substantiate the link between the quality of substitute caretakers for children and poverty is to verify whether relatively more women chose to work for cash in 1998 than in 1992 in order to increase their household's income. The results confirm that, effectively, a significantly higher proportion of women worked for cash income in 1998 (39.0% compared to 36.4% in 1992). Ideally, we would go on to conduct a test of the hypothesis that children whose mothers work for cash are left in greater proportion with non-adults than children whose mothers do not work for cash. Unfortunately, data on substitute childcare is only available for children whose mothers work away from home (whether paid cash or not), so this step cannot be taken.

Table 6.1 Independent variables: weighted means and standard deviations (Sd) by year
Child nutritional status models

Variable	Year = 1992 Mean	Sd	Year = 1998 Mean	Sd
Child characteristics				
Child aged 0-1	0.422	0.491	0.378	0.484
Child aged 1-2	0.296	0.462	0.332	0.472
Child aged 2-3	0.282	0.453	0.290	0.454
Male child	0.534	0.499	0.527	0.499
Female child	0.466	0.499	0.473	0.499
Characteristics of woman and partner				
Woman's age	27.56	6.80	27.71	7.29
Index of women's relative decision making power	36.32	12.01	39.10	11.61
Woman's education in years	0.43	1.62	0.61	1.96
Monogamous union	0.652	0.476	0.646	0.478
Polygynous union	0.348	0.476	0.354	0.478
Haoussa	0.576	0.494	0.628	0.484
Djerma	0.221	0.415	0.183	0.387
Kanouri	0.044	0.205	0.041	0.197
Touareg	0.103	0.304	0.082	0.274
Peulh	0.036	0.186	0.049	0.215
Other	0.020	0.142	0.018	0.133
Partner's age	39.14	10.05	38.42	10.01
Partner's education in years	0.47	1.97	0.81	2.48
Household characteristics				
Household size	8.577	4.841	7.919	4.648
Percent females 0-15	25.39	15.16	25.74	15.74
Percent females 15-55	22.92	7.71	24.06	8.20
Percent females 55+	2.05	4.67	1.80	5.24
Percent males 0-15	27.82	15.49	27.85	15.98
Percent males 15-55	19.83	9.36	18.59	9.86
Percent males 55 +	1.98	4.58	1.96	4.65
Surface water used	0.035	0.184	0.026	0.158
Well water used	0.762	0.426	0.776	0.417
Piped water used	0.203	0.403	0.198	0.399
No latrine used	0.831	0.375	0.834	0.372
Pit latrine used	0.161	0.367	0.158	0.365
Flush latrine used	0.008	0.090	0.008	0.090
Rural location	0.842	0.365	0.858	0.349
Urban location	0.158	0.365	0.142	0.349
"Poor" economic status	0.432	0.495	0.504	0.500
"Middle" economic status	0.452	0.498	0.389	0.488
"Rich" economic status	0.116	0.320	0.107	0.309

Table 6.2 Determinants of child's weight-for-age z scores: regression results

Variable	Coefficient	*t* - statistic	1998 coefficient if different from 1992	*t* - statistic 1/	*p-value* for difference between 1992 and 1998 coefficient
Child characteristics					
Child aged 1-2	**-1.259** ***	-32.39			
Child aged 2-3	**-1.107** ***	-26.69			
Female child	-0.025	-0.65			
Characteristics of woman and partner					
Woman's age	-0.005	-1.15			
Index of women's relative decision making power	**-0.012** **	-1.95			
Index of women's relative decision making power squared	**0.000** **	2.03			
Woman's education in years	**0.027** ***	2.99			
Polygynous union	-0.037	-0.88			
Djerma	-0.002	-0.04			
Kanouri	0.001	0.02			
Touareg	**-0.236** **	-2.36	0.049	0.37	0.040
Peulh	0.211	1.55	-0.122	1.26	0.042
Other	0.070	0.65			
Partner's age	0.004	1.22			
Partner's education in years	**0.025** ***	3.49			
Household characteristics					
Household size	-0.001	-0.21			
Percent females 15-55	-0.001	-0.47			
Percent females 55+	-0.003	-0.73			
Percent males 0-15	-0.001	-0.71			
Percent males 15-55	-0.003	-1.42			
Percent males 55 +	**-0.007** **	-1.74			
Well water used	**0.264** **	2.44			
Piped water used	**0.300** **	2.51			
Pit latrine used	**0.105** **	1.98			
Flush latrine used	0.234	1.62			
Urban location	**0.176** **	2.45			
"Middle" economic status	0.051	1.36			
"Rich" economic status	0.091	1.50			

Table 6.2 Determinants of child's weight-for-age z scores: regression results *(continued)*

Variable	Coefficient	*t* - statistic	1998 coefficient if different from 1992	*t* - statistic 1/	*p-value* for difference between 1992 and 1998 coefficient
Region effects					
Niamey	**0.209** **	2.62			
Dosso	**0.211** ***	3.06			
Maradi	-0.099	-1.53			
Tahoua/Agadez	**0.139** **	2.18			
Tillaberi	**0.185** **	2.31			
Number of observations	5,674				
R-squared	0.240				
	Fstat	**P-value**			
Joint significance of region dummies	8.32	0.000			
Breuch-Pagan heteroskedasticity test	113.41	0.000			
RESET omitted variables test	5.63	0.001			

Notes: The p-values are based on White-corrected standard errors and are robust to intra-cluster correlation.

1/ t- statistic is from regression run for 1998 only.

* Significant at the 10% level. ** Significant at the 5% level. *** Significant at the 1% level.

Table 6.3 Determinants of child's height-for-age z scores: regression results

Variable	Coefficient	*t* - statistic	1998 coefficient if different from 1992	*t* - statistic 1/	*p-value* for difference between 1992 and 1998 coefficient
Child characteristics					
Child aged 1-2	**-1.437** ***	-36.34			
Child aged 2-3	**-1.532** ***	-33.82			
Female child	**0.085** **	1.98			
Characteristics of woman and partner					
Woman's age	0.0002	0.05			
Index of women's relative decision making power	-0.001	-0.24			
Woman's education in years	**-0.025** 2/	-1.16			
Woman's education in years squared	**0.006** **	2.76			
Polygynous union	-0.038	-0.80			
Djerma	-0.084	-1.29			
Kanouri	0.085	0.80			
Touareg	-0.073	-0.88			
Peulh	-0.068	-0.69			
Other	0.059	0.53			
Partner's age	0.003	0.79			
Partner's education in years	**0.021** ***	2.76			
Household characteristics					
Household size	0.000	-0.09			
Percent females 15-55	0.001	0.43			
Percent females 55+	-0.004	-1.00			
Percent males 0-15	0.001	0.55			
Percent males 15-55	-0.001	-0.42			
Percent males 55 +	-0.005	-1.23			
Well water used	0.131	1.20			
Piped water used	0.192	1.53			
Pit latrine used	**0.129** **	2.12			
Flush latrine used	0.128	0.73			
Urban location	**0.149** *	1.78			
"Middle" economic status	0.000	-0.01			
"Rich" economic status	0.079	1.11			

Table 6.3 Determinants of child's height-for-age z scores: regression results *(continued)*

Variable	Coefficient	*t* - statistic	1998 coefficient if different from 1992	*t* - statistic 1/	*p-value* for difference between 1992 and 1998 coefficient
Region effects					
Niamey	**0.578** ***	6.16	0.226	1.57	0.001
Dosso	**0.364** ***	4.82			
Maradi	**-0.183** **	-2.55			
Tahoua/Agadez	**0.186** **	2.41			
Tillaberi	**0.547** ***	4.85	**0.306** **	2.20	0.037

Number of observations	5,674
R-squared	0.276

	Fstat	P-value
Joint significance of region dummies	24.12	0.000
Breuch-Pagan heteroskedasticity test	7.98	0.005
RESET omitted variables test	4.80	0.002

Notes: The p-values are based on White-corrected standard errors and are robust to intra-cluster correlation.

1/ t- statistic is from regression run for 1998 only.

2/ Education variable and its square are jointly significant at a 1% level.

* Significant at the 10% level. ** Significant at the 5% level. *** Significant at the 1% level.

Table 6.4 Determinants of child's weight-for-height z scores: regression results

Variable	Coefficient	*t* - statistic	1998 coefficient if different from 1992	*t* - statistic 1/	*p-value* for difference between 1992 and 1998 coefficient
Child characteristics					
Child aged 1-2	**-0.761** ***	-13.74	**-0.642**	-12.33	0.121 2/
Child aged 2-3	**-0.237** ***	-4.35	**-0.301**	-6.24	0.380
Female child	-0.052	-1.59			
Characteristics of woman and partner					
Woman's age	**-0.009** **	-2.11			
Index of women's relative decision making power	**-0.009** *	-1.75			
Index of women's relative decision making power squared	**0.0001** *	1.94			
Woman's education in years	**0.015** *	1.97			
Polygynous union	-0.031	-0.84			
Djerma	0.055	1.19			
Kanouri	-0.083	-0.91			
Touareg	**-0.196** ***	-2.61	0.065	0.63	0.014
Peulh	0.217	1.51	-0.089	-1.29	0.063
Other	0.033	0.35			
Partner's age	0.003	1.07			
Partner's education in years	**0.011** *	1.75			
Household characteristics					
Household size	-0.001	-0.16			
Percent females 15-55	-0.001	-0.61			
Percent females 55+	0.000	0.10			
Percent males 0-15	-0.002	-1.24			
Percent males 15-55	**-0.003** *	-1.80			
Percent males 55 +	-0.005	-1.17			
Well water used	0.038	0.31	**0.476** ***	3.00	0.031
Piped water used	0.059	0.43	**0.495** ***	2.80	0.043
Pit latrine used	-0.059	-0.83	**0.113** 3/	1.64	0.058
Flush latrine used	-0.227	-1.29	**0.567** ***	3.11	0.001
Urban location	0.099	1.60			
"Middle" economic status	**0.063** *	1.74			
"Rich" economic status	0.057	1.01			

Table 6.4 Determinants of child's weight-for-height z scores: regression results *(continued)*

Variable	Coefficient	*t* - statistic	1998 coefficient if different from 1992	*t* - statistic 1/	*p-value* for difference between 1992 and 1998 coefficient
Region effects					
Niamey	-0.043	-0.57			
Dosso	0.011	0.19			
Maradi	-0.116	-1.49	0.114	1.57	0.007
Tahoua/Agadez	0.047	0.86			
Tillaberi	**-0.180** *	-1.82	0.006	0.52	0.065

Number of observations	5,674	
R-squared	0.098	
	Fstat	**P-value**
Joint significance of region dummies	2.28	0.044
Breuch-Pagan heteroskedasticity test	4.50	0.034
RESET omitted variables test	2.21	0.085

Notes: The p-values are based on White-corrected standard errors and are robust to intra-cluster correlation.

1/ t- statistic is from regression run for 1998 only.

2/ Difference coefficients for child's age are jointly significant at a 0.05 level.

3/ The 1998 coefficients of toilet variables are jointly significant at a 0.01 level.

* Significant at the 10% level. ** Significant at the 5% level. *** Significant at the 1% level.

Table 6.5 Means comparison of socioeconomic determinants of child nutritional status, 1992 and 1998

Variable	1992	1998
Characteristics of woman and partner		
Index of women's relative decision making power	**36.32**	**39.10** ***
Woman's education in years	0.43	0.61 a/
Partner's education in years	0.47	0.81
Household characteristics		
Surface water used	0.035	0.026
Well water used	**0.762**	**0.776** ***
Piped water used	**0.203**	**0.198** ***
No latrine used	**0.831**	**0.834** ***
Pit latrine used	**0.161**	**0.158** ***
Flush latrine used	0.008	0.008 a/
Rural location	**0.842**	**0.858** ***
Urban location	**0.158**	**0.142** ***
"Poor" economic status	**0.432**	**0.504** ***
"Middle" economic status	**0.452**	**0.389** ***
"Rich" economic status	**0.116**	**0.107** ***

* Significant at the .10 level. ** Significant at the .05 level. *** Significant at the .01 level.

Year means are calculated using sample weights provided with the Niger DHS data sets.

a/ Although the weighted mean is higher in 1998 than in 1992, the 1998 unweighted mean obtained from the test of significant difference is lower. Therefore the result of the two-sample z test is not conclusive. The significance of the difference in weighted means was not evaluated.

Table 6.6 Comparison of caring practices determinants of child nutritional status, 1992 and 1998

Determinants	1992	1998
Prenatal and birthing care for mother		
Whether woman received any prenatal care	0.327	0.395 a/
Whether woman with any prenatal care had at least three visits	0.640	**0.639** **
Number of months before birth woman had first prenatal visit	5.554	5.548
Whether woman gave birth in a medical facility	0.168	0.172 a/
Child feeding practices		
Whether breastfeeding was initiated within one day of birth	0.304	0.419 ***
Whether child 0-4 months is exclusively breast fed	0.000	0.035 ***
Whether child 0-4 months receives no bottle	0.978	0.971
Number of months breastfeeding	19.09	18.91
Whether child 6-12 months has received complementary foods	0.825	**0.777** ***
Health seeking behaviors for children		
Whether child with diarrhea was taken to a medical facility	0.099	0.175 **
Whether diarrhea was treated	0.289	0.415 ***
Whether child received any vaccinations	0.372	0.528 ***
Whether child received recommended vaccinations	0.164	0.174 a/
Quality of substitute child care takers		
Whether child has adult caretaker while woman works	0.892	**0.752** ***

Notes: Stars indicate significant differences across the 1992 and 1998 years at the 1 percent (***), 5 percent (**) and 10 percent (*) levels.

Annual means are calculated using sample weights provided with the Niger DHS data sets.

a/ Although the weighted mean is higher in 1998 than in 1992, the 1998 unweighted mean obtained from the test of significant difference is lower.

Therefore the result of the two-sample z test is not conclusive. The significance of the difference in weighted means was not evaluated.

CHAPTER 7

RESULTS: WOMEN'S NUTRITIONAL STATUS

This chapter sets out to identify the relevant underlying determinants of women's nutritional status using a cluster fixed effect regression analysis. There is a consensus that the health and well being of a mother throughout her life is directly associated with the health and well being of her child. Malnourished women are more likely to deliver malnourished children who will grow into malnourished adults, creating a vicious circle. In developing countries, the main determinants of growth retardation *in utero* are nutritional: inadequate maternal nutritional status before conception, short maternal stature (due to undernutrition and infection during childhood), and poor maternal nutrition during pregnancy (ACC/SCN 2000). Child development is to a large extent influenced by the caring capacity of mothers (FANTA 2001). When a mother is malnourished, her ability to effectively carry, deliver and care for her child is diminished. Maternal nutritional status is therefore directly associated with child malnutrition, not to deny that it is also of great concern in its own right.

7.1 Determinants of Women's Nutritional Status

Table 7.1 presents the descriptive statistics of the independent variables used in the women's nutritional status model. Table 7.2 lists the mean and standard deviation of body mass index (BMI), and the proportion of underweight women for 1992 and 1998. Like child nutritional status, women's nutritional status worsened over the study period.

Mean BMI significantly decreased by -0.169. The decline in BMI translated into a 2.37 percentage point rise in the prevalence of underweight women (17.37% to 19.74%).

Table 7.3 presents the cluster fixed effect regression results for BMI. A general Chow-test for structural differences between the determinants of women's nutritional status in 1992 and in 1998 was previously run to verify if they had changed over time. The F test failed to reject the null hypothesis (p-value=0.4311). That is, we determine that there was no change in the determinants of women's nutritional status between 1992 and 1998.

The second column in the table reports the coefficients of the explanatory variables. At the right of the coefficients, the number of stars discloses the level of significance of the coefficients (see notes at the bottom of the tables). The last column reports the t-statistics derived from robust standard errors, which are used to correct for heteroskedasticity (detected with the Brush-Pagan test). The Ramsey-Reset test (listed at the bottom of tables) (Statacorp 2002) reveals possible omitted variable bias in the regression. The variance inflation factor (VIF) test indicates the presence of weak multicollinearity. The largest VIF is equal to 10.93 (below 30). The mean VIF is 2.79, which is not far above the cut-off of 1.

The regression results reveal multiple explanatory variables in this model having significant effects on mother's nutritional status in Niger. Starting with women's characteristics, we find that a woman's BMI increases significantly, but at a decreasing rate, with her age. A woman's nutritional status also improves significantly with education. One year of education boosts BMI by 0.156 points, which amounts to 0.936

points if primary school was completed and 2.028 points if secondary school was completed. With education, women are able to increase their caring capacity, thus substantially improve their health. Education also influences the type of work of an individual. It is possible that with education, women are less likely to participate in physical work. Many women in Niger are uneducated and live in rural areas where farming, the main activity, requires long and demanding hours. Therefore, the education variable may be capturing also the effect of reduced energy expenditure.

The regression results show that being in a polygynous union negatively affects a woman's nutritional status, reducing BMI by 0.249 points. Also, ethnicity has a significant effect on women's nutritional status. For some reason, a woman's BMI significantly falls off if she belongs to the Peulh rather than the Haoussa ethnic group (-0.618). Conversely, the effect of a Djerma or "other minority" ethnic background on a woman's BMI is significantly larger than the effect of a Haoussa ethnic background, by 0.965 and 1.295, respectively. Contrary to Smith et al.'s (2002) findings for Sub-Saharan Africa as whole, a woman's relative decision making power is not significantly associated to her nutritional status in Niger. Partner's schooling does not affect a woman's nutritional status. However, a one-year increase in her partner's age modestly and significantly raises her BMI by 0.017.

With respect to household characteristics, the presence of a relatively large number of males between 0 and 15 years old in the household has a small positive effect on women's nutritional status. The results also show that household health environment variables are important determinants of women's nutritional status. While the quality of

drinking water available does not manifestly affect BMI, the presence of pit a latrine increases BMI by 0.591 points. In addition, BMI increases significantly with the use of a flush latrine over no latrine. This increase is almost three times greater than the effect of use of a pit latrine (+1.493). Infections contracted under high unsanitary conditions adversely affect women's nutritional status. Economic status contributes to improvements in women's nutritional status. A move from the "poor" group to the "middle" group significantly improves women's nutritional status, by 0.185 points. As for women who live in "rich" households, their BMI increases by 0.622 over women from "poor" households.

The cluster dummy variables as a group are significant at the 1% level (statistics available at the bottom of Table 7.3). The R^2 in this regression is relatively small but still comparable to those found in other studies of woman's health.

Initially, it was determined in chapter 6 that two key socioeconomic variables significantly changed over the study period in Niger. Poverty substantially increased and household health environments such as the quality of drinking water and sanitation deteriorated. Lastly, regression analysis uncovered in this chapter that household economic status and sanitary conditions are important underlying determinants of women's BMI in Niger. When concurrently analyzed, these results explain the decline in women's nutritional status over 1992-1998. With poverty spreading out, women's access to food and medical care during illness, for example, decreased. Their exposure to infections and diseases increased as well because relatively more households lacked adequate sanitation.

7.2 Summary

Women's nutritional status significantly decreased over 1992-1998. Given the strong relationship between women's nutritional status and children's nutritional status, we can deduce that this decline contributed to the deterioration of child nutritional status over the period. As discussed in chapter 3, children of malnourished women are likely to start life with low birth weight and to fall victims of protein-energy malnutrition, iodine deficiency, vitamin A and iron deficiency anemia disorders among others.

The results also confirm a strong relationship between a woman's nutritional status and various socioeconomic factors such as women's education, health environments and income. A woman's level of education significantly influences her nutritional status. In addition, environmental sanitation makes a considerable difference in a woman's BMI. There is evidence that low household income in Niger prevents poorer households from meeting the food and/or health care needs of all their members. The results support as well a relationship between certain cultural and social factors in Niger and women's nutrition. Polygyny is found to have a negative and significant influence on a woman's BMI. Similar to results on child nutritional status, the ethnic group a woman belongs to makes a substantial difference to her nutritional status.

Finally, it can be deduced from the results that the deterioration of women's nutritional status over the study period was mainly due to worsening household economic status and household sanitation.

Table 7.1 Independent variables: weighted means and standard deviations (Sd) by year
Woman's nutritional status model

Variable	Year = 1992 Mean	Sd	Year = 1998 Mean	Sd
Characteristics of woman and partner				
Woman's age	27.60	6.95	27.71	7.43
Index of women's relative decision making power	36.19	12.05	39.03	11.68
Woman's education in years	0.42	1.63	0.63	2.00
Monogamous union	0.655	0.475	0.641	0.475
Polygynous union	0.345	0.480	0.359	0.480
Haoussa	0.568	0.495	0.630	0.483
Djerma	0.230	0.421	0.184	0.387
Kanouri	0.045	0.207	0.042	0.200
Touareg	0.101	0.302	0.079	0.269
Peulh	0.035	0.184	0.049	0.215
Other	0.021	0.143	0.017	0.129
Partner's age	39.26	10.25	38.51	10.13
Partner's education in years	0.48	1.99	0.83	2.53
Household characteristics				
Household size	8.64	4.86	7.99	4.73
Percent females 0-15	25.37	15.15	26.07	15.63
Percent females 15-55	22.83	7.74	23.94	8.18
Percent females 55+	2.04	4.67	1.83	5.30
Percent males 0-15	27.97	15.71	27.80	15.90
Percent males 15-55	19.73	9.31	18.33	9.89
Percent males 55 +	2.06	4.68	2.02	4.72
Surface water used	0.034	0.181	0.024	0.154
Well water used	0.774	0.418	0.774	0.418
Piped water used	0.192	0.394	0.202	0.401
No latrine used	0.838	0.369	0.832	0.374
Pit latrine used	0.154	0.361	0.161	0.367
Flush latrine used	0.008	0.089	0.007	0.085
Rural location	0.847	0.360	0.857	0.350
Urban location	0.153	0.360	0.143	0.350
"Poor" economic status	0.434	0.496	0.505	0.500
"Middle" economic status	0.453	0.498	0.387	0.487
"Rich" economic status	0.113	0.317	0.108	0.310
Number of women	1,839		2,651	

Table 7.2 Woman's nutritional status by year

	Mean BMI	Standard deviation	Percent Underweight	Valid cases
1992	20.805	2.87	17.37	1,839
1998	20.636	2.82	19.74	2,651
Change	-0.169 ***		2.37 ***	

*** Significant at the .01 level.

Table 7.3 Determinants of mother's nutritional status: regression results

Variable	Coefficient	*t* - statistic
Characteristics of woman and partner		
Woman's age	0.146 ***	2.77
Woman's age squared	-0.002 *	-1.82
Index of women's relative decision making power	0.002	0.34
Woman's education in years	0.156 ***	4.68
Polygynous union	-0.249 **	-2.15
Djerma	0.965 ***	3.38
Kanouri	-0.500	-1.42
Touareg	-0.037	-0.18
Peulh	-0.618 **	-2.06
Other	1.295 ***	2.88
Partner's age	0.017 *	1.93
Partner's education in years	0.006	0.22
Household characteristics		
Household size	0.015	1.25
Percent females 15-55	-0.002	-0.29
Percent females 55+	0.001	0.07
Percent males 0-15	0.007 **	2.34
Percent males 15-55	-0.006	-1.07
Percent males 55 +	-0.017	-1.46
Well water used	0.227	0.48
Piped water used	0.471	0.93
Pit latrine used	0.591 ***	2.73
Flush latrine used	1.493 **	2.00
"Middle" economic status	0.185 **	1.99
"Rich" economic status	0.807 ***	3.75

Number of observations	4,490
R-squared	0.376

	Fstat	P-value
Joint significance of cluster dummies	1.80	0.000
Breuch-Pagan heteroskedasticity test	842.99	0.000
RESET omitted variables test	44.08	0.000

Notes: The t-statistics are based on White-corrected standard errors and are robust to intra-cluster correlation.

* Significant at the 10% level. ** Significant at the 5% level. *** Significant at the 1% level.

CHAPTER 8

SUMMARY AND CONCLUSIONS

8.1 Main Findings

This study has shown that malnutrition as measured by deficient weight-for-age, height-for-age and weight-for-height, indeed increased significantly in Niger between 1992 and 1998. It has also revealed that acute malnutrition increased the most over the period.

Regional differences were distinguished as well. In Dosso the percent of children suffering from all forms of malnutrition grew at an alarming and higher than national average rate. There, the proportion of stunted, wasted and underweight children increased the most. Stunting rose considerably in Maradi as well, whereas wasting among children grew notably in the pooled regions of Tahoua/Agadez and Zinder/Diffa. It is regrettable that it was not possible to evaluate separately the change in nutritional status for these four regions.

The study found that children of educated women were the worst hit by the increase of chronic malnutrition. In contrast, acute malnutrition increased only among children of uneducated women. Likewise, the rate of chronic malnutrition increased the most among children living in "rich" households and acute malnutrition rose only among children living in "poor" households. While malnutrition remains more prevalent in rural Niger, chronic malnutrition rose at a higher rate in urban communities while acute malnutrition was found to have increased the fastest in rural areas. Thus, malnutrition

increased the most among children living in "rich", urban households and whose mothers are educated, while acute malnutrition increased the most among children living in poor rural households with uneducated mothers.

The regression analysis uncovered that the underlying determinants of the nutritional status of children under three in Niger beyond the child's age and sex are maternal and paternal education, women's status, household health environments, economic status and area of residence.

The subsequent analysis uncovered that poverty considerably increased among the population of Niger between 1992 and 1998. At least three major conditions can be linked to the proliferation of poverty: (1) the 1997 drought that severely damaged a highly agricultural economy, (2) the significant cuts in social programs such as education and health as policy responses to the 1994 structural adjustment, and (3) the sustained political crisis that plagued the country in the 1990's.

Household health environments, as measured by the quality of water supply and sanitation, worsened between 1992 and 1998, most likely exacerbated by the accelerated population growth in the country. This deterioration occurred at the same time that the quality of household health environments became more crucial to children health, perhaps because government health services were deteriorating.

While most caring practices improved over 1992-1998, the levels of two determinants substantially declined. On one hand, a higher proportion of women obtained prenatal care and delivered their children in a medical facility. Also, relatively more children were initiated to breastfeeding within one day of birth, and were

exclusively breast-fed in the first four months of their life. Health seeking behaviors for children improved as well over the study period as a higher percentage of children were taken to a medical facility when suffering from diarrhea and a higher percent of diarrhea cases were treated. On the other hand, a lower percentage of children were given timely complementary feeding. Additionally, a larger percentage of children received substitute care of inferior quality.

The results confirm that women's nutritional status significantly declined over the six-year period, which likely affected child nutritional status. The results also showed a strong relationship between a woman's nutritional status and various socioeconomic factors such as women's education, health environments and economic status. Essentially, the deterioration of women's nutritional status over the study period was mainly due to worsening household economic status and household sanitation.

In sum, the rise in malnutrition between 1992 and 1998 occurred with the significant changes of two central socioeconomic variables. Along with poverty, the inability to access economic resources escalated, which translated into more food deprived children and more parents unable to tend to their children supplementary basic needs including securing competent substitute caretakers. The previously terrible conditions of household health environments captured by quality of water supply and sanitation, slightly but significantly worsened. When combined with the suddenly *large* and *significant* effect these conditions have on acute child malnutrition in 1998, even the minor deterioration of health environment quality over the period can be detrimental to

child nutritional status. Other explanations for the higher levels of malnutrition in Niger include "de-urbanization", and growing maternal malnutrition, which hinders mothers' ability to effectively carry, deliver and care for their children, thus increases child malnutrition.

8.2 Policy Implications

Public policy can take many actions toward improving child nutritional status in Niger. However, political stability must be achieved at the basic level beforehand. Without political stability, governments have, for example, a harder time developing and implementing sound and sustained economic and social policies. The results of this study demonstrate that policies that aim to improve household economic status and health environments, complementary feeding practices and the quality of substitute child caretakers while mothers are working, as well as women's nutritional status could help to reverse the deterioration of child nutritional status in Niger.

Alleviate poverty. Poverty is endemic in Niger, affecting over 63% of the population. Most of the poor live in rural areas. Action to eradicate poverty must be taken because it is one of the most influential underlying determinants of women's nutritional status, which is linked to child nutritional status. Poverty is also a key determinant of older children's (2-3 year olds) nutritional status. In the short-term, targeted income transfers to the poorest section of the population will provide some immediate relief and create safety net. Off-farm income generating activities must be

promoted, especially in rural areas, in order to reduce the pressure of agricultural activity on the already nutrient depleted soils. This can be achieved by facilitating access to capital at the village, association and individual level without gender and ethnic discrimination. Also, employment opportunities and earnings can be increased, for example, through investment in education and skills training. A revitalization of Niger's educational system would help increase households' income. It is critical that the government seeks to support the creation of new jobs for educated citizens, new school-graduates and skilled workers. Therefore, the strengthening of the country's institutional capacity and the creation of an enabling environment for faster economic growth and development is essential.

Access to adequate water and sanitation facilities. The government of Niger should also invest in social amenities, increasing the proportion of people with access to potable water and sanitary latrines. With its support, sanitary latrines can be built each year for households, neighborhoods and markets. Hygiene education also could be implemented at the village level by having workers spread information about the importance of safe hygiene practices through artistic mediums such as plays, storytelling and posters.

Care for children. Special attention must be directed to infant feeding. In the short run, targeted supplementary feeding needs to be offered to all infants born with growth deficiency so that they can catch up sooner with their healthier counterparts.

Niger needs supplementary feeding programs particularly focusing on children 6-24 months in conjunction with free programs with health care centers. The benefits of breast-feeding, complementary feeding and supplemental feeding can also be communicated to mothers through peer counseling. In the long run, major efforts need to be invested for an increase of the proportion of educated women and women's status. For example, the value of girls' education can be stressed to families and communities by consistently organizing social mobilization and gender awareness activities. The introduction of non-formal education centers could fulfill the basic educational needs, such as literacy, to some out-of-school girls and older women. Financial assistance in the form of credit should be directed to poor women in order to encourage income-generating activities.

The study found that women's decision making power relative to men's has a non-linear effect on child nutritional status. The effect is initially negative but becomes positive after a particular status index level (upper 40's) is reached. This result can be linked to Smith et al. (2002) findings that cutback in the duration of breast-feeding (essentially due to women's preference) increases with women's status in Sub-Saharan Africa. For that reason, it is critical that efforts to increase women's status in Niger are joined by coordinated efforts that reinforce the benefits of breast-feeding and help eliminate negative connotations. Such campaigns must be directed across the country through the media and special lectures in school. Also, the government can exercise its right to oppose aggressive advertising of infant formulas by implementing the

WHO/UNICEF International Code of Marketing of Breastmilk Substitute[20] in its "entirety" as a "minimum requirement" to protect infant health.

Programs that allow women who work to have access to alternative caretakers must be implemented as well to assist parents. For example, the government can create employment by subsidizing some women to provide childcare while mothers are working away from their homes.

Care for mothers. Programs to improve the nutritional status of children in developing countries have to give much priority to women because improving women's nutritional status enhances child nutritional status. In the short run, a nutrient intake (Iodine, Vitamin D...etc.) program targeting pregnant women countrywide can help reduce low birth weight. To be successful in the long run, prenatal intervention programs need to be focused on both nutrient deficiency prevention and treatment.

This study has shown that the deterioration in economic status, health environments, infant complementary feeding, the quality of substitute child care, and women's nutritional status led to a substantial decline of child nutritional status in Niger over the 1990's. Reversing the decline requires attention to improvements in all of these areas. There are significant benefits to increasing the nutritional status of the next generation of producers, educators and leaders of this country. Not only will doing so

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[20] The WHO/UNICEF International Code of Marketing of Breastmilk Substitute was initially adopted by a Resolution of the World Health Assembly in 1981. The International Code bans all promotion of bottle feeding and specifies requirements for labeling and information on infant feeding.

enhance development prospects, but it is also a first step to granting million of children their basic human rights.

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