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THE EFFECT OF THE MOTHER'S CHOICE AND TIMING OF COMPLEMENTARY FOODS ON THE GROWTH OF CHILDREN IN GABANE, BOTSWANA

By

Maria S. Nnyepi

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ABSTRACT

THE EFFECT OF THE MOTHERS CHOICE AND TIMING OF COMPLEMENTARY FOODS ON THE GROWTH OF CHILDREN IN GABANE, BOTSWANA.

By

Maria S. Nnyepi

The choice and timing of complementary foods are pivotal to the sustained growth of a breastfeeding child. In developing countries, 3-36 months old children are at risk of malnutrition due to unfavorable environments that surround complementary feeding. Efforts to address malnutrition require an understanding of the relationship between the mother's feeding practices, the household's demographic characteristics and the child's growth. This study investigates the effect of the mother's choice and timing of complementary foods on the child's growth parameters. Using an interview schedule data on the child's diet, anthropometrics, feeding practices and demographic factors were collected from respondents and clinic records. Respondents were mothers, aunts or grandparents accompanying the child to the clinic. Complementary diets in Gabane are predominately sorghum-based and do not meet requirements for adequate growth. Both the choice and the timing of complementary foods were associated with the child's growth. Sorghum-use was associated with low weight-for-age and weight-for-height z-scores. Children in households with more than two children and/or resident were at greater risk for malnutrition.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Nutritional Needs of Children and Breastfeeding

Nutrition is integral to optimum child growth especially between birth and five years. Between birth and six months, for example, the caloric needs of a child are estimated at 108 Kcal/kg body weight (National Academy of Sciences, 1989). When the child is exclusively breastfed, these very high nutritional needs are often easy to meet, even in poor households. Breastfeeding has been shown to meet the nutritional, health and developmental needs of infants and young children.

In the first 6 months of life, breastfeeding meets the three determinants of child growth and development defined in the United Nation's Children' Fund (UNICEF) conceptual frame work of nutrition as Care, Food Security and Health (UNICEF, 1996; Butte et al., 1992; Cohen et al., 1995).

Additionally, during the first 4 to 6 months of life, the exclusively breastfed child's access to breast milk is not adversely influenced by factors that normally influence household food distribution. Consequently, socio-economic factors such as the size of the family, head of family, household income level, quality of family housing, and mother's education level have minimal influence on the exclusively breast fed child's growth and development during this period (Harrison et al., 1993; Millard, 1994; Zumrawi, 1991). Therefore, the

exclusively breast-fed infant tends to be relatively more food secure and healthy during this period than other members of the household.

Problems Associated with Complementary Feeding

Beyond 4-6 months however, when breastfeeding alone cannot adequately meet the nutritional needs of the child, nutritionally dense and hygienic complementary foods are essential for continued growth and development. Even though the caloric needs of the child drop from 108 Kcal/kg to 98Kcal/kg body weight after 6 months, these needs are often difficult to meet in developing countries as a result of unfavorable circumstantial child rearing environments, health and socioeconomic factors (Harrison et al., 1993; Howard, 1994; Walia et al., 1985). When complementary foods are inadequate and unhygienic, as is often the case in poor families in developing countries, growth faltering and increased incidences of diarrhea and other gastrointestinal infections become prevalent. All these can precipitate malnutrition and become the major components of the vicious cycle of malnutrition and infection.

Comparative studies on child growth in poor communities (Peru) and affluent communities (US) found similar growth patterns in children under 12 months between the two populations as long as both groups of children were exclusively breastfed (Dewey et al., 1992). However, when complementary foods were introduced, children in poor communities in developing countries fared worse than those in affluent communities (Dewey et al., 1992). Analysis

of the diet in this comparative study indicated that children from poor communities had lower calorie and protein complementary foods and higher incidences of gastrointestinal infections. This finding, corroborated by others, suggests that the low nutritive quality of complementary foods, among other things, in developing countries significantly contributes to growth faltering in children of weaning age (Harrison et al., 1993; Simango, 1997; Simondon and Simondon, 1995; Zumrawi, 1991).

The child's age at the onset of complementary food can differ greatly. The most common reasons mothers give for introducing complementary foods are: perceived insufficient breastmilk, slow weight gain, child's reaching a suitable age and pregnancy (Cosminsky et al., 1993; Harrison et al., 1993; Al-Mazrou et al., 1994; Ubomba-Jaswa and Belbase, 1996). In some studies the introduction of complementary foods was most likely when the mother perceived the child as being too small or not getting enough breast milk regardless of the child's age (Simondon and Simondon, 1995; 1997). However, introduction of complementary foods earlier than the 4-6 months World Health Organization (WHO) recommendation is detrimental to child growth. Early introduction of complementary foods may increase the risk of gastrointestinal and other infections or promote the replacement of breast milk with less nutrient dense complementary foods (Cohen et al., 1985; 1995; Al-Mazrou et al., 1994; Zumrawi, 1991). More recently, the introduction of complementary food earlier

than 4-6 months was found to have no added growth benefit even in children born small for their gestation age (Dewey et al., 1999).

Similarly, as the timing of complementary food differs, so does the onset of growth faltering. In some studies growth faltering was observed in children from 2 to 3 months through 6 months, while in others, growth faltering was not observed until at least 9 months (Butte et al., 1992; Cohen et al., 1995; Cosminsky et al., 1993; Dewey etal.,1992; Simondon and Simondon, 1995, 1997; Zumrawi, 1991). In several of these studies, growth faltering was found associated with the timing of complementary foods. However, the complexity of weaning environments in developing countries or study limitations often make the temporal delineation of growth faltering and the onset of complementary foods difficult to define. In some studies, for example, growth faltering was observed following the introduction of complementary foods (Dewey 1992), while in other studies mothers reported introducing complementary foods in response to the child's slowed growth (Claufeild et al., 1995).

Besides the nutritional and hygienic quality of weaning diets and the timing of complementary foods, several correlates of malnutrition in developing countries have also been identified. Factors such as the mother's beliefs related to child feeding, household socio-economic factors, intra-household food allocation rules, urbanicity, and mother's education level are strongly related to malnutrition (Armstrong, 1995; Barret and Browne, 1996;

Doan and Bisharat, 1990; Harrison et al., 1993; Millard, 1994; Rahmanifar et al., 1996; Zumrawi, 1991). In attempting to investigate the role of complementary diets on child growth, these factors will be controlled.

Nutritional Status of the Under-five's in Botswana

Recent reports show that although 95 % of mothers in Botswana initiate breast-feeding, and a large number of them continue breastfeeding for an average of 14.9 months, child health parameters in Botswana are still below desired levels (Aplogan et al, 1996; Ubomba-Jaswa and Belbase, 1996). Diseases known to be minimal in exclusively breast fed children, such as pneumonia, intestinal infections and other acute upper respiratory infections are among the leading causes of childhood mortality and morbidity in Botswana (Central Statistics Office, 1995; Feachem and Koblinsky, 1994). In addition, malnutrition remains high in Botswana with 27.6%, 16.9% and 6.6% of children under five years stunted, underweight, and wasted respectively (Ubomba-Jaswa and Belbase, 1996). Ubomba-Jaswa and Belbase (1996) also found a significant decline in all growth parameters (height- for-age, weight-for- age and weight-for-height) from 9 months of age to 6 years across sexes. The worst levels of these parameters coincided with the 6 months to 3-year growth window. In addition, chronic malnutrition (stunting) appeared to be more severe (range of 20.5% -37%) than acute malnutrition or wasting (4.4-8.4%). All these forms of malnutrition also coincided with the cessation of breastfeeding by most

mothers. Given that this period of low nutritional status starts two months after the introduction of complementary food by most mothers, it is possible that the timing of complementary foods is also associated with the decline in nutritional parameters.

Complementary Feeding in Botswana

Complementary feeding in Botswana is started early, with 11.5% of infants on complementary foods by 3 months and nearly 80% by four months (Ubomba-Jaswa and Belbase, 1996). Only about 22% of infants are exclusively breast fed from birth to about 4 months (Omondi et al., 1990). In congruence with the cultural belief that infants thirst, but contrary to the WHO/UNICEF Baby and Mother Friendly Hospital Initiative (BMFHI) adopted by the Botswana Government, a large number of infants are given water shortly after birth (Aplogan et al., 1996). Other milks and sorghum porridges are also introduced before 4- 6 months old. This high prevalence of introduction of complementary foods by 4 months might be closely associated with the free provision of tsabana (a sorghum/soy bean porridge mix) to children from 4 to 36 months through the Botswana Supplementary Feeding Program.

According to Ubomba-Jaswa and Belbase (1996) water, juices[1], porridges, cow's milk, and infant formula are the main complementary foods given to infants. On average 47%, 33%, and 10% of mothers complemented their infant's

1 Locally the word juice may also be used to include dairy-juice mixes.

diets with porridge, commercial infant formula, cow/goat milk respectively. Women with no formal education tended to use porridge (60%) more than infant formula (26%). Among educated women, 46% of mothers used porridges and 33% used infant formula.

The mother's choice of complementary food also varies by geographical location in Botswana. Infant formula use was more common in small towns (55%), big villages (35%) and big towns (44%) compared to small villages (11%) and settlements (24%). The use of porridge was higher in small villages (53%) and settlements (72%) compared to small towns (26%), big towns (35%), and big villages (39%) (Ubomba-Jaswa and Belbase, 1996).

Problem Statement

Recent studies (Aplogan et al., 1995; Lesetedi et al., 1988; Ubomba-Jaswa and Belbase, 1996) have provided general and descriptive background information on child health in Botswana. Although such information is valuable, in that it provides the bases for research, it lacks the specificity required for planning effective nutrition intervention for children under five years old. The high prevalence of malnutrition in children of ages 6-36 months, despite the presence of the Supplementary Feeding Programs, may in part be a reflection of the inadequate information on the nutritional needs available for this age group.

Since no dietary quantitative assessment was done in any of these studies,

we are unable to fully characterize complementary diets in Botswana or describe their association (if any) with child growth or nutritional status. Additionally, the relationship between household demographic profiles, prevalence of porridge use for complementary feeding, and the nutritional quality of porridges is still not well understood. In Botswana, cereal-based meals are collectively known as porridges. However, the consistency and constituents of these porridges may differ greatly by households and regions in the country. Hence the observation that 46% versus 60% formally educated or non-formally educated mothers in Botswana respectively, use porridge in complementary feeding as reported by Ubomba-Jaswa and Belbase (1996) is not very revealing. It is likely that socio-economically more advantaged households prepare nutritionally dense porridges more than poorer households who lack the financial means required to procure adequate quantities of meat, milk, butter/margarine or mayonnaise on a regular basis.

Justification of the Study

An in-depth, understanding of complementary diets especially porridge use in Botswana is essential for several reasons. 1) Porridges are culturally accepted as weaning foods and are relatively inexpensive. 2) They are versatile and their nutritive value can be enhanced by adding fats and oils (margarine, mayonnaise, cooking oil), rich sources of proteins (milk, sour milk, peanuts

(ground or butter), or served with meat or beans. 3) Other ways of improving the nutritional quality of porridges include replacing cooking water with melons and /or use of fermented or malted flours. Nutritionally enhanced porridges therefore have the potential to improve the diet quality of complementary foods and thus help reduce child malnutrition in Botswana.

The village of Gabane was chosen as the study site for several reasons. Gabane's proximity (15 km) to the Capital City of Botswana (Gaborone), makes it susceptible to changes that take place in the cities. Therefore, some villagers have similar characteristics to people living in the city. Consequently, Gabane people are a mixture of people with village-like and urban-like life styles. Additionally people originating from other regions of the country, with jobs in Gaborone have settled in Gabane to avoid the high housing rental costs in the city. Thus, Gabane embodies a variety of subcultures found in the country and this was considered an advantage in this study. Gabane Clinic, like other clinics in Botswana, provides both preventive and curative services.

Information generated by this study, such as the characterization of mothers who use porridge consistently in complementary feeding, might help the Supplementary Feeding Program target households with the most need for these resources. Such households are those with children below the cut off point for malnutrition. Such a move would also improve the efficacy of the program by providing food to households with a higher likelihood of using the food as recommended. Additionally, the characterization of food items that

study households serve with their porridges may assist the program in increasing the variety of supplementary food as well as provide more culturally acceptable foods. It is also conceivable that the savings brought about by improved targeting might help the program increase their rations from the current 30% of the child's nutritional needs per month to a slightly higher proportion.

Nutrition programs with education and communication prerogatives in the country, particularly the Supplementary Feeding Program and the Breast Feeding Program, will also benefit from the study findings because they may flag areas where program evaluation or target-specific nutrition education messages are needed. More specifically, the Supplementary Feeding Program, which provides mothers with cooking oil in addition to tsabana (sorghum-soy bean meal), would benefit from the study findings by ascertaining whether mothers use tsabana for children or add cooking oil to tsabana porridge as recommended. This information has not been available, although health workers have suspected that the cooking oil might be used for other purposes, such as in preparing relishes for the whole family.

Objectives

The overall objective of this proposed study therefore, is to build on the recent studies on child nutrition in Botswana, by studying the influence of the mother's choice and timing of complementary food on the growth of children

between 3 months and 3 years in Gabane. The specific objectives of this study are to:

1. Characterize complementary diets for children between 3 months and 3 years in Gabane, Botswana
2. Evaluate growth indicators (weight for age, height for age, and weight for height) for children in Gabane, Botswana
3. Characterize households with children at risk for malnutrition as determined by low height-for-age, weight-for-age and weight-for-height Z-scores.
4. Describe the relationship between the mother's choice and timing of complementary foods, household, and child demographic characteristics and child's anthropometrics.
5. Identify predictors for children with inadequate growth.

Conceptual Framework

In studying the effects of the choice of complementary feeding in children of ages 3-36 months, this study will help expand our understating in the first two levels of UNICEF's conceptual framework (Figure 1. 1) on the determinants of child survival and development (UNICEF, 1996). In this framework, the causes of malnutrition are classified as immediate, underlying, or basic causes. The immediate causes, which include inadequate dietary intake and diseases,

directly influence nutritional status. At this level, the model underscores the importance of "Access to food" and "access to basic health services" in the survival and development of children. The framework describes the underlying determinants of malnutrition as factors that influence "household food security, maternal and child care, health services, and the health environment". These factors have been shown to influence nutritional status by modifying the immediate factors (dietary intake and diseases). Though outside the scope of this study, the framework also defines the basic determinants of malnutrition as global factors that include the economic resources and political system of a given country.

In this study, the choice and timing of complementary foods and the household hygiene level represent the immediate determinants of malnutrition. These are considered appropriate for this level because the lack of nutritionally adequate complementary food choices and unhygienic feeding environments such as lack of proper waste disposal and toilet facilities can ultimately compromise the child's nutritional status. Additionally, the increased rate of infection in household with poorer hygiene level compared to those with adequate hygiene level may also increase the nutritional needs of the child. Thus, the resulting imbalance between the child's nutritional needs and actual dietary intake may precipitate malnutrition.

The underlying determinants of malnutrition are represented by factors that influence the household's food security, childcare and the overall

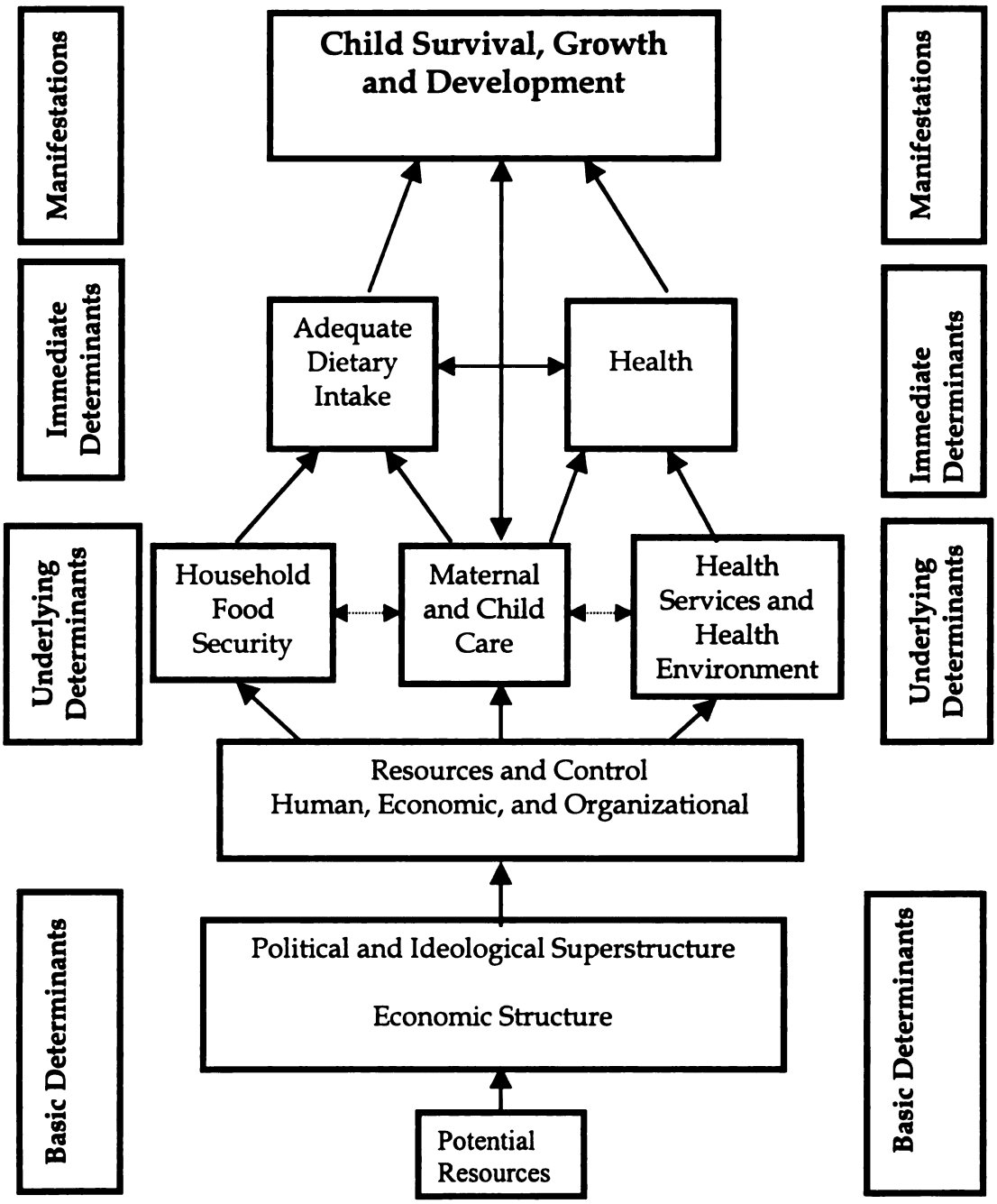

Figure 1 CONCEPTUAL FRAMEWORK OF THE DETERMINANTS OF CHILD GROWTH, SURVIVAL AND DEVELOPMENT. (UNICEF, 1996)

environment within which the child is reared. These are factors such as maternal income, maternal education, household headship, type of primary childcare giver, number of children in the households, presence of residing relatives and the quality of household housing. These factors fall in this classification level because they influence child growth indirectly by modifying the child's dietary intake or illness rate.

In this study, the growth indices, height-for-age, weight-for-age, and weight-for-height are used to assess the effects of the outlined determinants of malnutrition on the child's nutritional status. Malnutrition results when the immediate or the underlying factors promote the decline of the growth indices to levels below two standard deviations of the reference mean. The model refers to these indicators as the "manifestations of child survival, growth and development".

WORKING DEFINITIONS

Terms, variables and concepts used in this study are defined in this section. Several of these definitions were taken from the Food and Agriculture Organization (FAO)/WHO Codex Alimentarius publications (FAO/WHO, 1992).

1. Complementary food: Any food or beverage regardless of nutritive value given to supplement breast milk. In this study, complementary feeding is

synonymous to supplementary feeding.

2. Weaning: A process characterized by the gradual replacement of breast-feeding/infant formula by other foods or beverages. The process ends when the child completely depends on family food to meet his/her hunger and nutritive needs.
3. Infant: A person from birth to not more than 12 months.
4. Young child: A person between 12 months and 36 months.
5. Child feeding practices: The child's caregiver characteristics centered on the preparation of the child's food and feeding. These practices may include the duration of breast feeding/ formula feeding, timing of complementary foods and the cultural beliefs or circumstantial behaviors regarding child feeding.
6. Household: A unit of people living together and sharing the same resources.
7. Moderately wasted: Z score at two standard deviations below the mean weight for height of the CDC/NHCS references.
8. Severely wasted: Z score at three standard deviations below the mean weight for height of the CDC/NHCS references.
9. Moderately Stunted: Z score at two standard deviations below the mean height for age of the CDC/NHCS references.
10. Severely stunted: Z score at three standard deviations below the mean height for age of the CDC/NHCS references.

11. Moderately underweight: Z-scores at two standard deviations below the mean weight-for-age of the CDC/ NCHS references.
12. Severely underweight: Z-scores at three standard deviations below the mean weight for age of the CDC/NHCS references.
13. Growth faltering: A decline of anthropometric measurements, particularly in reference to weight or height.
14. Pula: Local currency in Botswana. Current conversion rates can be obtained from commercial institutions. At the time of the study, one Pula was about 25 cents.
15. UHT milk: Ultra high temperature pasteurized milk.
16. Surrogate parent: Any adult who accompanied the child to the clinic. Surrogate mothers in this study were either the child's aunt or grandmother.

CHAPTER II

LITERATURE REVIEW

Correlates of Child Health in Developing Countries

Child health in general is influenced by global socio-economic and health care systems that surround and influence the household; the unit within which each individual child is reared (Berman et al., 1994; Millard 1994). Since decisions made within the household and the child rearing practices are subject to the environment defined by these global systems, it is assumed that studying the household can reveal the impact of these factors on child health. It is also anticipated that complementary feeding and weaning practices within each household, like other components of child health, will likewise be influenced by these global systems.

In this section, the correlates of child health will be discussed at the household level because; 1) Decisions made within the household affect the child directly. 2) The household may adapt within the constraints of the global systems to make its environment more favorable to child's health as reported by Schumann and Mosley, 1994. 3) The household is the main target for social and health services within each state. In fact, the household is said to be well suited for processing resources from social and health programs to "produce health" for its members (Schumann and Mosley 1994).

The discussion in this section will focus only on those factors that have been strongly associated with child health in developing countries such as: maternal education, maternal employment outside the home, family headship, intra-household food allocation, child's gender and the nutritional and hygienic quality of weaning diets.

Mother's Income and Employment Outside the Home

Within the household, several studies over many countries have shown that the mother's income, and/or employment outside the home correlate well with child health indicators (Bicego and Boerma, 1993; Dargent-Molino et al., 1994; Tekce, 1990; Zumrawi, 1991). In several of these studies, children born to employed mothers were found to fare much better than those whose mothers were not employed. The benefits of maternal employment were greater when the mother had secured a suitable childcare alternative for her child. However, children who were cared for by older siblings or who accompanied their mothers to work, as is often the case among street vendors, fared much worse than those cared for by adult relatives (Lamontagne et al., 1998). In some studies however, maternal income/employment appeared to offer more protection for infants and young children who were already on partial or full complementary foods. In some studies, maternal employment/income did not appear to have a differential impact on child health in the pre-weaning stage presumably because both groups of children had equal access to breast milk

despite their mothers employment status (Lamontagne et al., 1998; Tekce, 1990; Zumrawi, 1991).

Mother's Formal Education Level

Maternal education has also been shown to have positive effects on child health (Barret and Browne, 1996; Doan and Bisharat, 1990; Tekce, 1990). Several studies have shown that maternal education remains a significant determinant of child health even after other socioeconomic status variables like household assets were controlled (Bicego and Boerma, 1993;Ubomba-Jasha, 1996; Lamontagne et al., 1998). It should, however, be noted that some researchers suggest that maternal education alone is not a significant determinant for child survival (Millard, 1990), especially with the understanding that the protective effect of maternal education may, to some extent, be dependent on the prevailing socioeconomic environment (Dargent-Molino et. al., 1994). Dargent-Molino et al., found that the protective effect of maternal education against diarrhea in Cebu (Philippines) was contingent upon the availability of community resources. In this study, maternal education was also more protective in the more socio-economically advantaged communities. This finding is not surprising given that educated mothers were more likely to use community resources (health facilities) than mothers with low or no education. Additionally, mothers with higher education level were shown to have better comprehension and implementation of health education messages (Barret and

Browne, 1996).

Dargent- Molino et al. (1994) also found that the protective effect of education was less significant in the wealthiest families. These researchers attributed this observation to the suggestion that the protective effect of maternal education against diarrhea in wealthy families was comparable to the effects of other socio-economic resources that wealthy families have available to them.

In yet another study on the impact of maternal education on child survival in 17 developing countries, maternal education had a varying impact on child survival depending on the socio-economic status of each individual country (Bicego and Boerma, 1993). In some countries, maternal education was strongly protective while in others the protection was low or non-existent. In a recent work in Malaysia, no association was observed between the mother's education level and decision making regarding intra-household food allocation (Shariff, 1998).

The impact of maternal education on child health in some situations may also be influenced by the mother's position in the household's decision-making structure (Doan and Bisharat, 1990). In highly patriarchal societies where the new (and usually younger) mother resides with her in-laws, maternal education has been shown to have no effect on the well being of the children. In these situations, the daughter-in-law (child's mother) only follows and implements decisions made by her mother-in-law and occasionally, her

husband. Thus, the influence of the mother's education on the child's growth parameters would differ depending on the culture.

Household Hygiene

Household hygiene/sanitation has also been identified as one of the strong correlates of child health (Barret and Browne, 1996; Rahmanifar et al., 1996). Some indicators of sanitation/hygiene whose impact on child health has been explored include: room occupancy ratio, type and use of latrines, source of household water (Zumrawi, 1991), type of housing material (Ubomba-Jaswa and Belbase, 1996), hand washing after using latrines/toilets, and care and storage of cooking and eating utensils (Rahmanifar et al., 1996). Generally, children in more hygienic households had better growth indicators than those in less hygienic households. The more hygienic households were more likely to be built with more permanent housing material, have running water in the household whereas the less hygienic household were built with less durable housing material and had pit latrines.

Intra-Household Food Allocation Rules

Rules and practices regarding intra-household food distribution have also been shown to influence child health indicators. However, the degree to which intra-household food distributions impact child health appears to be highly influenced by cultural/ethnic beliefs regarding the "worth" of one household

member over the other (Engle and Nieves, 1993;). In some communities food allocation is biased in favor of income earners (Engle and Nieves, 1993), while in other communities the member's gender may determine his/her proportion of the household's food. Such biased food distribution tends to discriminate against young children and in some specific situations girls more than boys (Engel and Nieves, 1993; Miller, 1984). In some Asian countries, for example, girls are more disadvantaged than boys. At marriage, girls are culturally required to take their family's wealth to the husband's household and so girls' parents consider them impoverishing. Consequently, girl children may be discriminated against very early in life because they are considered to be less of an investment than are boys (Miller, 1984; Winkvist and Akhtar, 2000). There are however, other communities such as those in Peru and Botswana where food allocation does not appear to be biased based on gender (Graham, 1997 and Ubomba-Jaswa and Belbase, 1996).

Child Feeding Practices

With respect to child feeding practices, breastfeeding and the nutritional and hygienic quality of complementary food have been associated with child health in developing countries (Brutte et al.,1992; Cohen et al., 1995; Dewey, 1992, 1998; Tekce, 1990; Walia et al.,1985). Comparative studies on child growth in poor communities and affluent communities found similar growth patterns between the two populations as long as both groups of children were

exclusively breastfed (Dewey et al., 1992). However as complementary foods were introduced, children in poor communities in developing countries fared worse than those in affluent communities (Dewey et al., 1992). Analysis of the diet in this comparative study indicated that children from poor communities had diets low in calories and protein and higher incidences of gastrointestinal infections. This finding, corroborated by others, suggests that the low nutritive quality of complementary foods, among other things in developing countries significantly contributes to growth faltering in children of weaning age (Harrison et al., 1993; Simango, 1997; Simondon and Simondon, 1995; Zumrawi, 1991).

The correlates of child health in developing countries are many and at times have a synergistic impact. The magnitude of their impact on child health may also vary between communities depending on the culture/ethnic beliefs and the prevailing conditions at the time of the study. Nonetheless, this review provides some general concepts that may be explored further when studying the determinants of child health in developing countries in general, or as in the case in this thesis, the choice of complementary food and/ or weaning practices on child health in Botswana.

CHAPTER III

METHODS

Approval to Conduct the Study

Approval to conduct the study was sought from the University Committee on Research Involving Human Subjects (UCRIHS) and from the Kweneng District Health Team, Molepolole, Botswana. The request letter to Kweneng District Health Team and the UCHRIS approval letter are appended in appendix A. Kweneng District did not send an approval letter. However upon a follow-up telephone call, it became apparent that the District Medical Officer was outside the country on job related trip. Permission was granted over the telephone by Matron Boiteto, who also called Gabane Clinic Sister-in-Charge and notified her. A blank questionnaire was left with the clinic, upon request by the Sister-in-charge of the clinic.

Subjects and Sample Size

Data were collected on a convenience sample of respondents attending the Child Welfare Clinic at Gabane Clinic funded by the government of Botswana. The data collection was started on June 10 and completed on July 10, 1999. Eligible respondents were those with children of ages 3 months to 3 years. Although complementary feeding is recommended for children who are at least 4 months old, a significant number of children in Botswana are complemented

before 4 months. Hence, for this study, data collection also included 3-month-old infants. A sample size of about 30 is considered reasonable for a descriptive survey (Fraenkel and Wallen, 1996). However, data would be collected from a larger sample because it is anticipated that this study will also serve as a pilot project for a Ph.D. dissertation. Additionally, Gabane CWC Register indicates that the clinic provides services to about 700 children under five years of age every month, so a sample size of at least 30 children of ages 3-36 months old children would be possible to obtain.

In this study, a convenience sample was used despite its limitations because it was the most feasible. Child Welfare Clinic attendance in Botswana averages between 60 and 80 percent of children under five years depending on the season. The attendance rate was also expected to be higher for children under- three years because of their intense immunizations schedule, whereas older children have a more spread out immunization schedule. Thus, even with our convenience sample we still would be capturing a large proportion of children between 3 months and three years.

Subject Recruitment

Mothers/surrogate parents of children between 3 months and 3 years were approached individually by the investigator and asked to participate in the study. A consent statement, explaining the purpose of the study, the kind of information requested and known risks and benefits to the child and the

mother were read to all potential respondents in Setswana (local language). Mothers or surrogates willing to participate in the study were asked to sign the consent form. Consenting mothers or surrogate parents with no writing skills were asked to put a mark (X or +) in place of their name or have a close friend or relative sign their name for them. Mothers opting to verbalize their consent were allowed to do so, because insisting that they sign the consent form might have been very embarrassing when the mothers did not have writing skills. In this study, only children seeking preventive services (growth monitoring and/ or immunizations) between June 10th and July 10th, 2000 were included. As illness negatively influences growth, inclusion of ill children could bias the findings.

Interview Schedule

A questionnaire, similar to the one previously used in Botswana (Ubomba-Jaswa and Belbase, 1996) was adapted and used to collect household socio-demographic characteristics and information on the mothers' child feeding preferences and practices. The investigator interviewed consenting parents and surrogate parents. Although it would be cost effective to have parents complete the questionnaires, this option seemed inappropriate given the low literacy levels in Botswana (69%). The interviews were conducted in Setswana-the national language for Botswana, to ensure that respondents who could not communicate in English would not be omitted.

Anthropometrics

The weight and height (length if age < 2 years) of children were measured by the investigator using a Salter Scale[2] and a Harpenden portable stadiometer[3], respectively. The length of children younger than 2 years was taken by mounting the portable stadiometer on a measuring bench previously used in the Ubomba-Jaswa study (1996). The length measurements could have been read from the bench directly, but the portable stadiometer was preferred because it was also used to measure heights children over 2 years. Weight was measured in kilograms and recorded to the nearest 0.1kg (allowed by the instrument). The scale was re-calibrated every morning with a known weight. Children were weighed once and this measurement was used both for the study and the child's record for the month. The height (length for age< 2 years) was measured to the nearest centimeter. Since clinics in Botswana do not have the capacity to measure height/length, the investigator provided the equipment. Since this was the first time the children had their height/length measured, care was taken to ensure that the procedure elicited as little stress as possible.

Review of Records

Information on the child's age, birth weight, Apgar score, and sometimes

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2 Salter Scales. CMS Weighing Equipment Limited. London, England.

3 Harpenden portable stadiometer. Model VF2M. Holtain LTD. England

the mother's age and the child's birth order was taken from the Child Welfare Clinic card (CWC card). Information on the mother's age and the child's birth order were further verified by the respondent. The information contained in the CWC card is generally accurate and reliable because the CWC card is completed by nurses (midwives) at the hospital when the child is born and is given to the mother to keep. Cards are kept by the mothers and are brought to the clinic each time the child visits the hospital/clinic for services. Mothers protect CWC cards because they are required to produce them when the child begins primary school or when the mother completes application forms for the child's birth certificate or passports. Thus, all respondents had their CWC cards.

Dietary Data

The dietary data were collected by a 24-hour recall conducted by the investigator. Local utensils for serving children were made available during the interview to help mothers describe the portions of food served to the child. The capacity of each of the utensils was estimated using a 250-milliliter measuring cup prior to the interview. Furthermore, mothers were asked to use a 250-milliliter teacup as the reference measure when estimating amount of food served to the child. Kilocalories, total protein, animal protein, carbohydrates and fat were estimated from the 24-hour recall using Dietary Manager (1998), a nutritional analysis software program bought from Program

Management, Bromhof, and South Africa.

Research questions, Hypothesis and Variables

Research Questions

1. What are the nutrient compositions and diet qualities of complementary foods in Gabane, Botswana?
2. What is the prevalence of malnutrition in Gabane, Botswana?
3. What are the characteristics of households with malnourished children?
4. What is the relationship between the mother's choice and timing of complementary foods and
   a) mother's education level, b) household size, c) head of household, d) household's income, e) child's birth order, f) child's growth, g) child's father's presence in the home, and h) child's gender?
5. What are the predictors of low weight-for-age, low height-for-age and low weight-for-height in 3-36months old children?

Null Hypotheses

1. The nutrient qualities of complementary diets for children between 3 months and 3 years in Gabane, are not different compared to those required for adequate growth.
2. The prevalence of malnutrition for children of ages 3-36 months in Gabane village is different compared to malnutrition rates in the entire country (Botswana)
3. Households with malnourished children of ages 3-36 months are not

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different from households with well nourished children in these demographic factors:

a) mother's income, b) mother's education level, c) household's income level, d) child's gender, e) child's birth order, f) child's age, g) household size, and h) headship (head of household).

4. There is no relationship between a) the mother's choice and b) the timing of complementary foods and the child's weight for age, height for age, and height for weight Z-scores.

There is no relationship between the nutritional quality of the mother's choice of complementary foods and the child 's weight-for-age, height-for-age and weight-for-height Z-scores in children of ages 3-36 months.

Independent Variables

1. Child's demographic characteristics:

a) age, b) gender, c) birth order, and d) birth weight.

2. Household demographic characteristics:

a) mother's income, b) mother's education level, c) household's income level, d) total number of children, e) number of children under five years, f) presence of father in the home, g) household size, h) headship (head of household), i) type of household housing, and j) type of toilet used.

3. Child feeding practices:

a) duration of breastfeeding, b) duration of exclusive breastfeeding, c) infant formula use, d) store-bought cow milk, e) home-milked goat/cow's milk, f) timing of complementary foods, g) proportion of protein (animal) in the diet, i) caloric content of complementary food, j) types of primary complementary food items, and k) types of food items added to or served with the main complementary food item.

Dependent Variables

Child's growth parameters:

The child's growth indicators used in this study are weight-for- age, height-for age and weight-for-height z-scores. These are based on the Center for Disease Control /National Center for Health Statistics (CDC /NCHS) reference standards.

Statistical Analysis

Three data analysis programs were employed in this study. SPSS 7.5 /PC was the primary statistical analysis program used. The Dietary Manager nutritional analysis program was used to analyze dietary data and Epi. Info. 6.04 was used to calculate Z-scores and analyze anthropometric data. Statistical tests allowing group comparisons were employed in this study. T-

tests for two independent groups, chi square test and ANOVA when more than two group means were compared.

Since associations of weaning diets and child growth indicators are difficult to make because of confounding factors, children were assigned to two groups based on their weight-for- age, height-for-age and weight for height Z-scores. The two groups; adequately nourished (above -2 Z scores of HAZ or WAZ WHZ), and malnourished (-2 Z scores) were compared relevant to their diet and household and child socio-demographic characteristics. This approach highlights the differences between children with adequate and poor growth during weaning and enables us to investigate the differences in weaning diets amongst the groups.

The Pearson Product Moment correlation coefficient was used to assess the relationship between continuous variables such as the relationship between the proportion of kilocalories in diet from porridge, Z- scores, household's income and others. Logistic regression models for predicting Z-scores for the dependent variables were generated for this study. In all statistical tests, a significant level (alpha) was set at 0.05.

CHAPTER IV

RESULTS

SAMPLE CHARACTERISTICS

In this section, the characteristics of the 132 children and the households sampled for this study are presented. The household's and the index child's demographic characteristics, child feeding practices, and anthropometric measurements are described.

Household's Demographic Profiles

Table 4.1 summarizes the sample characteristics. On average, the study households had 2.89 ± 1.9 children born within the household and 2.48 ± 2.33 child-relatives. Sixty-eight (68), 49, and 11 of the 132 households sampled were headed by the child's father, the grandparent and mother respectively. A higher proportion of men (98/109) was employed outside the home compared to women (45/132). Additionally, employed men earned more money than women. Ninety one percent (91%) of employed women had incomes below 699 pula per month compared to 37.2% of men. However, fewer men (43/111) had secondary and tertiary education than women (78/132).

Household housing was predominantly modern, with (101/132) households living in corrugated iron -roofed houses compared to (27/132) with thatch roofing. Over sixty percent (80/132) of the households owned their

houses. The remaining households either stayed in the child's grandparents' (40/132) or rented (10/132) houses. Most households (80/132) had public standpipes as their water source. Forty-seven (47) households had private standpipes within their yard and three households had in-door plumbing. The types of toilet used in this population paralleled the household's source of water. Most households (123/132) had pit latrines compared to flush toilets (3/132)

Child's Demographic Characteristics

The average age for the 132 children sampled in this study was 17.8 ±10.0 months. The youngest child was 3 months and the oldest was 40 months. Fifteen percent (15.2%), 38.6% and 74.3% of children were under 6, under 12, and under 24 months respectively. Fifty-two percent (n=69) of the subjects were males and 48% (n= 63) were females. In this sample, 56.8%, 78.8% and 21.2% of children had birth orders under 2, under 4 and over 4 respectively.

As reflected in Table 4.1, the children were well nourished at birth, with an average birth weight of 3.09 ± .44 kg. Only 7.1% (9) of the children had birth weights below the cut off point for low birth weight (2.5kg). The average (1, 5, and 10 minutes) Apgar score for children in this sample ranged from 8 to 10 with a mean of 9. 2 ± .6.

TABLE 4. 1 SAMPLE CHARACTERISTICS

Household profiles	N	%	Index Child's profile	N	%
Headship			Sex		
Father	68	51.5	Male	69	52.3
Grandparent	49	37.1	Female	63	47.7
Mother	11	8.3			
Other	4	3.0			
Mother's education level			Child's birth order		
None	21	15.9	1 and 2	75	56.8
Primary	33	25	3 and4	29	22.0
Secondary	76	57.6	over 4	28	21.2
Tertiary	2	1.5			
Maternal employment			Child's birth weight		
Yes	45	34.1	≤ 2.5kg	9	7.1
No	85	64.4	2.5- 3.25kg	75	59.5
In School	2	1.5	Over 3.25 kg	42	33.3
Maternal age(yrs)			Average Apgar Score		
15-19	8	6.2			
20-29	61	46.9	Less than 9	27	20.5
30-40	51	39.2	Greater than 9	47	35.6
41- 50	7	5.4	Unknown	58	43.9
51-59	3	2.3			
Father's employment			Child's breastfeeding status		
Yes	98	74.2	Yes	65	49.2
No	9	6.8	No	67	50.7
School	2	1.5	Ever breastfed	63	47.7
Unknown	23	17.4	Never breastfed	4	3.0

Table 4.1 (Cont'd).

Father's education level			Duration of breastfeeding		
None	41	31.1	≤ 6 months	15	23.1
Primary	27	20.5	7-12 months	15	23.1
Secondary	40	30.3	13-18 months	22	33.8
Tertiary	3	2.3	19-24 months	12	18.5
Unknown	21	15.9	Over 24 months)	1	1.5
Number of Child relatives			Intended duration of breastfeeding		
1-3	42	59.2	≤ 6 months	0	0
4-6	20	28.2	7-12 months	14	21.5
7-8	9	12.7	13-24 months	44	67.7
			over 24 months	7	10.8
Home ownership			Primary complementary food		
Parent	80	60.6	Fermented sorghum	91	68.9
Grandparent	40	30.3	Unfermented sorghum	12	9.1
Rented	10	7.6	Commercial baby foods	11	8.3
Other	2	1.6	Other	13	9.8
			None	5	3.8
Main house roofing			Primary food served with		
			Milk	51	41.5
Corrugated iron	101	76.5	Milk and sugar	31	25.2
Thatch	27	20.5	Bean/vegetable soup	12	9.8
Tile	4	3.0	Variety of foods	17	13.8
			Nothing	12	9.8

Table 4.1 (Cont'd).

Main house lighting			Complementary foods or fluids before 6 months (0-5 months)		
Paraffin lantern	125	94.7	Water (129)[4]	122	94.6
Candle stick	3	2.3	Infant formula (64)	57	89.1
Electric lamp	4	4.0	Mashed food (126)	111	84.1
			Cows/goat's milk (32)	14	43.8
			UHT milk(29)	29	36.7
			Tea (70)	10	14.3
Household's source of water			Protein adequacy ratio[5]		
Public stand pipe	80	60.6	Less than 66%	25	51
Stand pipe in the yard	47	35.6	Greater than 67%	24	49
Indoor plumbing	3	2.3			
Other	2	1.5			
Maternal Income (Pula)			Calorie adequacy ratio[6]		
Under 400	20	15.2			
Over 400	22	16.7	Less than 66	2	4.1
Unemployed	90	68.2	Greater than 67%	47	95.9
Type of toilet			Primary person who feeds the child		
Pit latrine	123	93.2			
Flush toilet	3	2.3	Mother	80	60.6
None	6	4.5	Grandmother	32	24.2
			Other relative	10	7.6
			Other	10	7.6

[4] The number in parenthesis indicates the total number of children introduced to the indicated food/fluid. It includes children introduced to the indicated food at ages outside the (0-5) months age bracket.

[5] This is the proportion of protein provided by the child's diet. This ratio is calculated using the Dietary Manager. It is based on the 1989 age and sex specific RDA.

[6] The proportion of calories provided by the child's diet. It was calculated by the Dietary Manager.

Child Feeding Practices

Breastfeeding was very common in this population. Sixty-five (65) mothers were breastfeeding at the time of the study. Sixty-three (63) of 67 mothers who were not breastfeeding at the time of the study reported they had breastfed their children an average of 13.4 months in the past. Mothers who were still breastfeeding during the study intended to breastfeed their children for an average of 20 months. However, exclusive breastfeeding from birth to 6 months was rare. A high proportion of infants was given water (94.6%), infant formula (89.1%), ultra high temperature pasteurized milk (36.7%) and/or mashed food (88.1) before 6 months of age.

Children were generally fed by their mothers (80/132), grandparents (32/132) or other adult relatives (10/132). Of the 127 children who were already on mashed or regular food at the time of the study, 71.6% (n=91) and 9.4% (n=12) were predominately fed fermented sorghum porridge and unfermented sorghum (or maize meal porridge) respectively. Besides sorghum/maize porridges, a few children were predominately fed commercially prepared baby food (11/127) while others (13/127) had no predominant complementary food. The child's primary food was served with either milk (51/123), milk and sugar (31/123), vegetable/ bean soup (12/123) or a combination of varied food (17/123). Twelve (12) children were served their primary food only.

Based on the analysis of the 24-hour dietary intakes, complementary diets

in Gabane had lower calorie content compared to protein relative to the 1989 age and sex specific United State Recommended Dietary allowances (RDA). Nearly fifty percent (49%), and 51 of diets had protein adequacy ratio of below 66% and above 67% respectively. With respect to calories, 89.8 and 10.2% diets had calorie adequacy ratio of below 66% and above 67% respectively. These nutrient adequacy ratios were based on the 1989 United States Recommended Dietary Allowance (RDA). The mean nutrient adequacy ratios for protein and calories in this study were 82% and 35.1% respectively.

Child Anthropometric Measurements

The prevalence of stunting, underweight and wasting defined as -2 standard deviations of height-for-age, weight-for-age or weight-for-height in this sample was 9.1%, 12.1%, 5.3% respectively. The prevalence of wasting, stunting and underweight was comparable across the sexes. In both sexes, no children under 6 months were stunted, wasted or underweight. Furthermore, only one child was both stunted and wasted. Although the prevalence of low height-for-age, weight-for-age and weight-for-height appears to be more common in males than in girls, the difference is not statistically significant. Tables 4.2 and 4.3 and Figure 4.1 provide summaries of the nutritional status of children in this population.

TABLE 4. 2 PREVALENCE OF LOW HEIGHT-FOR-AGE, WEIGHT-FOR-AGE AND WEIGHT-FOR-HEIGHT.

Nutrition Indices	*Prevalence in boys*	*Prevalence in Girls*	*Prevalence in Boys and Girls*
Low height-for-age	11.6%	6.3%	9.1%
Low weight-for-age	13.0%	11.1%	12.1%
Low weight-for-height	5.8%	4.8%	5.3%

TABLE 4. 3: HEIGHT-FOR-AGE AND WEIGHT-FOR-AGE DISTRIBUTION

Low Height-for-Age

Low Weight-for-Age		Yes	No	Total
	Yes N	1	6	7
	%	0.8	4.5	5.3
	No N	11	114	125
	%	8.3	86.9	94.7
	Total	12	120	132
	N	9.1	90.9	100

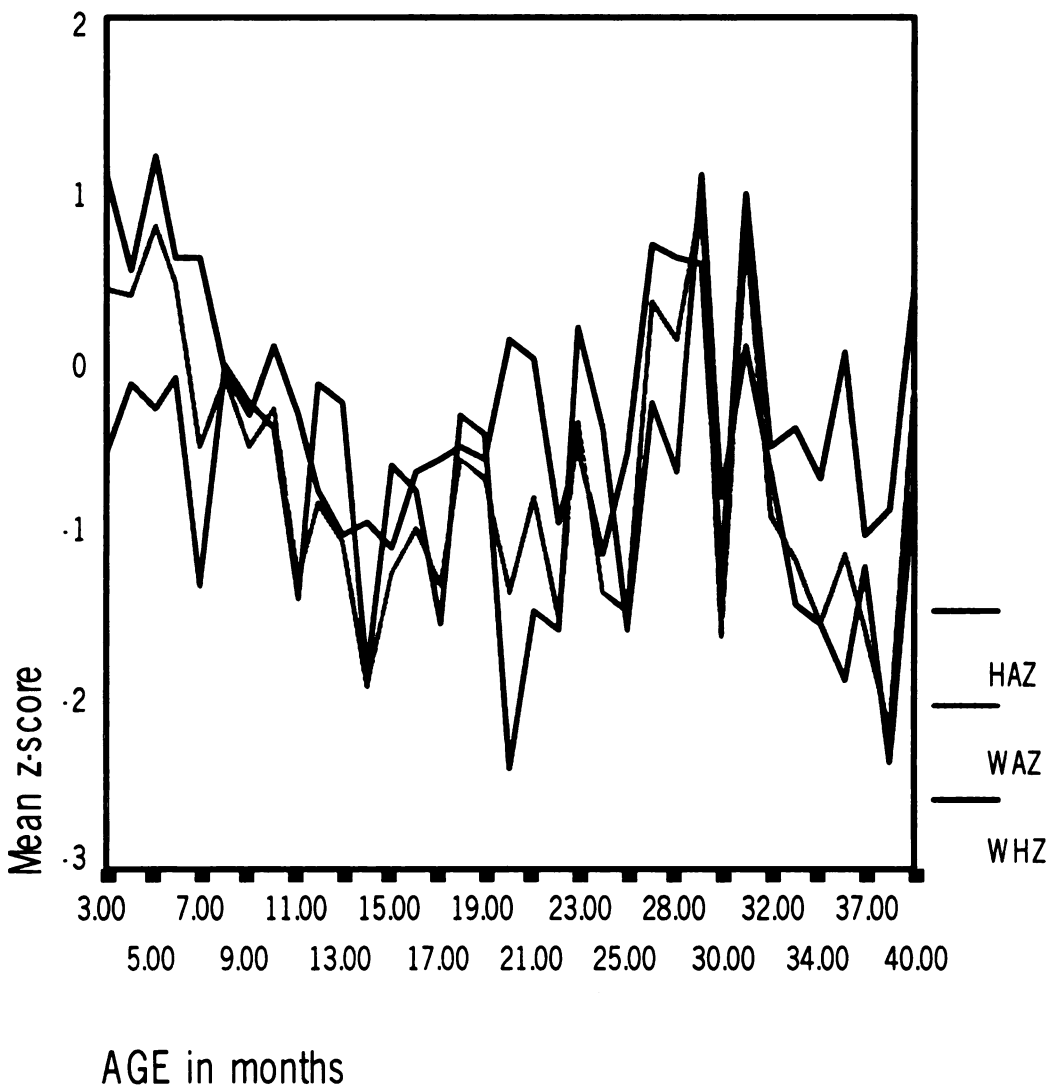

FIGURE 4. 1 MEAN Z-SCORE DISTRIBUTION BY CHILD'S AGE

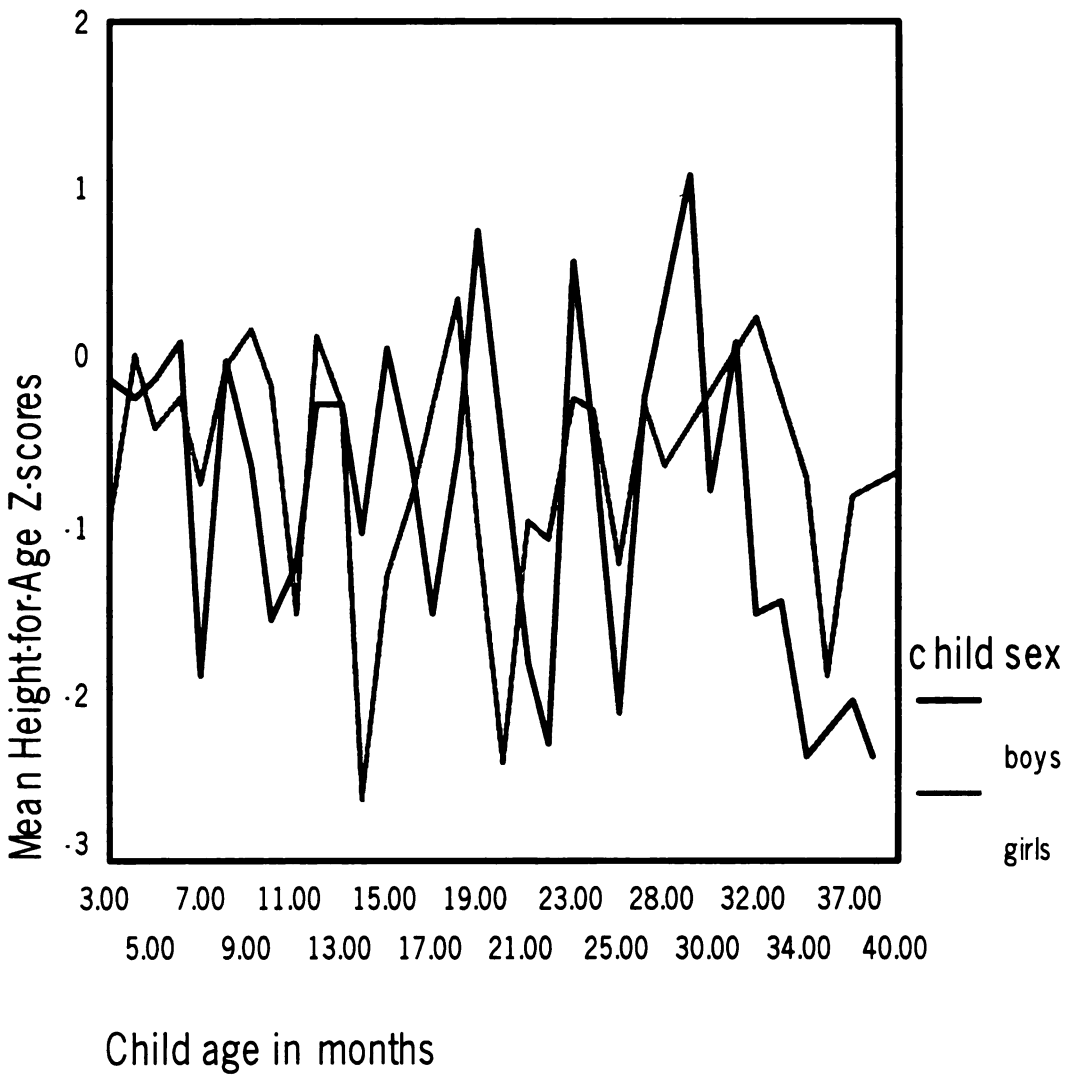

Figure 4. 2 HEIGHT FOR-AGE Z-SCORE DISTRIBUTION

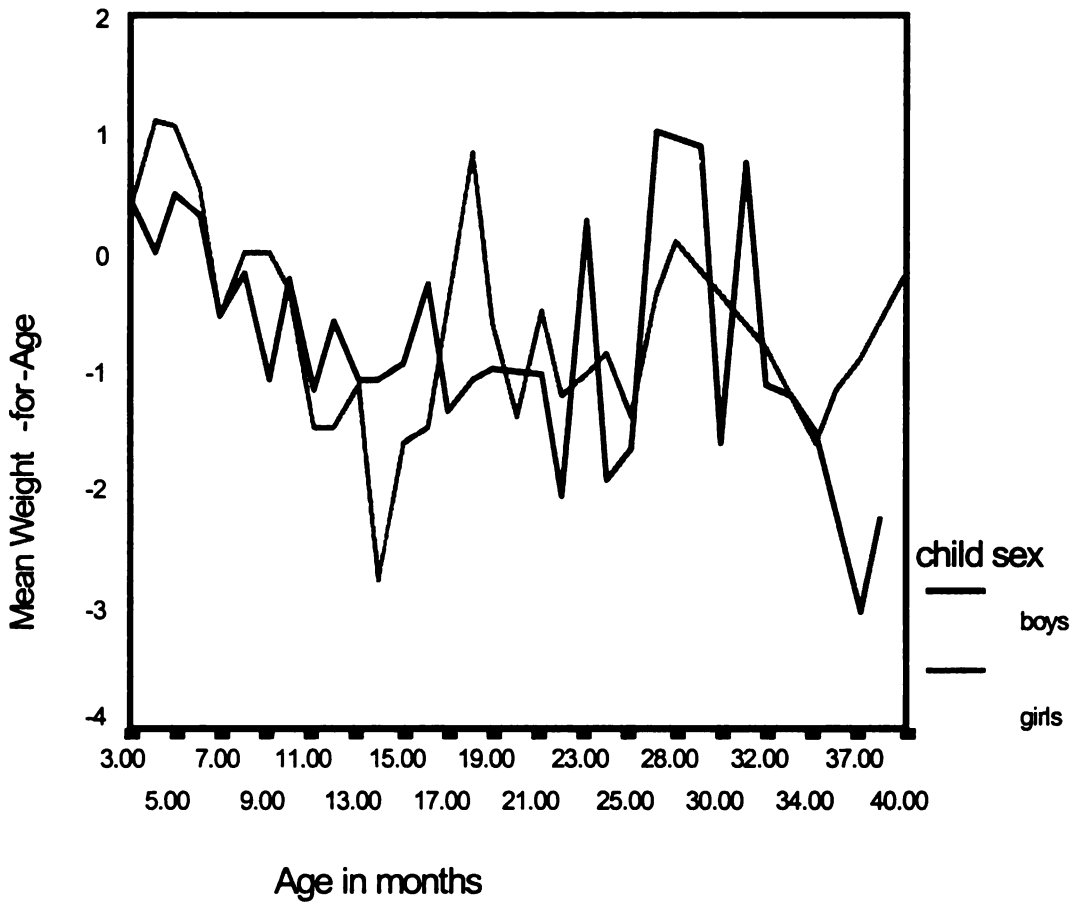

FIGURE 4. 3 WEIGHT-FOR-AGE Z-SCORE DISTRIBUTION

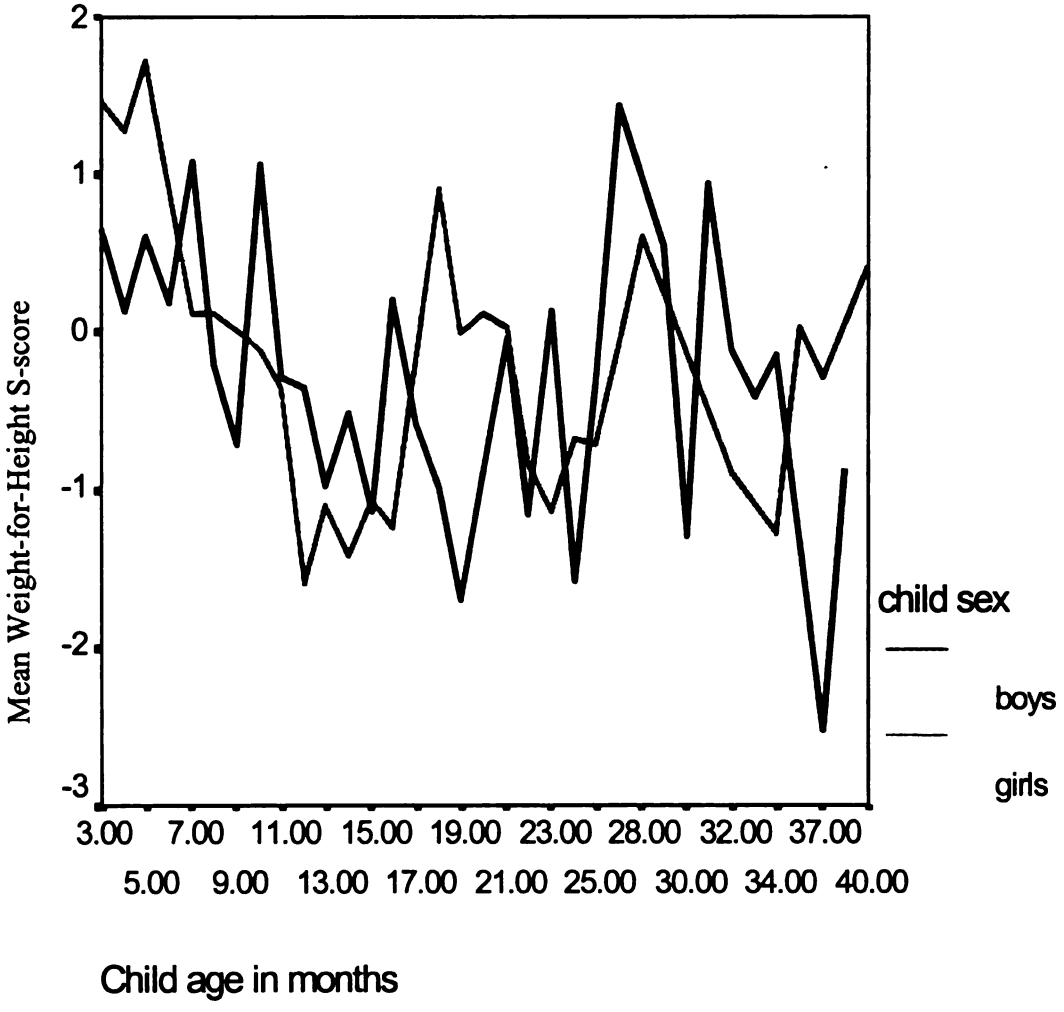

FIGURE 4. 4 WEIGHT-FOR-HEIGHT Z-SCORE DISTRIBUTION

RESEARCH FINDINGS

In this section, the study findings pertaining to the specific hypotheses stated in Chapter 1 are presented. For ease of reference, the study hypotheses are restated as headings of the relevant discussion sections.

Nutrient Qualities of Complementary Diets

Null Hypothesis 1: The nutrient qualities of complementary diets for children between 3 months and 3 years in Gabane are different from those required for adequate growth.

The assessment of the nutritional adequacy of breastfeeding children's diet is often complicated by problems in estimating the amount of breast milk consumed by the child (Dewey et al., 1996). Furthermore, it is not adequate to rely on the volume of breast milk consumed by the infant because the nutritional quality of breast milk has been shown to reflect the mother's nutritional status (Fomon, 1993). Given these challenges, the child's physical growth performance is considered the most objective measure of the overall nutritional quality of the child's diet. Thus, in this study, the nutritional quality of Gabane children 's diet was assessed by comparing their growth parameters to the CDC/NCHS growth standards.

This comparison reflects that the prevalence of stunting, wasting and underweight observed in 3-36 months old children in Gabane (see Tables 4.2 and 4.4) is high compared to the CDC/NCHS reference population (2.3%). T-tests evaluating whether the sample mean weight-for-age, height-for-age and

weight-for-height differs from zeros (the mean of the CDC/NCHS the reference population) yielded large and highly significant t- statistics. Thus, the HAZ, WAZ and WHZ-scores of children in Gabane are significantly lower than those observed in the reference population as shown in Table 4.4. Based on this observation the null hypothesis 1 is rejected.

TABLE 4. 4: Z-SCORE COMPARISON OF GABANE CHILDREN WITH CDC/NCHS REFERENCE POPULATION.

Index	SUM	Mean	Standard dev.	T-statistic	P-Value
HAZ	-100	-0.754	1.182	7.303	0.000
WAZ	-89	-0.677	1.234	6.304	0.000
WHZ	-31	-0.232	1.186	2.246	0.026

Prevalence of Malnutrition in Gabane

Null hypothesis 2: The prevalence of malnutrition in children of ages 3-36 months in Gabane village is not different compared to malnutrition prevalence rates in the entire country (Botswana).

A comparison of the prevalence of malnutrition in Gabane and the entire country is presented in Table 4.5. The cut off point used to define malnutrition is set at -2 z scores of the mean for all three indices. The prevalence of low weight-for-age, weight-for-height and height-for-age in Gabane followed the same trend as was observed in a 1996 nationally representative survey in Botswana (Ubomba-Jaswa and Belbase, 1996). Children below six months of age had a lower risk of malnutrition in both samples than children over 6

months of age. The prevalence of malnutrition in both samples was highest in children between 12 and 36 months. Additionally, a t-test comparing the national prevalence of malnutrition with that of Gabane was not significant for weight-for-age and weight-for-height, suggesting that underweight and wasting rates for 3-36 month old children in Gabane compared well with the country's rates. The difference in the prevalence of stunting in Gabane and the nationally representative sample was approaching P = .06. Though this difference did not reach a P-value of .05 set a priori, it may be important. Thus, this possible difference in the prevalence of stunting in Gabane and the entire country may need to be clarified through a larger sample size follow-up survey. Based on these findings, the null hypothesis of no difference in the prevalence of malnutrition in Gabane and the rest of the country is definitely retained for WAZ and WHZ, but tentatively retained with respect to HAZ. Nevertheless, these results need to be evaluated with caution because the comparison relied on grouped data from Ubomba-Jaswa and Belbase's study instead of raw data. The researcher was not able to gain access to Ubomba-Jaswa and Belbase's raw data in spite of several requests for it.

TABLE 4. 5 A COMPARISON OF MALNUTRITION IN GABANE (CURRENT STUDY) WITH BOTSWANA[7] DATA

Nutrition Index and child age in months	Gabane			Botswana (1996)		
	%	<-2 SD	N	%	< -2 SD	N
WAZ						
3-5.99	0	0	11	0	0	51
6-11.99	5.9	2	34	7.4	7	94
12-23.99	15.7	8	51	17.0	30	176
24-35.99	16.1	5	31	17.3	29	168
36- 47.99	20.0*	1	5	16.1	22	137
All ages	11.5	15	132	11.5	66	489
3-36	9.4	14	127	10.4	44	352
HAZ						
3-5.99	0	0	11	7.1	3	42
6-11.99	5.9	2	34	19.5	17	87
12-23.99	7.8	4	51	29.3	44	150
24-35.99	16.1	5	31	27.4	44	161
36- 47.99	20.0*	1	5	23.7	28	118
All ages	9.1	12	132	21.4	136	468
Ages 3-36	8.6	11	127	20.8	108	440
WHZ						
3-5.99	0	0	11	4.9	2	41
6-11.99	0.0	0	34	5.9	3	85
12-23.99	11.8	6	51	6.8	10	147
24-35.99	0.0	0	31	6.2	10	161
36- 47.99	20.0*	1	5	4.4	5	113
All ages	5.3	7	132	5.1	30	547
Ages 3-36	3.0	6	127	5.4	25	434

7 Ubomba-Jaswa and Belbase, 1996

* Cell size very small. In the Gabane sample only children from 36 months up to 40 months are included in this cell.

Household Factors and Child Malnutrition.

Null hypothesis 3: Households with malnourished children of ages 3-36 months are not different from households with well nourished children in these demographic factors: a) mother's income, b) mother's education level, c) household's income level, d) child's gender, e) child's birth order, f) child's age, g) household size, and h) headship (head of household).

In this population, no association (at P =. 05) was observed between height-for-age, weight-for-age, or weight-for-height and the mother's income, mother's education level, the index child's birth order, child's sex and the number of children in the household. The F-test, one-way analysis of variance, comparing the means of weight-for-age, weight-for-height or height-for-age z-scores and these variables was not significant (Tables for non-significant tests are in Appendix D). Similarly, Chi-square tests, between these variables and levels of stunting, underweight and wasting were not significant.

However, children below the age of six months had a different (lower) risk of stunting, wasting and underweight than children above six months. An F-test comparing means of weight-for-height, height -for-age and weight-for-age Z-scores for children aged, 3-6, 7-12, 13-24 and 25-36 months yielded a large and significant F-statistic. Table 4.6 summarizes these findings. Follow- up analysis with Tukey's post hoc test reflects that the mean weight-for-age and weight-for-height Z-scores for children of ages 3 and 6 months is significantly different (larger) from that of the other 3 age groups. Thus, children under 6 months were less likely to be underweight or wasted than children over 6

months old. However, the mean height-for-age Z- scores for the 3-6 months old is only significantly different from that of children 25-40 months. Additionally, at P-value of 0.05, Tukey's post hoc test has the mean subsets outlined in Table 4.7.

Additionally, stunted children were significantly older than children with normal linear growth. The average age of stunted children was 23.5 months compared to 17.2 months for children with normal linear growth. This difference in age was significant at P =. 03. However, there was no significant difference in the ages of children with normal and below normal weight-for-age and weight-for-height in this population.

TABLE 4. 6 ANOVA RESULTS FOR HAZ, WAZ, AND WHZ BY CHILD'S AGE.

Nutrition indices	DF	F-Statistic	P-Value
Height for Age	3,128	3.087	.030
Weight for Age	3, 128	9.304	.000
Weight for Height	3,128	7.754	.000

TABLE 4. 7 TUKEY'S TEST RESULTS COMPARING MEAN HAZ, WAZ AND WHZ BY CHILD'S AGE

Malnutrition Index	Cell Sides	Mean Subsets at alpha = .05	
		Subset 1	Subset 2
HAZ			
i) 25-40 months	34	-1.1362	
ii) 13-24 months	47	-.8789	-.8789
iii) 7-12 months	31	-.5077	-.5077
iv) 3-6 months	20		-.2445
WAZ			
i) 25-40 months	34	-1.0265	
ii) 13-24 months	47	-1.0028	
iii) 7-12 months	31	-.5848	
iv) 3-6 months	20		.4840
WHZ			
i) 25-40 months	34	-.6115	
ii) 13-24 months	47	-.3565	
iii) 7-12 months	31	-.1771	
iv) 3-6 months	20		.7905

Based on the preceding tests, hypotheses 3 a-e, g and h are retained while hypotheses f is rejected. These observations suggest that households with malnourished children were more likely to have older children.

Choice and Timing of Complementary Foods

Null hypothesis 4: There is no relationship between a) the mother's choice and b) the timing of complementary foods and the child's weight-for-age, height-for-age, and weight-for-height z-scores.

The Choice of Complementary Foods

Table 4.8 summarizes t-test results comparing the mean WAZ, WHZ, and HAZ-scores for children fed different primary complementary foods. Children primarily complemented with sorghum porridges had significantly different

(lower) WAZ and WHZ-scores at p-values .011 and .008 respectively from those complemented with commercially prepared baby foods and UHT milk. However, the mean HAZ-scores did not differ depending on the child's primary complementary food. Furthermore, children whose primary complementary food was served with milk (i.e. sorghum and milk) had significantly different (lower) WHZ-scores and WAZ-scores from those whose complementary food was served with other foods.

However, 84% (n=69/82) of children whose primary food was served with milk, had sorghum as the primary complementary food whereas 68% (34/50) had a non-sorghum complementary food. A chi-square test of independence between sorghum porridge and milk was highly significant (Chi-square; df 1, P value = .03). Thus, a t-test showing lower mean WAZ and WHZ-score for children whose complementary food was served with milk, as is the case in this study, does not necessarily suggest that milk has a lower nutritive quality but rather reflects the strong correlation between porridge consumption and milk use.

Height-for-Age Z-scores were not influenced by whether or not the child's primary complementary food was served with milk. Thus, the null hypothesis stating no association between the HAZ-score and the mother's choice of complementary food is retained while those stating no association between WAZ and WHZ and the mother's choice of complementary food are rejected.

TABLE 4. 8. RELATIONSHIP BETWEEN THE CHOICE OF FOOD AND HAZ, WAZ AND WHZ-SCORES

Nutrition Index/Type of complementary food	*N*	*Mean*	*T-statistic*	*P-Value*
HAZ			-1.104	.272
1. Sorghum	103	-.8231		
2. Other foods	29	-.5445		
			-1.105	.271
3. Served with milk	82	-.8521		
4. Served with non milk based food/relishes	50	-.6140		
WAZ			-2.596	.011
5. Sorghum	103	-.8316		
6. Non-sorghum based	29	-.1666		
			-2.408	.017
7. Served with milk	82	-.8856		
8. Served with non milk-based food/relishes	50	-.3572		
WHZ			-2.679	.008
9. Sorghum	103	-.3747		
10. Non-sorghum based food	29	.2776		
			-2.628	.010
11. Served with milk	82	-.4384		
12. Served with non milk-based foods/relishes	50	-.1082		

The Timing of Complementary Foods

The child's nutritional status measured in z-scores (HAZ, WAZ and WHZ) did not differ depending on the child's age at the introduction of ultra high temperature pasteurized milk, tea, infant formula, water and milk from a home

reared animal in this population. None of the t-tests comparing mean HAZ, WAZ and WHZ-scores for children introduced to these complementary foods and drinks at different ages was significant (data tables for non-significant tests are in appendix D). However, there was a significant difference (t-test: df =1, p value = 022) in mean WAZ-scores between infants introduced to mashed food between 0-3 months and those complemented from 4 months. Consequently, the null hypothesis of no association between the timing of complementary foods and HAZ-scores, WAZ-scores and WHZ-scores is retained for all fluids (water, tea, animal milk, infant formula and UHT milk) assessed in this study. However, early (0-3 months) introduction of mashed food in this population was associated with better WAZ-scores than introduction of mashed food at 4 months. Hence the null hypothesis of no association between the age at introduction of mashed food and weight-for-age is rejected. However, this observation was based on a small number of children (14) because of the small sample size in this study.

When carrying out these analyses, the nutritional status of children introduced to infant formula, or mashed food between 0-3 months was compared to that of children complemented at four months or later. With respect to cows/goat's milk, water, or tea, the nutritional status of children complemented between 0-6 months was compared to that of children complemented at 7 months or greater (Appendix D).

TABLE 4. 9 TIMING OF MASHED FOOD AND HAZ, WAZ AND WHZ

Nutrition Index/Age of child at introduction of mashed food	N	Mean Z-score (SE)	T-statistic (df 119)	P
HAZ			1.115	.267
1. 0-3 months	14	-. 4286 (.3327)		
2. 4-6 months	107	-.7991 (.1155)		
WAZ			2.335	.021
1. 0-3 months	14	6.07E-2 (.3830)		
2. 4-6 months	107	-.8479 (.4060)		
WHZ			2.360	.37
1. 0-3 months	14	.3357 (.4601)		
2. 4-6 months	107	-.4061 (.7E-2)		

Nutritional Quality of Complementary Foods

Null hypothesis 5: There is no relationship between the nutritional quality of the mother's choice of complementary foods and the child's weight-for-age, height-for-age, and weight-for-height z-scores in children of ages 3-36 months.

The T-test comparing the mean height-for-age, weight-for-age and weight-for-height Z-scores for children in the groups with nutrient adequacy ratio (NARs) for protein and calories below 66% or above 67% was not significant (data tables for non significant tests are in Appendix D). Additionally, the results of chi-square testing the null of independence between stunting, wasting or underweight and NARs of protein calories were not significant. Therefore, the null hypothesis 5 is retained. This hypothesis testing should be evaluated carefully because the dietary analysis only reflects the child's complementary diet. The contribution of breast milk could not be assessed. Furthermore, this

hypothesis testing was based on a sub-sample of 49 cases.

Summary Hypothesis Testing

Table 4.10 presents a summary of the null hypotheses tested in this study. The findings suggest that the nutrient qualities of complementary diets for Gabane children are different from the requirements for adequate growth, but they are not different from that of children in the entire country. Also, households with malnourished children were similar in maternal income, maternal education, household's income, child's gender, child's birth order, household's size, and headship when compared with adequately growing children. However, malnourished children were significantly older than adequately growing children.

Regarding complementary feeding there was an association between the choice and the timing of the introduction of complementary foods and WAZ and WHZ. However, there was no relationship between the nutritional quality of the choice of complementary foods and WAZ, WHZ and HAZ.

TABLE 4. 10 SUMMARY OF THE NULL HYPOTHESES TESTED

Null Hypotheses	Statistical Tests	Decision Reached
1. The nutrient qualities of complementary diets for children between 3 months and 3 years in Gabane, are not different compared to those required for adequate growth.	T-test Table 4.4	Reject
2. The prevalence of malnutrition for children of ages 3-36 months in Gabane village is not different compared to malnutrition rates in the entire country (Botswana)	T-test Table 4.5	Retain
3. Households with malnourished children of ages 3-36 months are not different from households with well nourished children in these demographic factors: a) mother's income, b) mother's education level, c) household's income level, d) child's gender, e) child's birth order, f) child's age, g) household size, and h) headship (head of household).	ANOVA, Tukey's & T-test Tables 4.6 & 4.7	Retain a-e, g and h Reject f
4. There is no relationship between a) the mother's choice and b) the timing of complementary foods and child's weight for age, height for age, and height for age Z-scores in children of ages 3-36 months.	T-test Tables 4.8 & 4.9	Retain 4a with respect to HAZ, reject with respect to WAZ and WHZ Retain 4b with respect to fluids, reject with respect to mashed food
5. There is no relationship between the nutritional quality of the mother's choice of complementary foods and the child's weight-for-age, height-for-age, and weight-for-height z-scores in children of ages 3-36 months.	T-test	Retain

PREDICTION MODELS FOR HEIGHT-FOR-AGE, WEIGHT-FOR-HEIGHT AND WEIGHT-FOR-HEIGHT.

Logistic regression models were built to distinguish households with children at greater risk for low height-for-age, low weight-for-age, and low weight-for-height from those with adequately growing children.

Height-for-Age

A highly significant (P value .0016) logistic regression model estimating the likelihood that a given child's height-for-age Z score would be above or below the cut off point for stunting was built. The variables entered included the child's birth weight, number of meals a day, age, birth order, current breastfeeding status, the number of children at home, the presence of relatives at home, and household headship. The magnitudes of the influence of these variables on height-for-age are reported in odds ratios in Table 4.11. This model accurately predicted 45.45% and 98.48% of stunted and non-stunted children respectively.

The Homer and Lemeshow Goodness-of-Fit test (Norusis, 1990), which tests the null hypothesis that the model fits, was used to evaluate the goodness of the model. This test was not significant (chi-square 2.3047, df 8, p-value .9702), so the null hypothesis was retained. In this model, the child's probability of stunting was higher for children with low birth weight (p-value .0085), birth order less than 2 (p-value .0286), and who had the father as the

head of the household (p-value .0238). Children with low birth weights (less than 2.5kg), were 52 times, more likely to be stunted than children with birth weights greater than 2.5kg. Also, first and second born children were 51 times more likely to be stunted than children with birth orders greater than 2. Regarding household headship, children in households headed by the child's father were 16 times more likely to be stunted than those in households headed by the child's grandparent. Nevertheless, the probability of stunting for children in households headed by the mother was not significantly different from that of children in households headed by the child's grandparent. The presence of relatives in the household increased the likelihood of stunting by about 10 times. This odds ratio was approaching significance.

Conversely, the likelihood of stunting was lower for children in households with 2 or less children compared to households with more than 2 children. More specifically, households with fewer than 2 children were only 1% as likely to have stunted children as households with more than 2 children.

In this model, the influence of the child breastfeeding status, the child's age, and the number of meals the child had a day did not reach significance. However, when the child age and number of meals variables were removed from the model, the significance of the breastfeeding variable improved from .5882 to .0625. This might be a reflection of the high correlation between the variables child's age and the child's breastfeeding status. In addition, the model significance improved from .0016 to .0006. However, the reduced

model was only able to accurately predict 27.17% of stunted children compared to 45.15 % reported earlier. The new reduced model is summarized in Table 4.12.

TABLE 4. 11 LOGISTIC REGRESSION MODEL 1: PREDICTION OF STUNTING (1 = Yes 0 = No)

Model chi-square 29.960 df 11 sig .0016
Homer and Lemeshow chi-square 2.3047 df 8 Sig .9058

Variables	R	B	Odds Ratio	95% CI Odds Ratio	P-value
Child age (months)					
1-12	-.0786	-2.250	.105	.006 - 1.758	.29
13-24			.332	.033 - 3.304	.12
25-40	ref[8]				
Birth Order					
≤ 2	.1947	3.934	51.10	1.511 -728.40	.029
≥ 3	ref				
Number of children					
≤ 2	-.2408	-4.3731	.0102	.0003 - .369	.012
≥ 3	ref				
Household Headship					
Father	.2055	2.812	16.637	1.454 - 190.328	.024
Mother		1.570	4.805	.158 - 145.800	.367
Grand parent	ref				
Child's breastfeeding					
Yes		-.678	.5078	.0437-5.896	.5880
No	ref				
Meals/ day					
2-3		.6868	.5851	.0114 -29.952	.6990
4-6	ref		1.987	.0612 -64.570	
Residing Relatives?					
Yes	.146		10	.918 -125.485	.0586
No	ref				
Birth weight					
≤ 2.50kg	.259	3.96	52.901	2.760-1015.972	.0085
≥ 2.51kg	ref				

8 Ref denotes the reference variable in the logistic regression model.

In congruence with the current understating as reflected in the literature review, the reduced model (model 2) suggests that breastfeeding is protective against stunting. More specifically, children who were breastfeeding at the time of the study were only 16% as likely to be stunted compared to those who were weaned. However, this association was only approaching significance with a p-value of .0624. Also, the variables; birth weight, number of children in the home, birth order, and household headship remained significant predictors of stunting while the variable, presence of relatives at home, was approaching significant.

Other variables often associated with child nutrition such as; the mother's employment outside the home, child's gender, mother's education level, the mother's choice of complementary foods, and the duration of breastfeeding were not significantly associated with stunting in this population.

TABLE 4. 12 LOGISTIC REGRESSION MODEL 2: PREDICTING STUNTING (1 = Yes; 0 = No)

Model Chi-square 25.639 df. 7 Sig. .0006
Homer Lemeshow Chi-square 3.4138 df. 8 Sig. .9058

Variable	B	R	P-value	Odds Ratio	95% CI Odds Ratio
Birth weight					
≤ 2.50kg	3.700	.309	.0026	40.456	3.629 - 451.07
≥ 2.51	ref				
Birth order					
≤ 2	3.382	.159	.0492	29.432	1.01 - 855. 839
≥ 3	ref				
Breastfeeding					
Yes	-1.829	-.149	.063	.161	.023 - 1.100
No	ref				
Residing relatives					
Yes	2.258	.141	.062	9.560	.890 - 7059
No	ref				
Children born in the household					
≤ 2	-3.749	-.196	.028	.0235	.0008 - .667
≥ 3	ref				
Headship					
Father	2.782	.222	.015	6.155	1.709 - 152.71
Mother	1.548		.336	4.704	.201- 110.706
Grandparent	ref				

Weight-for-Age

Table 4.13 summarizes the logistic regression model built to estimate the child's likelihood of being under weight or normal weight from the entered variables. In this model, low weight-for age was more likely in children who were currently breastfeeding (p-value .008), had other relatives in the home

(.0239), or had mother's with incomes over 400 Pula (.0499). More specifically, children in households with residing relatives were 26 times more likely to be underweight than children without residing relatives. Children of mothers with formal incomes of above 400 Pula were 5 times more likely to be underweight compared to those whose mothers had no formal incomes. Additionally, the likelihood of being underweight for children whose mothers earned less than 400 Pula was not significantly different from that of mothers without formal employment.

Regarding infant feeding, the likelihood of low weight-for-age was not significantly influenced by breastfeeding or lack thereof. However, among children who were breast fed, low weight-for-age was 2% as likely in weaned children compared to those currently breastfeeding. In addition, children who were introduced to complementary food before 4 months of age were 13% as likely to be underweight compared to those introduced to mashed after 4 months of age.

The child's birth order, birth weight, sex, and the number of meals the child received per day did not significantly influence the likelihood of low weight-for-age. Other variables often associated with child growth performance, such as the household headship, the mother's education level and the household size were not significantly associated with the child's weight-for-age.

TABLE 4. 13 LOGISTIC MODEL 3: PREDICTING UNDERWEIGHT
Yes = 1, No = 2

Model chi-square	34.972	df.	13	Sig.	.0011
Hosmer and Lemeshow chi-square	2.7113	df.	8	Sig.	.9512

Variables	B	R	P-Value	Odds Ratio	95% CI for Odds Ratio
Mother's formal income level					
≤ 400	-1.022		.4819	.360	.0211- 6.20
≥ 400	1.714	-.141	.0499	5.552	1.00 - 30.80
None	ref				
Child's age (months)			.0249		
1-12	-4.412	-22.57	.0105	.0121	.0004 - .356
13-24	-1.197		.2664	.3022	.0366 -2.49
25-40	ref				
Child's age at introduction of mashed food					
≤ 4 months	-1.989	-.1885	0229	.1368	.0246 - .759
≥ 4 months	ref				
Residing relatives					
Yes	3.274	.1864	.0239	26.404	1.543-51.91
No	ref				
Sex					
Boys	.2278		.7866	1.256	.241 - 6. 534
Girls	ref				
Number of meals/day					
2-3	-.4851		.6027	.6156	.0991 - 3.825
4-6	ref				
Child's breastfeeding status					
Ever breastfed	10.204		.794	27005	.000- 4.6E+37
Never breastfed	ref				
Current breastfeeding status					
Weaned	-3.53	-.237	.0080	.0292	.0021 - .398
Breastfeeding	ref				

Table 4.13 (Cont'd).

Birth Order ≤ 2 ≥ 3	 .714 ref		 .394	 2.043	 .396 - 10.548
Toilet facility Yes No	 -3.422 ref	 -.154	 .0422	 .0326	 .0012 - .886
Birth weight ≤ 2.5kg ≥ 2.5kg	 1.171 ref		 .307	 3.225	 .3420 - 3.404

Weight-for-Height

The logistic regression model summarized in table 4.14 accurately classifies 66% and 99.1% of wasted and normal weight-for-height children. This model is significant at p-value .0111. The goodness-of-fit test is not significant, thus the null hypothesis that the model fits is retained. According to this model, the probability of wasting might be higher for children with younger mothers (P-value .0995 and.0764) and those in household whose source of cooking energy was wood (.0757). These relationships should be evaluated carefully because the p-values are only approaching significance.

The introduction of mashed food earlier than 4 months (P-value = .0131), first and second birth orders (P-value = .0257) and the child's good appetite (P-value = .0391) were very protective against wasting. In this model children introduced to mashed food earlier than four months were 0.6% as likely to be wasted compared to those introduced to food at 4 months or later. In addition, children whose mother's perceived as eating enough food were only 1.3% as

likely to be wasted compared to those who were perceived to be eating too much. Furthermore, first and second born children were 1.5% as likely to be wasted compared to children with birth order of three and greater.

TABLE 4. 14 LOGISTIC REGRESSION MODEL 4: PREDICTING WASTING (Yes =1, No = 0)

Model chi-square 24.424 df. 11 Sig. .0111
Hosmer and Lemeshow Chi-square 1.9152 df. 8 Sig. .9644

Variables	B	R	P-Value	Odds ratio	95% CI for Odds Ratio
Residing relatives					
Yes	4.055	.168	.068	57.669	.745- 4465
No	ref				
Mother's age (years)					
≤ 21	6.053	.123	.0995	425.183	.317- 570825
22-30	5.493	.155	.0760	242.980	.558- 105794
≥ 31	ref				
Child current breastfeeding status					
Weaned	-1.645		.317	.193	.0077 - 4.853
Breastfeeding	ref				
Child's age at introduction of mashed food					
≤ 4 months	-4.984	-.296	.0131	.0068	.0001 - .352
≥ 4 months	ref				
Birth order					
≤ 2	-4.172	-.250	.0257	.0154	.0004 - .6032
≥ 3	ref				
Child's eating pattern					
Eats enough	-4.314	-.218	.0391	.0134	.0002 - .8053
Eats too little	-2.380		.2765	.0925	.0013 - 6.732
Eats too much	ref				
Birth weight					
≤ 2.50kg	-10.28		.8707	0000	.000-1.95E49
≥ 2.51kg	ref				
Household cooking energy					
Wood	3.2875		.0797	26.776	.712-1007.59
Gas	ref				

CHAPTER V

DISCUSSION AND CONCLUSIONS

In this chapter, the observations made in the previous chapter are discussed. Each of the following sections attempts to address each of the five study objectives. Evidence is drawn from the findings of the relevant research hypotheses tested in Chapter 4. Furthermore, the similarities and/or differences between the study findings and the current understanding of the issues as reflected in the reviewed literature are highlighted.

Objective 1: To characterize complementary diets for children aged between 3 months and 3 years in Gabane.

The Predominant Role of Sorghum in Complementary Diets

Complementary diets in Gabane are primarily sorghum-based. Eighty-one percent (81%) of children on complementary food were served sorghum-based porridges. The majority (88%) of these children had fermented sorghum. Soft porridge (motogo) was served for breakfast, mid-morning snack and supper. Thicker consistency of porridge was prepared for the mid-day (main) meal. Adults were more likely to have meat or vegetable relishes accompanying their thicker porridges whereas children's were served with milk. In fact in this study, sorghum porridges for children were mostly (69/103) served with milk or milk and sugar (chi-square; 4.7 df 2 p .030). Among those children whose primary food was served with milk, 84% had sorghum as the primary

complementary food.

Association of Sorghum Porridges with Low Nutritional Status

The observed association between the use of sorghum porridges in complementary feeding and lower mean WAZ and WHZ but not HAZ scores in this study is not surprising. First, porridges are bulky and children can tolerate only very thin consistencies. Yet, these thin porridges, locally referred to as motogo, are less nutrient dense than thicker porridges and may not meet the high caloric needs of the growing child. Furthermore, other studies have also found an association between the use of porridges (sorghum or maize) in complementary feeding and lower nutritional status (Simondon and Simondon, 1995).

Secondly, it is expected that a child's inadequate intake will be reflected by decreased weight-for-age Z- scores. This is because weight-for-age is a very sensitive measure of the current nutritional status (Gibson, 1990). It responds quickly to the child's current inadequate dietary intake and/ or acute illnesses. Hence, weight-for-age has become the nutritional index of choice in less-developed countries, where resources do not permit regular measurement of height. Weight-for- height on the other hand is an indicator of the child's overall nutritional status. It is influenced by changes in either the child's weight or height over time (Gibson, 1990). For children between 1 and 10 years, the accuracy of weight-for-age's in assessing nutritional status is stable. It is therefore considered a more reliable indicator of nutritional status over time.

The observed association between the use of sorghum porridges in complementary foods and lower weight-for-height, validates observations made earlier with regard to weight-for-age. Thus, decreased weight-for-age and weight-for-height in this situation may be indicative of the inability of these porridges to meet the current nutritional needs of growing children.

The observed association between serving complementary food with milk and lower weight-for-age and weight-for-height was rather surprising (Table 4.8) because it is expected that the higher nutritive value of milk over sorghum would be beneficial to the child. Also, nutritionally milk and sorghum are regarded as complementary proteins because milk provides lysine, the limiting amino acid in sorghum. This unexpected observation might be explained by the fact that 84% of children whose primary complementary food was served with milk had sorghum porridge as their primary complementary food. Thus, the beneficial effects of milk proteins may have been negated by the low calorie levels of the overall diets.

Observations that calories and not proteins are often the limiting nutrients in protein energy malnutrition may also help explain this observation. Particularly because the efficiency with which the body uses dietary proteins may be influenced by the adequacy of other nutrients, including calories, in the diet. In one high protein supplementation study, caloric intake and not protein was well correlated with both linear growth and weight gain (Martorrell and Habicht, 1986). This study suggested that the derived benefits of

supplementation with high protein supplement might not be explained solely on the amount of protein in the diet. Similarly, a Collaborative Research Study Project (CRSP) study, observed that the prevalence of malnutrition in Mexican, Kenyan and Egyptian preschool children, remained high even though their diet was high in protein and essential amino acids (Beaton et al., 1992)

The Relationship between the Mother's Choice of Complementary Food, Culture, and Food Availability

The use of sorghum porridges and UHT milk in complementary foods may also be indicative of both cultural preferences and availability. Sorghum is a drought resistant crop and performs much better than maize in Botswana, because of the country's semi-arid climate (Hiebsch and O'Hair, 1986). A nationally representative survey also found sorghum and UHT milk among the common complementary foods (and fluids) used in Botswana (Ubomba-Jaswa and Belbase, 1996). However, the proportion of mothers choosing porridge, as the primary complementary food compared to other foods in Gabane (88%), was higher than the national average (47%) reported in 1996 However, it was more comparable to that seen in settlements (72%).

The use of porridges in complementary food is not unique to Gabane, Botswana. Porridge (maize, sorghum or millet) use in complementary diets has been reported in several other studies in less developed countries (Cosminsky et al., 1993; Simango, 1997; Simondon and Simondon, 1995). In some of these

studies, porridge was preferentially given to children perceived to be young for their age or perceived as unsatisfied by their mother's milk (Simondon and Simondon, 1995). Tea, water, home reared animal's milk and commercially prepared baby foods are the other food used in complementary feeding. Interestingly, these fluids were not correlated with the child's growth parameters.

The use of tsabana, a soy/sorghum complementary food provided by the Government, was rarely reported as a primary complementary food by mothers. Only one parent out of the 127 whose children were already on complementary foods considered tsabana as the child's primary complementary food. This was rather surprising because tsabana is made available to all children between the ages of ages 4 and 36 months at a cost to the government and not to the family. In addition, tsabana is nutritionally superior to sorghum porridges because it is made from a combination of sorghum and soybeans. Furthermore, tsabana is fortified with vitamins and minerals. Surprisingly, eligible mothers were seen receiving tsabana and cooking oil at the time of the study. Additionally, the clinic supplementary food log indicated that the supply of tsabana had been uninterrupted for at least 3 months prior to the study. It is likely that tsabana is not prepared for the index child only but is shared by all children in the households and /or the whole family. Thus, the allotment is used up sooner than expected because the program only provides 5-10 kg of tsabana meal depending on the age of the child. Further investigation into the intra-

household distribution and use of tsabana is recommended.

Nutritional Quality of Complementary Foods in Gabane

There is a consensus that nutrient dense complementary foods are required to sustain a child's growth and development when breast milk no longer meets a child's nutrition needs. The adequacy of the contribution of complementary diets' towards a child's overall nutritional need is estimated based on the difference between the child's breastfeeding intake and the requirements for sustaining the growth trajectory, as defined by a given growth standard (Brute, 1996; Dewey, 1996). This approach requires accurate assessment of the volume and the nutritional quality of breast milk and measurements of complementary food consumed by the child. Given the problems inherent in this approach, it is recommended that these estimates not be used to replace the child's physical growth performance (Institute of Medicine, 1992). In keeping with this recommendation, growth parameters were used in evaluating the nutritional quality of the child's intake.

As reflected in the analyses (Table 4.4), Gabane children had lower height-for-age, weight-for-age and weight-for-height than the CDC/NCHDS reference population. The prevalence of both chronic and current malnutrition increased with age. The higher prevalence of undernutrition in older children may be an indication of the inadequacy of complementary foods. Similar observations in some studies were associated with low calorie and protein complementary diets

or increased gastrointestinal infection (Dewey et al., 1992). In this study, morbidity may also have played a role because of the mildly significant relationship between children's curative clinic visit in the past two weeks and weight-for-age ($x^2 = 3.657$, P-value =.053).

Objective 2: To evaluate growth indicators (height-for-age, weight-for-age and weight-for-height) for children in Gabane.

Height-for-age, weight-for-age, and weight-for-height z-scores were used to assess the growth of children in Gabane. These measures were chosen over percentiles because they have been shown to more accurately assess nutritional status of children in developing countries (Gorstein et al., 1994; WHO, 1986). Percentiles have been shown inadequate in estimating malnutrition prevalence in populations where a large proportion of anthropometric measurements falls below the fifth and the third percentile.

The prevalence of low height-for- age, weight-for-age and weight-for-height in Gabane is high compared to the CDC/NCHS reference population. As reflected in Figures 4.1- 4.4 the growth indicators of sample children are within normal limits from birth to about 3 months. However, all three indices begin to decline at about 6-7months of age reaching the lowest levels between 12-18 months. These gradually declining growth patterns might be a reflection of nutritional insults associated with the introduction of complementary foods at about 4-6 months and the cessation of breastfeeding by most mothers at about 13 months. The increasing prevalence of undernutrition with age, especially

height-for-age, may also be a reflection of the extended period of time during which the children were exposed to inadequate diets. Similar observations were made by Ubomba-Jaswa and Belbase (1996) in a nationally representative survey.

When compared to other African countries, malnutrition rates in Gabane may be considered moderate to low. On a three point scale where 5-10%, >20% and >40% are considered usual, high and severe respectively, the prevalence of low weight-for-height (5.3%) in Gabane is typical for African countries (UN-ACC/SCN, 1998).

Objective 3: Characterize households with children at risk for malnutrition as determined by low height-for-age, weight-for-age and weight-for-height. Objective 5: Identify predictors of children with inadequate growth.

In this section, the findings of the logistic regression models described in the previous chapter are discussed in an attempt to address objective 3. Objective 5 is also addressed here because it is a logical transition from objective 3.

Height-for-Age.

The increased odds of stunting in children with low birth orders seen in this study are difficult to explain (Tables 4.12 and 4.13). This difficulty comes about because birth orders may be used to reflect the relationship between the child's growth parameters and the household's size or assess the possibility of differential treatment of children based on their birth orders. Given the former

understanding, higher birth orders reflect larger nuclear families and may be associated with increased socio-economic strains. However, it is possible that this variable is capturing other maternal demographic factors, particularly because there is a strong (66%) and significant (p-value = .01) positive correlation (Pearson's r) between maternal age and birth order. It may be that younger and inexperienced mothers have difficulty raising their first and second born children or that the child's nuclear family is not economically established. In fact, the inclusion of the maternal age variable in the logistic regression model causes the birth order variable to loose significance but the maternal age variable does not reach significance.

The possibility of differential treatment of children based on the child's birth order in this study is remote. None of the bivariate analyses completed earlier suggests any differences in the child's growth parameters related to the child sex or birth order. Furthermore, none of the research completed in Botswana and reviewed in this study supports this possibility (Aplogan et al., 1996; Ubomba-Jaswa and Belbase 1996).

However in both scenarios, the findings should be evaluated with caution because the helpfulness of the child's birth order in assessing the impact of the household on the child growth performance may vary depending of the structure of the household. Some households may be made up of multiple nuclear families while others may have one nuclear family. Thus, a child with a birth order of two from a given nuclear family may not characterize the growth

performance of children from other nuclear families within the same household.

The presence of relatives in the home also appeared to be a disadvantage to the growing child, in that stunting was 10 times more common in households with residing relatives. However, this relationship was approaching significance (P-value = .0586). This variable might also be a reflection of the economic burden of maintaining a large family. In this study, 70/83 households with adult relatives reported that the relatives helped purchase food. However, each household also had a mean of 2.48 child relatives with no ability to purchase food. The suggested association between the presence of residing relatives and socio-economic constraints is plausible because this study also found that the likelihood of stunting was higher in households with fewer than two children compared to those with more than two children (P-value .0123). Furthermore, a recent study in Letlhakeng village (Botswana) found that 96% of households depend on store bought food (Holmboe-Ottesen, 1991). However, 67%, 47% and 13% depended on remittance from household's member, other relatives and social welfare respectively.

The increased odds of stunting for children in male-headed households relative to those headed by the child's grandparent was also very surprising. If this variable captured income, as was intended, we would expect better growth performance for children in male-headed households, because fathers earned more than mothers regardless of education level in this study. Additionally, male-headed households were more likely to have older mothers than younger

mothers (previously associated with better height-for -age). In this study, a high proportion (20/26) of young mothers (up to 21 years) remained in a households headed by their mothers (child's grandparent) compared to 22/68 and 6/32 of mothers of ages 22-30 and at least 31 years respectively. Furthermore, an even higher proportion 23/32 of older mothers (at least 31 years old) were in homes headed by the child's father compared to 39/68 and 5/26 for mothers of ages 22-30 and under 21 years respectively. A chi-square assessing independence of mother's age and household headship was significant at p-value less than .0005.

The suggested association between the male headship and increased stunting in this sample is difficult to explain. However, further assessment of the data indicates that in 20 and 21 of the 68 male-headed households' the father's monetary support could not purchase adequate food for the family and/or the father was also working and resident in a different town/country from the rest of the family. The impact of male headship on the child's stature may need to be investigated further using a larger sample size.

In congruence with the current understanding on the relationship between birth weight and the child's stature, low birth weight strongly increased the odds of stunting in this population. Low birth weight is thought to result from intrauterine growth retardation. Other studies have also shown that low birth weight is a strong predictor for stunting (Adair and Guilkey, 1997).

The likelihood of stunting in this study was minimal in households with currently breastfeeding children and fewer than two children (Table 4.11 & 4.12).

Lower birth orders, presence of relatives in the home and low birth weight increased the odds of being stunted. Among all these variables, the number of children in the household, birth order, and household headship were highly significant predictors of height-for-age, whereas the presence of relatives in the home and current breastfeeding status were less significant predictors.

Other variables often associated with child's growth such as mother's income, child's gender and primary complementary food were not significant predictors of height-for-age. In the model, the child's age appeared not to be a significant predictor of height-for-age, but this needs to be evaluated carefully because of the high (68%) and significant (p= .01) correlation (Spearman's rho) between current breastfeeding status and child's age.

Weight-for-Age

With respect to weight-for-age, the odds of being underweight were higher for currently breastfeeding children, children of mothers who earned more than 400 Pula ($100.00/month) and who had residing relatives. Studies have shown that maternal income is generally protective if suitable child-care alternatives are available. However, in such studies a clear distinction was made between low and high-income households. In this study however, the majority of employed mother could be easily classified as low-income. Twenty (20) of the 45 mothers with formal employment earned less than 400 Pula, thirteen earned between 400 and 699, eight earned less than 1,000.00 while only 4 earned over 1,000 Pula.

Thus, the higher likelihood of low weight-for-age in households with maternal income of at least 400 Pula does not necessarily suggest that a higher income is worse than no income but rather reflects the unfavorable trade off between childcare and formal employment for low-income employed mothers compared to mothers with no formal income. It is therefore plausible that the income earned by mothers with incomes greater than 400 Pula did not off set the disadvantages of leaving the index child with an alternative childcare giver. Additionally, since most Gabane residents are employed in the nearby city, it is likely that such mothers were more likely to spend the whole day away from the index child. On the other hand, mothers with incomes below 400 Pula and unemployed mothers were more likely to take care of or possibly supervise the index child's care during the day.

However, given the small sample size in this study and the tendency for respondents to under report incomes, these observations may need validation. Furthermore, no associations were observed between measures of household's wealth such as the type of housing, roofing material and household source of water with any of the child's growth parameters.

The higher odds of underweight in currently breastfeeding children compared to weaned children may appear puzzling, particularly because of the well established benefits of breastfeeding across cultures. However, it has also been shown that the introduction of teas and water to breastfeeding children may be detrimental to their growth. The introduction of these fluids has been

associated with increased exposure to gastrointestinal pathogens and decreased suckling of the child at the breast. The World Health Organization (WHO) estimated that 70% of 1, 400 million episodes of diarrhea in children under five years worldwide are caused by pathogens in contaminated food (WHO, 1993). Twenty-five percent (25%) of these episodes are caused by *E. coli.* In turn, diarrheal and other gastrointestinal diseases predispose children to malnutrition as described in the vicious cycle of malnutrition.

The introduction of teas, water and other fluids to breastfeeding children promotes the replacement of breast milk with these fluids. In addition, the amount of breast milk produced by the mother falls, as demand diminishes. Given that almost 95%, 44%, 37% and 14% of breastfeeding children in this study were introduced to water, cow's or goat's milk, UHT milk and tea before 6 months respectively (Table 4.1), their growth potential may have been compromised by both increased exposure to gastrointestinal pathogens and reduced breast milk intake.

Although the current breastfeeding variable collectively looks at children who are currently breastfeeding, it is also likely that older breastfeeding children fared worse compared to younger children because breastfeeding contributes only a small portion of their nutritional requirements. Hence in this model, younger children ($p = .0238$) and children introduced to mashed food before four months ($p = .0129$) were less likely to be stunted compared to older children.

The presence of relatives in the home also increased the likelihood of underweight. This variable might undermine the child's weight-for-age as previously suggested for stunting.

Conversely low weight-for-age was less likely in younger children (1-12 months) and children introduced to mashed food before 4 months. Additionally, older children were disadvantaged relative to younger children because they were exposed to the poor complementary diets for an extended period.

In the Gabane population therefore, weight-for-age can be accurately predicted by the variables: the mother's formal income level, the timing of introduction of mashed food, the presence of relatives in the home, and the child's current breastfeeding status. With these variables, 53% and 94% of wasted and normally growing children respectively was accurately predicted.

Weight-for-Height

The built logistic regression model for weight -for -height accurately predicts 66% and 99% of wasted and normally growing children respectively. Households with mothers of ages 22-30, residing relatives and those who used wood as source of cooking energy were more likely to have wasted children. However, these associations did not quite reach significance. The source of cooking energy is a proxy indicator for household's income. Households with higher incomes tend to use propane gas and gas stoves compared to poorer

households. Thus, this relationship suggests that children in poorer households (cook with wood) may have slightly higher probabilities of being wasted. Along the same line, residing relatives may increase the cost of maintaining the family and thus make it harder for families to provide for their children. The presence of residing relatives has consistently been associated with increased odds of malnutrition in all growth indices in this study.

The association between mothers of ages 22-30 years with higher probabilities of stunting was puzzling at first. However, further analyses revealed that 22-30 year old mothers were more likely to be in a household headed by the child's father. Previously, households headed by the father were more likely to have stunted children compared to those headed by the child's grandparent. In a chi-square test, 39/68 mothers of ages 22-30 were in households headed by the child's father, whereas 13/68, and 22/68 were headed by the child's mother and grandparent respectively. Furthermore, 22-30 year old women constituted a larger proportion (39/67) of mothers in households headed by the child's father. Women under 21 and over 31 years constituted only 5/67 and 23/67 respectively. A chi-square test of independence between the variables mother's age and head of household was significant at p-value less than .0005. Given the relatively small sample size in this study, all these findings may need further validation.

The variables, introduction of mashed food earlier than four months, birth orders less than 2 and the child's good appetite, were protective against wasting.

The protective effect of introducing mashed food earlier than four months was seen earlier, with respect to the child's weight-for age. The recurrence of this variable and its consistency in protecting child growth across different models and indices may be an indication of its importance in child growth in Gabane. The variables birth order and the child's appetite were also protective against wasting. However, they were not consistent across the models. Table 5.1 summarizes the relationship between the predictor variables and height-for-age, weight-for-age and weight-for–height.

TABLE 5. 1 PREDICTORS OF HEIGHT-FOR-AGE, WEIGHT-FOR-AGE AND WEIGHT-FOR-HEIGHT.

Variable	Relationship of the variable with the growth index (P-Value)		
	Height-for-Age	Weight-for-Age	Weight-for-Height
Headship Father Mother Grandparent	Lowers (.0238)	NA[9]	NA
Residing relatives Yes No	Lowers (.0586)	Lowers (.0239)	Lowers (.0677)
Children born in the household ≤ 2 ≥ 2	Protects (.0123)	NA	NA
Birth weight ≤ 2.50kg ≥ 2.5 kg	Lowers (.0085)	NS[10]	NS

9 Predictor variables that were not significant and could not be retained in the model are designated as "not applicable" (NA).
10 Predictor variables that were entered into the model but were not significant predictors (NS) are designated as NS.

Table 5.1 (Cont'd).

Sex Boys Girls	NS	NS	NA
Child's age (months) 1-12 13-24 ≥ 25	NS	Protects .0105)	NA
Birth order ≤ 2 ≥ 2	Lowers (.0286)	NS	Protects (.0257)
Breastfeeding status Weaned Breastfeeding	NS	Protects (.0080)	NS
Breastfeeding Ever breastfeed Never breastfeed	NA	NS	NS
Child's age at Introduction of mashed food ≤ 4 months ≥ 4 months	NA	Protects (.0229)	Protects (.0131)
Number of meals/day 2-3 4-6	NS	NS	NA
Child eating pattern Enough Too little Too much	NA	NA	Protects (.0391)
Mother's formal income ≤ 400 ≥ 400 None	NA	Lowers (.0499)	NA
Mother's age (years) < 21 22-30 > 31	NA	NA	Lowers(.0995) Lowers (.0764)
Cooking fuel Wood Propane Gas	NA	NA	NA

Objective 4: Describe the relationship between the mother's choice and timing of complementary foods, the household's demographics and the child's anthropometrics.

In the bivariate analysis, the mother's choice of complementary foods appeared to influence the child's growth parameters (t-tests, Table 4.8). However, this influence did not persist when other variables were factored into the analyses. In the logistic regression models built earlier, the child's primary complementary food was not a significant predictor for any of the three growth parameters measured in this study. This finding is not surprising because a large proportion of children is given the same food item (sorghum porridge). In essence, the predictive power of the mother's choice of complementary food is weakened by its commonality compared to other predictors. In short, there appears to be one primary complementary food item -sorghum porridge and children exposed this choice (holding all other variables constant) will inevitably have comparable growth parameters.

Similarly, a higher proportion of children in the sample was breastfed. Thus, breastfeeding was not a significant predictor of any of the three growth parameters measured. However, since the children were breastfeed at different times relative to the data collection time, some growth parameters could be predicted based on whether the child was weaned or currently breastfeeding at the time of the study.

In contrast to the choice of complementary food, the influence of the

timing of the introduction of mashed food on weight-for-age was consistent in both the bivariate (Table 4.9) and the multivariate (Tables 4.13 & 4.14) analysis. This variable was highly significant in protecting against low weight-for-age and low weight-for-height.

Among the household demographic variables, the presence of residing relatives consistently increased the probability of malnutrition. Younger children were less likely to be malnourished than older children (Table 4.5), but the influence of the child's birth order was variable across the growth parameters. Regarding household headship, children in households headed by relatives other than the child's father, mother, or grandparent were more likely to be malnourished. In addition, the odds of stunting were higher for children in households headed by the child's father compared to the child's grandparent.

Summary and Conclusions

Understanding the child's feeding practices, the relationships between the household profiles, and the prevailing types of child malnutrition are essential for the proper management and prevention of malnutrition. Such information is also crucial in the formulation of sound and effective public health policies. The purpose of this study was to fully describe the relationship between the choice and timing of complementary food, household demographic factors and the outcome variables (height-for-age, weight-for-age and weight-for-height z-

scores).

The key variables in describing the child feeding practices included the child's primary complementary food, the age of the child at introduction of the different complementary foods and fluids, breastfeeding and the relationship between the child's primary caregiver. The variables household headship, mother's income, father's income, the presence of residing relatives, number of children in the household, type of toilet facilities, nature of household housing, and the sources of water, cooking and lighting energy were used to describe the household demographic characteristics. The variables sex, birth weight, and birth order were used to describe the child's characteristics.

The study findings suggest that low height-for-age, weight-for-age and weight-for-height are significant problems in children of ages 3- 36 months in Botswana. The risk of all forms of malnutrition is lowest in children under 6 months and highest in children of ages 25-36 months.

In general, complementary diets in this study did not adequately meet the nutritional requirements for children of ages 3-36 months. In addition, complementary diets are largely constituted of unfortified fermented sorghum porridge. Tsabana, a high energy, high protein government formulated weaning food is not considered a major complementary food by mothers. In addition, complementary fluids and foods are introduced earlier than the recommended age of introduction. Water and mashed food are introduced earlier than 4-6 months while cow's milk is introduced earlier than 1 year.

Using prediction models built in this study, at least a third of children were accurately predicted as malnourished. Significant predictors of low height-for-age in order of increasing partial correlations were, residing relatives (15%), birth order (19%) number of children in the home (- 24%) birth weight (26%). Significant predictors of low-weight-for-age were; mother's income over 400 pula (14%), presence of a toilet facility (-15%), age at introduction of mashed food (-19%), residing relatives (19%), the child's age (-23%), and weaned from breastfeeding (-24%). With regard to weight-for-height the significant predictors were the mother's age under 21 (12%), and between 22 and 30 (16%) years, residing relatives (17%), source of cooking energy (17%, child's eating behavior (-22%), birth order (-25%) and age at introduction of mashed food (-30%).

Study Limitations and Strengths

This study had several limitations. A convenience sample was used instead of a random sample. Homes in Gabane, like other villages in Botswana, do not have numerical physical addresses. Thus, although the clinic register had all names of children under-five years, it was not possible within the time available for this study to track these households and number all children of ages 3-36 months. Our inability to identify and number these children made random sampling impossible. Additionally, time and monetary constraints restricted the sample size in this study.

Furthermore, only children who regularly attended Child Welfare Clinic (CWC) had a chance of being in the study. Children who did not attend the Child Welfare Clinic for any reason may have different growth parameters from those who attend. It is expected that the welfare of children whose lack of government CWC attendance is not replaced by a comparable service would be worse compared to those who attend.

In addition, the study respondent could be any adult who accompanied the child to the clinic. In an attempt not to exclude children who were not accompanied by their mothers, an aunt or a grandparent was allowed to stand in the place of the child's mother. This decision was based on the assumption that adults who are prepared to seek clinic services for the child should be accountable enough to serve as study respondents. Thus, in this study the respondents included the child's aunt, mother, or grandparent. However, it is not known how the variability in the respondent's relationship with the study child might have influenced the accuracy of the information provided.

In analyzing the dietary data, it was not possible to estimate the amount of breast milk consumed by the child, thus the contribution of breast milk and complementary diets to the child's overall intake could not be estimated. Consequently, the adequacy of either could not be evaluated.

The 24-hour dietary recall method used in this study has inherent limitations. The method relies on recall and requires correct estimation of serving sizes of the food consumed. Even with the use of interview aids, the

latter requirement may particularly be difficult to meet in a culture that does not use measurements regularly. Furthermore, only a sub-sample of dietary data was selected to evaluate the child's dietary intake in this study.

The study also had several strengths. The investigator's familiarity with the culture and language of the study population was especially helpful during the data collection stage. The other strength in this study was her professional training and work experience in the area of maternal and child nutrition. Additionally, the data were checked for possible data coding and entering errors by another student.

This study comprehensively assesses child growth parameters in Gabane. The collected data includes the child's anthropometrics, child feeding practices, the household's and child's demographic characteristic and dietary intake. This is probably the first study that has attempted to quantitatively assess dietary intakes in Botswana. Consequently it is the only study that has attempted to describe the relationship between the child growth parameters, dietary intake and household's demographic characteristics.

Study Implications and Recommendations.

The government sponsored Baby and Mother Friendly Initiative and the Vulnerable Group Feeding programs are designed to curtail the prevailing rates of malnutrition in children under five years old in Botswana. The former aims at strengthening and protecting breastfeeding for the benefit of all children except

in situations where breast milk is contraindicated. The latter has different target groups. Of interest to this study are children from 4-36 months. Through the program, qualifying children are provided with a vitamin and mineral fortified soy/sorghum mix (Tsabana) and cooking oil. The vitamin and mineral fortification of tsabana is done in accordance with the Codex Alimentarious guidelines. Thus, the amount of tsabana provided when used as recommended could potentially meet at least 1/3 of the nutritional requirements for children of ages 4-36 months.

The Baby and Mother Friendly Hospital Initiative (BMFHI) and the Vulnerable Group Feeding (VGF) programs are therefore complementary. Exclusive breastfeeding from birth up to 4-6 months as advocated by BMFHI program, followed by complementation with nutrient dense foods (including tsabana) and continued breastfeeding until 2 years, as advocated by the latter (VGF) would eventually meet the needs of the growing child.

However, given the observed child feeding practices in Gabane and the prevailing malnutrition rates as reported in this study, the effectiveness and efficiency of these two programs, among other Government programs, need improvement. It is thus recommended that these programs be evaluated and possibly be restructured to address the problems such as those seen in Gabane. Furthermore, this recommendation needs to be given immediate attention because the country anticipates higher malnutrition prevalence rates due to high HIV/AIDS prevalence in childbearing mothers. Currently it is estimated that

7000-9000 children are infected yearly (Family Heath Division, 2000). Gabane villagers will definitely have their share of the problem, particularly because Gabane village has a high prevalence of HIV/AIDS compared to other villages in the country (AIDS/STD Unit, Ministry of Health, 1998).

A sizable number of study children also came from households headed by grandparents. The evolution of this family type may need further investigation. Such investigation may shed more light into circumstances surrounding this family type. Does this family type arise due to orphaned children or lack of family planning by younger mothers? If the former is true then, what proportion of these orphans are due to AIDS? Further investigation may clarify these questions and consequently signal the relevant agencies for intervention. Additionally, health and nutrition education messages may need to target grandmothers in addition to the child's mother.

Extended families are very common in Botswana. The composition of such families and their impact on the child's growth may need to be elucidated. This recommendation is based on the observed relationship between the presence of relatives in the home and increased odds of stunting, underweight and wasting. The partial correlation for this variable was 15%, 22%, and 17% for height-for-age, weight-for-age and weight-for height respectively. In the past, extended families were believed to be helpful in that all adults shared in the raising children. However, the current observation reflects an opposite effect.

Recommendations for Future Research

This study has highlighted areas that may need further research. First, the prevalence of malnutrition observed in Gabane compares well with malnutrition trends reported in 1996 (Ubomba-Jaswa and Belbase, 1996). Malnutrition persists despite the continuation of the BMFHI and VGF programs. This lack of improvement suggests that the disparity between the child's dietary intake and the nutritional needs of the growing children still exist. This disparity might be a direct consequence of poor access to food by households and / or unfavorable changes in any of the underlying causes of malnutrition {also known as ecological variables}(Jelliffe and Jelliffe, 1989, UNICEF, 1996)

It is also likely that the program inputs (e.g. tsabana) do not reach the targeted children. Such a leakage in the flow of services might erroneously give the impression that the nutritional needs of 3-36 months Gabane children exceed the inputs of the nutrition intervention programs.

In either situation, a thorough needs assessment of the determinants of malnutrition in Gabane is essential. In studying these determinants, much emphasis should be put on the mother's perceived needs and on how the identified needs can be met. Furthermore, the BMFHI and VGF program objectives need to be evaluated against the findings of the needs assessment and appropriate adjustments be taken as needed.

The Vulnerable Group Feeding Program supplies tsabana through its clinic-based Supplementary Feeding Program to children between the ages of 4 and 36

months. However, in this study only one mother considered tsabana as the child's primary complementary food. It is unclear why tsabana was not considered as the child's primary food and thus was not reported in the 24-hour dietary interviews. However, if the tsabana was not mentioned in the interview because it was used up days before the interviews, then our observation is understandable. Nonetheless, the program may need to investigate the intra-household distribution of tsabana and its perception by mothers.

One major observation of this study is that over 80% of mothers used and considered sorghum porridge as the child's primary complementary food. However, unfortified sorghum porridges do not meet the nutritional needs of a child. Most mothers fed their children fermented sorghum porridge which has higher caloric density per given volume than unfermented sorghum. Fermentation has been shown to improve both the protein and energy digestibility of some sorghum varieties (Dendy, 1995). However, even with fermentation, the caloric content of complementary diets was lower than the age and sex specific recommended dietary allowances. It is thus recommended that sustainable household-level technologies for improving the nutrient densities of complementary sorghum porridges in Gabane be explored.

Extended families are very common in Botswana. Culturally these have been valued because they promote sharing of resources by members and transmission of information and skills from older to younger members of the household. However, in the study the presence of residing relatives was

associated with increased odds for underweight, stunting, and wasting. It is likely that the impact of residing relatives on the household has changed with the increasing reliance of households on formal income to procure food as opposed to subsistence agricultural production. In the latter, all members of the household contributed to the production of food whereas in the former only a few members of the family may be employed at given time. It is recommended that the impact of residing relatives on the household and on growth parameters of 3-36 months old children be investigated.

APPENDIX A

CONSENT FORM

[11]**CONSENT FORM (English version)**

The investigator is interested in studying the relationship between the mother's choice and timing of weaning/complementary foods and child growth in Gabane. The objective of this study is to describe the main weaning foods that mothers in Gabane feed their children regularly, identify factors which influence the type of foods the mothers choose, and the age of the child when these foods are introduced.

As part of this study, I am requesting information from you and other mothers attending Gabane Clinic today. The information I am requesting include, your household's size, income level, type of housing, source of drinking water, how you normally feed your child, your formal education level, the weight and height measurements of your child and other factors related to how you care for your child.

Although young children are generally not bothered by weight measurements, their weights will be taken using Gabane Clinic equipment because the children are accustomed to them. However, some children appear not to like height/length measurements because this procedure requires that they be helped to stand or lie down as straight as possible. This being the first time the children 's height/length will be taken in the clinic, we intend to make the measurements less stressful as much as is possible. Length measurements

11 Respondents were read a Setswana version of the consent form (directly translated from this one).

will therefore not be taken from any child who appears particularly fearful of the procedure.

The whole data collection process is expected to take about 15 minutes of your time. However you are free to choose not to continue with the data collection process at any time without any penalty (i.e. you will continue to receive child welfare clinic services as usual even if you choose not to participate in the study).

Please complete the following information

I understand the objectives of this study and the information required as read to me by the investigator or self. I understand the known risks or concerns and believe that care has been taken to minimize the risks to my child and me.

I understand that even after signing the consent form, I can still decide not to proceed with the entire interview or choose not to answer certain parts of the questionnaire.

Mother's signature _____ Date_____

Research Investigator: Maria S. Nnyepi
University of Botswana
Private Bag 0022.
Gaborone, Botswana
Tel. 267-355 3469

APPENDIX B

UCRIHS LETTER

REQUEST LETTER TO KDC

MICHIGAN STATE
UNIVERSITY

June 10, 1999

TO: Dr.Jenny BOND
2100 South Anthony Hall

RE: IRB# **99344** CATEGORY: 1-C, E

APPROVAL DATE:June 10, 1999

TITLE:THE MOTHER'S CHOICE AND TIMING OF COMPLIMENTARY FOODS ON GROWTH OF CHILDREN IN BOTSWANA

The University Committee on Research involving Human Subjects' (UCRIHS) review of this project is complete and I am pleased to advise that the rights and welfare of the human subjects appear to be adequately protected and methods to obtain informed consent are appropriate. Therefore, the **UCRIHS approved this project.**

RENEWALS: UCRIHS approval is valid for one calendar year, beginning with the approval date shown above. Projects continuing beyond one year must be renewed with the green renewal form. A maximum of four such expedited renewals possible. Investigators wishing to continue a project beyond that time need to submit it again for a complete review.
REVISIONS: UCRIHS must review any changes in procedures involving human subjects, prior to initiation of the change. If this is done at the time of renewal, please use the green renewal form. To revise an approved protocol at any other time during the year, send your written request to the UCRIHS Chair, requesting revised approval and referencing the project's IRB# and title. Include in your request a description of the change and any revised instruments, consent forms or advertisements that are applicable.
PROBLEMS/CHANGES: Should either of the following arise during the course of the work, notify UCRIHS promptly: 1) problems (unexpected side effects, complaints, etc.) involving human subjects or 2) changes in the research environment or new information indicating greater risk to the human subjects than existed when the protocol was previously reviewed and approved.

If we can be of further assistance, please contact us at 517 355-2180 or via email: UCRIHS@pilot.msu.edu. Please note that all UCRIHS forms are located on the web: http://www.msu.edu/unit/vprgs/UCRIHS/

Sincerely,

David E. Wright, Ph. D.
UCRIHS Chair

DEW:

cc: Maria Nnyepi

OFFICE OF
RESEARCH AND GRADUATE STUDIES

niversity Committee on Research Involving Human Subjects (UCRIHS)

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Private Bag 0022 Gaborone Botswana
Telephone 351151 • Fax 356591 • Telex 2429 BD

May 10, 1999

Regional Medical officer
Kweneng Regional Health Team
Private bag 5
Molepolole

Dear Regional Medical officer,

Subject: The role of weaning porridges on the child's growth indicators: A Survey

I am interested in investigating the relationship between the mother's choice of complementary food and the child's growth indicators. My interest was sparked by the findings of the Determinants of Malnutrition Survey carried out in 1995 by the Family Health Division, UNICEF and the University of Botswana. A UNICEF Consultant, Ms. Ubomba-Jaswa and Mr. Krishna Belbase put the initial report for this survey together in 1996. Ubomba-Jaswa and Belbase reported differential use of porridges, infant formula and UHT milks by mothers of different demographic characteristics. However, the survey never attempted to correlate the child's complementary diet with the child's growth indicators. A step that might shed more light on the reported slowed growth (growth faltering) in children of weaning age.

As an attempt to shed more light on the relationship between weaning diets and growth faltering, I have proposed to investigate this issue further in one of the villages that was surveyed in the Ubomba-Jaswa and Belbase's survey. Therefore, the purpose of this letter is to request permission to interview **consenting** mothers of children attending the Child Welfare Clinic at Gabane Clinic. The interviews will not disrupt your regular Child Welfare Clinic services or require your employee's time, as I will be interviewing consenting parents as they await regular services or finish receiving their services.

Your assistance in this matter will be greatly appreciated.

Sincerely,

Maria S. Nnyepi

Department of Home Economics Education

APPENDIX C

QUESTIONAIRE

Respondent Number _____.

HOUSEHOLD DEMOGRAPHIC DATA

1.0 Are you this Child's mother?
  1.1 YES 1.2. NO. If NO, how long have you known the child?_____
2.0 If NO, is this child an orphan?
  2.1 YES
  2.2 NO
3.0 How many children do you have? Refers to mother or surrogate mother.
  3.1 Boys_____
  3.2 Girls _____
4.0 What is the total number of children less than five years. _____
5.0 Is this child's father staying with you?
  5.1 YES. *(Skip to 11)*
  5.2 NO
6.0 If NO, is this child's father working in another town/country?
  6.1 YES
  6.2 NO *(skip to 9)*
7.0 If YES, how often does this child's father come home?
  7.1 _____ per week
  7.2 _____per month
  7.3 _____per 3 months
  7.4 _____per 6 months
  7.5 _____per year
8.0 How long does the father stay with the family whenever he visits? _____
9.0 If NO, Are you the head of the family?
  9.1 YES (skip to 11)
  9.2 NO
10.0 If NO, who is the head of the family? _____
11.0 Does this child's father help support the children?
  11.1 YES
  11.2 NO *(skip to 13)*
12.0 IF YES, is the support enough to buy food?
  12.1 YES
  12.2 NO
13.0 Are there any close relatives staying with you? YES
  13.1 NO. *(skip to 18)* If YES, how many adults? _____ And Children? _____
14.0 Are some of these relatives this child's grand parents?
  14.1 YES 14.2 NO

15.0 Do all people in the household share meals?
- 15.1 YES
- 15.2 NO

16.0 If YES, do the adults staying with you help buy food?
- 16.1 YES
- 16.2 NO

EDUCATION AND EMPLOYMENT DATA.

17.0 What is your education level?
- 17.1 None.
- 17.2 Primary.
- 17.3 Secondary
- 17.4 Tertiary

18.0 Are you employed outside the home?
- 18.1 YES
- 18.2 NO. (skip to 23)

19.0 If employed outside the home, who takes care of this child while you are at work?Grand parent(s)
- 19.1 Employed helper
- 19.2 Relative other than grand parent
- 19.3 Neighbor
- 19.4 Day care center/preschool
- 19.5 I take the child with me to work
- 19.6 Other_____

20.0 What is your occupation? _____

21.0 How much are you (refers to the mother/ surrogate mother) paid per month?
- 21.1 under 400 Pula
- 21.2 401 to 699 Pula
- 21.3 700 to 999 Pula
- 21.4 1000 to 1399 Pula
- 21.5 1400 to 1899 Pula
- 21.6 1900 to 2399 Pula
- 21.7 2400 to 2999 Pula
- 21.8 over 3000 Pula

22.0 What (other) sources of income do you (mother/surrogate mother) have?

	Source of income	Amount per month
22.1	Rentals	_____
22.2	Sales of produce from your garden	_____
22.3	Sales of Handicrafts	_____
22.4	Support from Child's father	_____
22.5	Proceeds from a kiosk in the home	_____

22.6 Other_____ _____

23.0 What is the education level of the child's father?None
- 23.1 Primary
- 23.2 Secondary
- 23.3 Tertiary

24.0 Is this child's father employed outside the home?
- 24.1.1 YES
- *24.1.2* NO *(skip to 28)*

25.0 If YES, what is his occupation? _____

26.0 How much do think this child's fathers is paid per month?
- 26.1 under 400 Pula
- 26.2 401 to 699 Pula
- 26.3 700 to 999 Pula
- 26.4 1000 to 1399 Pula
- 26.5 1400 to 1899 Pula
- 26.6 1900 to 2399 Pula
- 26.7 2400 to 2999 Pula
- 26.8 over 3000 Pula

27.0 What (other) sources of income do you think the child's father has?

	Source of income	Amount per month
27.1	Rentals	_____
27.2	Sales of agricultural produce	_____
27.3	Sales of Handicrafts	_____
27.4	Proceeds from a kiosk in the home	_____
27.5	Other_____	_____

CHILD FEEDING PRACTICES.

28.0 Is this child breastfeeding?
- 28.1 YES (skip to 32)
- 28.2 NO

29.0 If NO, was the child ever breastfed?
- 29.1 Yes → how long was the child breastfed? _____
- 29.2 NO.

30.0 If NO, what was this child fed? *(answer this question and then Skip to 34)*
- 30.1 Infant formula
- 30.2 UHT pasteurized milk
- 30.3 Store-bought fresh milk

30.4 Milk from an animal at home
30.5 Other_____

31.0 How long do you intend to breastfeed? _____

32.0 How long was the child exclusively breastfed?_____

33.0 If employed outside the home, what was this child fed in place of breast milk while you were at work?

33.1 Expressed breast milk
33.2 Infant formula
33.3 UHT pasteurized milk
33.4 Store-bought fresh milk
33.5 milk from an animal at home
33.6 Other_____

34.0 If the following fluids have been introduced, when were they first given to the child regularly?

34.1 Infant formula _____
34.2 UHT milk
34.3 Store-bought fresh milk_____
34.4 milk from an animal at home_____
34.5 Tea_____
34.6 Water_____
34.7 Juice_____
34.8 Other _____

35.0 If this child has been introduced to mashed or semi-solid food, when they first given regularly? _____

36.0 How many meals does the family eat per day?

36.1 One
36.2 Two to three
36.3 More than 3

37.0 How many times is this child fed

38.0 per day?

38.1 Two to three
38.2 Four to Six
38.3 Other_____
38.4 If this child is still breast feeding, give number of breastfeeds per day _____

39.0 Who feeds this child most often?

39.1 Mother
39.2 Surrogate mother
39.3 Older Sibling
39.4 Grand parent(s)
39.5 Other Adult relative_____

39.6 Helper
39.7 Child feeds self

40.0 If the child is already on semi-solids foods, What is the major food item fed to the child(i.e. the most frequently fed food item per day)
40.1 Porridge, Type _____
40.2 Tsabana
40.3 Commercially prepared
40.4 baby food (bottled food)
40.5 Commercially prepared Instant baby cereals
40.6 Mashed potatoes/pumpkin
40.7 Other mashed vegetables _____
40.8 Mix of _____ and _____
40.9 Other _____

41.0 How do you usually prepare and serve _____(the major food item identified in 38 above). Check all that apply.
41.1 Type of cereal meal_____
41.2 Prepared /served with a source of animal protein(milk/meat) _____ times per day
41.3 Served with beans _____ times per day.
41.4 Served with sugar_____ times per day
41.5 Served with a rich source of fat/oil(nuts, mayonnaise, butter/margarine _____per day
41.6 Other_____

42.0 How do you describe this child's eating behavior?
42.1 Child eats enough food
42.2 Child does not eat enough food
42.3 Child eats too much food

43.0 Does this child have his/her own plate or shares the plate with other children
43.1 Child eats by herself/himself
43.2 Child eats with others

44.0 Is there usually enough for this child to eat?

45.0 Is there usually enough food for this child to eat?
44.1YES
44.2 NO

DIETARY DATA SPECIFICALLY FOR THE STUDY CHILD

45 24 hour- dietary recall

Time	Food item	Portion Size	Description of food

46 Is this recall typical of this child's intake?

46.1 YES

46.2 NO------ How is it different? _____

47 Does this child take other meals away from home? e.g. at preschool? Or Day Care Center?

47.1 YES

47.2 NO

CHILD ANTHROPOMETRIC AND HEALTH DATA

48.0. Complete the table

48.1 Birth Date		48.5 Birth weight	
48.2 Apgar score		48.6 Today's weight	
48.3 Birth order		48.7 Today's height/length	
48.4 Sex			

49.0 Was this child ill within the last two weeks?

49.1 YES
49.2 No

50.0 YES, was this child taken to the clinic?
50.1 YES
50.2 NO

51.0 How would you describe this child's general health?

51.1 Very healthy
51.2 Fairly healthy
51.3 Child is ill most of the time

52.0 How many times was this child hospitalized in the past year_____
53.0 Why was this child hospitalized? _____
_____
_____
____

HOUSING CONDITIONS.

54.0 What type of housing does the family live in?
54.1 Traditional houses/roundavels

54.2 Modern house
54.3 Other_____

55.0 Is the dwelling place rented or owned by the family?

55.1 Rented
55.2 Owned
55.3 Grand parent's home

55.4 Allowed use without charge by other relative
55.5 Other _____

56.0 What type of roofing is on the main house/roundavel

56.1 Thatch
56.2 Tiles
56.3 Metal sheets
56.4 Other

57.0 What is the household's source of drinking water?

57.1 Public standpipe
57.2 Stand pipe in the yard
57.3 In-door plumbing
57.4Other_____

58.0 What type of toilet does the household use?

58.1 Pit latrine
58.2 Flush toilet

59.0 How do you light your house?

59.1Paraffin lamp
59.2 Candle
59.3 Electricity
59.4Other_____

60.0 What type of energy is used for cooking?

60.1 Wood
60.2 Gas
60.3 Electricity
60.4 Other_____

APPENDIX D

OTHER DATA TABLES

TABLE D1: THE RELATIONSHIP BETWEEN AGE OF INTRODUCTION OF COMPLEMENTARY FOODS/FLUIDS AND THE CHILD'S GROWTH PARAMETERS

Nutrition Index/proportion of calories or protein in diet	N	Mean Z-score	T-statistics	P-value
HAZ				
Tea				
0-6	16	-1.2256	-.461	.678
7-12	11	-.9789		
UHT milk				
0-6	42	-.7907	.442	.660
7-12	20	-.9845		
Infant Formula				
0-3	48	-.6215	.254	.801
4-12	11	-.7255		
Cow/goat's milk				
0-6	17	-.8794	.737	.533
7-12	3	-1.9500		
Water				
0-3	96	-.8002	-.464	.644
4-12	31	-.6839		
WAZ				
Tea				
0-6	16	-.9094	.059	.954
7-12	11	-.9373		
UHT milk				
0-6	42	-.7740	.853	.397
7-12	20	-1.0480		
Infant Formula				
0-3	48	-.6215	.254	.801
4-12	11	-.7255		
Cow/goat's milk				
0-6	17	-.6018	1.190	.348
7-12	3	-2.0167		
Water				
0-3	96	-.6427	.796	.2090
4-12	31	-.8487		

TABLE D1 (Cont'd.)

WHZ				
Tea				
0-6	16	-.9172	.638	.529
7-12	11	-.4109		
UHT milk				
0-6	42	-.3350	.638	.526
7-12	20	-.5105		
Infant Formula				
0-3	48	6.667E-02	.165	.869
4-12	11	1.388E-17		
Cow/goat's milk				
0-6	17	-.453E-02	1.765	.095
7-12	3	-.9400		
Water				
0-3	96	-.1300	1.640	.103
4-12	31	-.5326		

TABLE D2: THE RELATIONSHIP BETWEEN THE PROPORTION OF CALORIES AND PROTEIN IN THE DIET[12] AND THE CHILD GROWTH PARAMETERS.

Nutrition Index/proportion of calories or protein in diet	N	Mean Z-score	T-statistics	P-value
HAZ				
% Protein				
≤ 66%	25	-.5824	.483	.633
≥ 67%	24	-.7346		
% Calories				
≤ 66%	47	1.500E-2	.885	.380
≥ 67%	2	-.6855		
WAZ				
% Protein				
≤ 66%	25	-.3904	.735	.466
≥ 67%	24	-.6821		
% Calories				
≤ 66%	47	.9050	1.54	.134
≥ 67%	2	-.5945		
WHZ				
% Protein				
≤ 66%	25	-3.12E-2	.652	.517
≥ 67%	24	-.2888		
% Calories				
≤ 66%	47	1.2150	1.460	.151
≥ 67%	2	-.215		

12 Dietary analysis excludes the contribution of breast milk

TABLE D3: THE RELATIONSHIP BETWEEN HOUSEHOLD'S DEMOGRAHIC FACTORS AND THE CHILD'S HAZ, WAZ, AND WHZ

Nutrition Index/Demographic factors	N	Mean Z-score	T-statistics	P-value
HAZ				
Sex				
Boy	69	-.8303	-.683	.496
Girl	63	-.6870		
Maternal education				
None	21	-.5914	.827	.410
Secondary	78	-.8355		
Maternal income				
≤ 400 Pula	20	-.8140	.382	.704
≥ 400 Pula	22	-.9664		
Maternal employment				
Yes	45	-.7836	-.148	.882
No	87	-.7507		
Birth order				
≤ 2	75	-.8141	-.571	.699
≥ 3	57	-.6932		
Headship				
Parent	79	-.6623	1.076	.284
Grandparent	52	-.8933		
WAZ				
Sex				
Boy	69	-.7399	-.524	.601
Girl	63	-.6259		
Maternal education				
None	21	-.6619	.120	.905
Secondary	78	-.6996		
Maternal income				
≤ 400 Pula	20	-.7990	.360	.726
≥ 400 Pula	22	-.9400		
Maternal employment				
Yes	45	-.7451	-.395	.694
No	87	-.6546		
Birth order				
≤ 2	75	-.7221	-.387	.699
≥ 3	57	-.6372		
Headship				
Parent	75	-.6768	.062	.946
Grandparent	52	-.6921		

TABLE D3 (Cont'd.)

WHZ				
Sex				
Boy	69	-.2712	-.402	.688
Girl	63	-.1878		
Maternal education				
None	21	-.3910	-.703	.484
Secondary	78	-.8355		
Maternal income				
≤ 400 Pula	20	-.3035	.269	.791
≥ 400 Pula	22	-.4050		
Maternal employment				
Yes	45	-.2927	-.428	.671
No	87	-.1997		
Birth order				
≤ 2	75	-.2435	-.134	.894
≥ 3	57	-.2154		
Headship				
Parent	79	-.2925	-.700	.485
Grandparent	52	-.1435		

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