The association of breast feeding and nutritional status of children 13-36 months of age

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ABSTRACT

Previous studies failed to report benefits of prolonged breast feeding on nutritional status. A nationally representative sample of 1411 children from Sri Lanka (1987) was used to compare breast feeders versus non breast feeders, as well as duration of breast feeding, through multivariate analyses for height-for-age, weight-for-age and weight-for-height Z-scores. Analyses of interaction showed prolonged breast feeding to be advantageous among children of working mothers, and children from households using an unimproved water supply. For example, children 35 months of age, breast fed for 24 versus 8 months were 0.9 centimetres (95% confidence interval; +0.0, 1.8) taller if mothers worked and 420 grams (140, 690) heavier if households used an unimproved water supply. Among uneducated mothers breast fed children were 1.3 cm (2.2, 3.3) shorter than non breast fed children. Prolonged breast feeding should be encouraged as it is advantageous for the nutritional status of certain subgroups of children older than 12 months of age.

RESUME

Les études antérieures ont échoué à démontrer les avantages de l'allaitement pour une dureé prolongeé sur le statut nutritionnel des enfants. Un echantillanage représentatif de 1411 enfants du Sri Lanka a éte utilisé pour faire une comparaison entre les mères qui ont allaité, celles qui n'ont pas allaité ainsi que la dureé qu'elles ont donné le sein. Les analyses mutivarieés ont employé la grandeur, le poids at la grandeur vis-à-vis poids selon l'âges (Z-Score) des enfants. L'analyse des interactions a indiqué qu'allaiter les enfants pour une période prolongeé est avantageux quand les enfants viennent de familles où la femme travaille et dont la famille reçoit de l'eau pauvre qualité. Les enfants âges de 35 mois et allaité pendant venant de familles où la femme travaille pendant 24 mois étaint 0.9 centimètres (95% Confidence de interval; +0.0, 1.8) plus grand que ceux qui ont été allaité pendant seulement 8 mois. Ces mêmes enfants pesaient 420 grammes (95%CI; 140, 690) de plus lors qu'ils venaient d'une famille où l'eau était de pauvre qualité. Parmi les mères non-scolariseés, les enfants allaités mesuraient 1.3 cm de moins (95%CI; 2.2, 3.3) que ceux qui n'ont pas été allaité. Pour certains groupes d'enfants âges de 12 mois et plus l'allaitement devrait être encouragé afin de faire profiter tous les avantages de l'allaitement au niveau du status nutritionnel.

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CHAPTER ONE: INTRODUCTION

I. OVERVIEW

The effect on growth, of breast feeding a child for more than twelve months, has been studied but without adequate control of confounding variables and consideration of effect modifiers. This thesis will address the effect of breast feeding on the growth of children 12 to 36 months of age. This issue will be examined through a secondary data analysis of the considerable information collected in the Sri Lanka Demographic and Health Survey (DHS).

The remainder of chapter one contains an introduction into prolonged breast feeding and background information on Sri Lanka. Chapter two is a review of literature in the measurement of nutritional status, child morbidity and mortality, breast milk quality, and the effect of prolonged breast feeding on growth. Chapter two also includes the objectives of the present study. Chapter three covers the methods used for this secondary data analysis. Chapter four presents the results of the analyses. The final chapter, five, is the discussion of the results.

II. INTRODUCTION

It is generally recognized and understood that breast feeding and sound weaning practices decrease morbidity. Decreasing morbidity in turn decreases mortality, which is an endpoint of concern.

The infant mortality rate in developing countries is alarmingly high (1). An underlying cause of this mortality is malnutrition. A five point strategy was proposed by the World Health Organization, to ensure the health of all children and reduce infant mortality rates. This strategy included promotion of breast feeding and sound weaning and dietary practice (2).

Breast feeding, a natural way of feeding, is highly prevalent in developing countries (3). The many advantages of breast feeding during the first few months of an infants' life are well documented. Breast milk is a safe, clean source of high quality nutrients that includes added immunological benefits. Breast milk alone is sufficient to meet an infant's needs for growth up to the first four to six months of life (2, 4, 5, 6, 7, 8).

Growth is a process from conception onward, which is affected by numerous interrelated factors, including breast feeding. As the infant grows older, the effect of breast feeding on growth becomes difficult to isolate from other factors, such as nutritional adequacy of supplemental foods and infections (9). The most severe faltering in growth usually occurs in the transitional weaning period which is during the second half of infancy, 6-18 months of age (9).

A. PROLONGED BREAST FEEDING IN DEVELOPING COUNTRIES

Breast milk, including mature breast milk, is an important source of nutrients and host resistant factors. It has a positive effect on growth through the nutrients that it provides and by decreasing rates of infection. Breast fed children are less exposed to disease and also benefit from the immunities that breast milk provides.

Infants' feeding duration and choice are tied to maternal and infant behavior, nutritional and health status, and cultural norms (10). The impact of prolonged breast feeding on growth faltering is not clear.

> Prolonged breast feeding is defined as supplemental breast feeding, along with other foods, of children over twelve months of age (11).
>
> Weaning is defined here as the complete termination of breast feeding. It does not refer to the initial introduction of foods while the child is still on the breast (12).

Although introducing foods, other than breast milk, to a child's diet gives additional sources of nutrients, it can also introduce problems related to hygiene and sanitation.

Due to the large number of factors involved, the age when breast milk alone becomes inadequate to completely meet all nutritional requirements for satisfactory growth varies between populations and between individuals within a population (9). However, breast milk produced during late lactation -- up to two years -- is a valuable nutritional supplement in the diet of a growing child (4, 5, 13, 14, 15, 16, 17).

Determination of the volume and composition of breast milk in poorly nourished communities should take into account ecological circumstances affecting both mother and infant (9). Although milk volume may decrease during the second year the overall proportion of protein, fat, and carbohydrate does remain the same in the milk of poorly nourished mothers(5).

Even after weaning foods are introduced, breast milk continues to be a critical source of energy, complete protein, nutrients, and immunologic components. Breast milk has many host resistance factors against tetanus bacillus, enteropathogenic E. Coli, salmonella, D. Pneumonia and the influenza virus. It also contains lysozyme, an active enzyme, which has a bactericidal effect (15, 18).

B. SRI LANKA: COUNTRY BACKGROUND

The rates of breast feeding are high well into the second and third years of a child's life in Sri Lanka. The Sri Lankan peoples' food and nutrition beliefs and practices are presented first. Next, the weaning practices of the Sri Lankan people are discussed. Then, to get a picture of the country, the geography and location are described.

1. FOOD AND NUTRITION

In Sri Lanka there is a food distribution system that attempts to provide food security to the population (19). Sri Lanka is self-sufficient in the production of one of the staple foods, rice (19).

Rice was found to be the main source of energy and protein in a study using data collected from secondary sources, from 1965-1980 (20). Wheat flour and fish were the other major sources of protein. However, one of the cheapest sources of protein was pulses, which are not widely eaten. Also, it was found that there was up to four times higher consumption of animal protein in urban sectors.

In southern Sri Lanka, a study examining seasonal variations in major crops and their relation to food shortages found that periods of food shortages occurred before the cultivation of rice (21). The shortage is most severe during February to March and July to August, which are the pre-harvest seasons. It was also found in this study that the typical village meal consists of rice and one to three dishes of vegetables, fruits and fish. This type of meal should be served three times per day to achieve adequate energy. However, rural workers and peasants can often only afford rice for two of the three meals in a day (21).

In another study, Wandel examined the traditional knowledge of food and nutrition in Sri Lanka and found that it was organized around the Ayurvedic medical system (22). In this system, people distinguish foods by classifying them as "hot" or "cold". Physical health is maintained when the body is in balance (22, 23). In times of illness balance is maintained by eating foods that are opposite to that of diseases (22, 23). In this study Wandel included a list of foods, which were classified as hot, cold and neutral (22). Hot foods include starchy foods, dried foods, tomatoes, mangoes, other acidic foods and foods considered to have a poisonous effect, such as manioc and mushrooms. Cold foods include liquids, and vegetables with a high water content, such as green leafy vegetables. Foreign foods, and rice and breast milk are classified as neutral. Meat is avoided by many people for religious and economical reasons. In addition, Wandel found that many factors such as availability, husbands' and children's' preferences have a stronger influence than adherence to the hot and cold system (22).

2. WEANING PRACTICES

In general, the type of weaning food chosen, age of introduction and reasons for introduction vary greatly and depend on interrelated factors including culture, food availability, socio-economic status, and health of the infant and mother (9). In a review of timing of complementary feeding it was concluded that there is "overwhelming evidence" showing that introduction of foods and liquid increases the risk of diarrheal diseases, especially in poor communities, starting at infancy (8). In this review, it was concluded that the best indicator of the need for complementary foods was growth faltering (8). In addition, a step towards understanding infant health and malnutrition was knowing the beliefs and practices of infant feeding in that area (24).

In Sri Lanka, one of the few times the hot and cold system was found to exert any influence was during infancy (22). Breast milk was considered superior by both Ayurvedic doctors and mothers for the first year. Formula was considered hot and was discontinued if the child got sick. In addition, hot foods were generally not given to children (22). Foods that were considered as good for weaning were biscuits, ash plantains, cow's milk and curd, all neutral or slightly cool foods, and foods introduced during colonial times, such as potatoes and carrots.

From the results of the Sri Lanka Demographic and Health Survey, 45% of infants aged 0-4 months are given breast milk and supplement, about 39% are given breast milk and water, 12% are exclusively breast fed and the remaining infants are not breast fed at all (17).

3. GEOGRAPHY AND DEMOGRAPHY

Sri Lanka, formerly known as Ceylon, is an island off the south eastern coast of India. It has an estimated population of 16.2 million (19). It is 435 kilometres long and 225 kilometres wide(19).

Sri Lanka has three climatic zones. The wet zone, in the south western part, has two annual monsoons. The dry zone, in the northern and eastern parts, depends on surface water for irrigation for over half of the year. The intermediate zone covers the south western hills.

Sri Lanka gained independence from Britain in 1948. Government policies have emphasized social development in areas of literacy, health services, and access to food; over time these have resulted in a low infant mortality rate (34/1000 births). Despite emphasis on manufacturing, the economy remains predominantly agricultural (25).

More than half of the population in Sri Lanka is concentrated in the wet zone. However, there has been a shift into the dry zone after improvement of the irrigation systems, and the eradication of malaria (19).

C. SUMMARY

Sri Lanka is a developing country in Asia where rates of breast feeding and malnutrition are high. Therefore, information collected as part of the Sri Lanka DHS will be analyzed to determine the relationship, if any, between breast feeding children over 12 months of age and nutritional status. Breast milk is an important source of nutrients and immunological factors protecting an infant, less than twelve months of age, against disease and malnutrition. Prolonged breast feeding may have similar benefits for a child over the age of twelve months.

CHAPTER TWO: LITERATURE REVIEW

Chapter two is a literature review of the areas associated with breast feeding children over twelve months of age and with nutritional status. The measurement of nutritional status, child morbidity and mortality in developing countries, and breast milk quality after the first year are examined. Then a proposed biological model of the link between prolonged breast feeding and nutritional status is presented. This is followed by a review of the effect of breast feeding on the nutritional status of children, above twelve months of age. Finally, the objectives of the present study are presented.

I. MEASUREMENT OF NUTRITIONAL STATUS

The nutritional status of children is one of the most sensitive indicators of sudden change in health status and food availability. It acts as an early warning of distress, ill health, famine, and death (26). Nutritional status indicators are a direct measure of problems affecting children. Most studies on the effect of feeding practices on infant growth and nutrition use anthropometric measurements to determine the adequacy of infant nutrition (9).

A. USES OF ANTHROPOMETRY

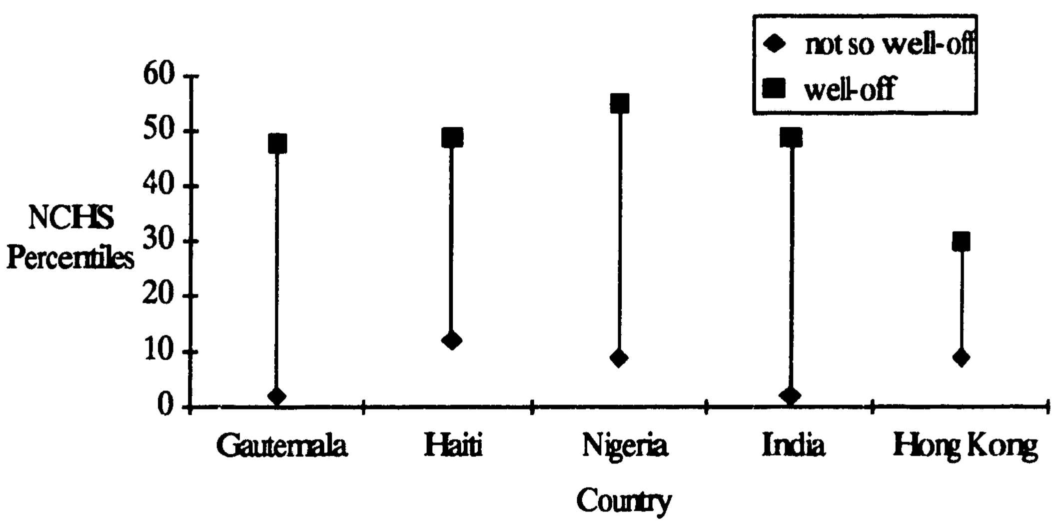
Anthropometry is useful because it (27):

1. identifies the process of failing to grow.
2. acts as a proxy for constraints to human welfare of the poorest, such as inadequate diets and infections.
3. is a predictor of poor health, functional impairment and mortality at individual and population levels.
4. is, in some cases, an indicator of the success or failure of interventions.

Four different measurements are needed for anthropometric assessment of nutritional status: age, sex, weight, and either height or length (26). These measurements can be used to calculate standard deviation scores (z-scores), which should be compared with international reference values, the NCHS growth curves (28).

The idea of z-scores being appropriate for comparison between countries depends on whether ethnic differences in heights of children are based on genetic variabilities or not. As illustrated in Figure 2.1, ethnic differences in heights of children were shown to be more related to environment than to genotypes (29). Most of the means of the well off groups are close to the NCHS 50th percentile. As seen in Figure 2.1, the range within countries is larger than the range within the well-off and not so well-off groups of children. Therefore, the NCHS growth curves are adequate for comparisons of children from a developing country, as there are greater differences within a country than between countries. However, in using z-scores for comparing children within a population the issue of genetic variability is not a concern.

Figure 2.1: Comparing Within and Between Country Differences for Mean Heights of 7 Year Old Boys



(adapted from 30)

A study in Hong Kong addressing why their children had lower heights concluded that it was genetics. Unfortunately, the daily energy intake of the Chinese infants in this study was lower than that of Caucasian infants (31). No conclusions could be drawn from this study because of the difference in energy intake confounding the results.

B. ANTHROPOMETRIC INDICATORS

There are three major indicators of different aspects of malnutrition that use anthropometric measurements (9, 26, 28,32):

1. Low weight-for-height (wasting)- indicate recent or acute malnutrition, either from failure to gain weight or weight loss. It is associated with seasonal patterns, changes in food availability and disease prevalence. It indicates that the tissue and fat mass are lower than expected for a reference child of that length.

2. Low height-for-age (stunting)- indicates that the child is shorter than the reference child for that age. It represents slowing in linear growth over time or a cumulative deficiency in growth. It is associated with long-term biological factors such as chronic insufficiency in protein and or energy intake, frequent infections, clinical factors such as low socio-economic-status of the family, and inappropriate feeding practices.

3. Low weight-for-age (underweight)- indicate either stunting, or wasting or a composite of stunting and wasting, indicating the extent of malnutrition. However, this does not distinguish between wasting and stunting.

The above three indicators can be used to describe a child or a child population. In addition, there are standards for classifying degrees of malnutrition, e.g., moderate malnutrition is weight-for-age less than minus two standard deviations from the reference median and severe malnutrition is weight-for-age less than minus three standard deviations from the reference median (26).

C. SUMMARY

The adequacy of child nutrition can be determined using anthropometric measurements, such as age, sex, height, and weight. Anthropometric indicators are used to compare children with the reference or to compare children from different groups to determine nutritional status. These indicators can reflect different aspects of malnutrition such as recent or long term growth failure.

II. CHILD MORBIDITY

There are many factors affecting morbidity in a developing country. Inadequate supplementation in the weaning period is generally considered to be a major factor affecting severe growth faltering, often beginning in the second half of infancy (9). Another factor is developmental impairment, which stems from nutritional, biological and social deprivation. It manifests itself as ill health, wasting, and growth retardation, affecting anthropometric indicators of nutritional status and increasing mortality rates (25).

A comparison of nutritional status, through anthropometric indicators, is shown in Table 2.1, using data collected from 1975-89 (26). Children whose z-scores were less than minus two standard deviations from the NCHS reference medians were considered to be malnourished. There is more wasting but less stunting and underweight in Sri Lanka as compared to South East Asia and the developing world total.

Table 2.1: Percent of Malnourished Children in Different Parts of the World (26)

Anthropometric Index	Total from Developing World (%)	South East Asia (%)	Sri Lanka (%)
Underweight	35.7	45.2	34.0
Stunting	39.0	41.3	27.0
Wasting	8.4	9.8	11.0

Within Sri Lanka there has been substantial improvement in height-for-age less than minus two standard deviations from 1980-1986 for children in urban (other than Colombo Metro) and rural districts. However, for children living in the estates there was only a slight improvement in weight-for-height (25). Estates are commercial plantations of tea, rubber, spices and coconut.

III. CHILD MORTALITY

In developing countries fifteen million children die from infection and malnutrition every year (33). Infant mortality (IMR) and under 5 mortality rates (U5MR) are used as yardsticks to measure the development of nations. U5MR is the rate of death in the first five years of life per one thousand live births (1). Table 2.2 shows a comparison of mortality rates.

Table 2.2: Infant and Under Five Mortality Rates In Different Parts of the World (1)

Mortality Rates	World Total	South Asia	Sri Lanka
0-1 yrs, per 1000 live births	57	99	21
0-5 yrs, per 1000 live births	69 (77)[a]	124 (123)	19 (27)

a-female (male)

The mortality rate in Sri Lanka is relatively low compared to other developing countries. The enigma in Sri Lanka is that the low levels of mortality do not correspond to the higher levels of malnutrition. It is not clear why this anomaly exists in Sri Lanka.

IV. BREAST MILK QUALITY

A. NUTRITIONAL COMPONENTS OF BREAST MILK

Mothers' milk composition changes over time to meet the changing needs of their growing children. In healthy women it can vary within a single feed, with the time of day, and stage of lactation (34). Maternal dietary status also affects milk composition (34). In malnourished populations maternal stores of nutrients are used to maintain the proper composition (5).

1. PROTEIN

The protein concentration of human milk generally meets infants' amino acid requirements (35). The protein nitrogen content in breast milk under twelve months is 0.9g/ml; alpha lactalbumin, lactoferrir and secretory IgA are the dominant parts of whey proteins (18). In prolonged lactation estimates of protein content vary, ranging from 0.8 to 1.6g/100ml, with findings of decline, rise, and no change from the content in the first year (14).

2. ENERGY

There is much controversy about the caloric content of breast milk from malnourished mothers versus well-nourished mothers. Some researchers state that milk volume and fat levels decrease with maternal under nutrition (9, 36). This, in turn, would result in a decrease of caloric content. However, in a review, it was concluded that the volume and composition of human milk in malnourished mothers are adequate, perhaps at the cost of maternal stores (14).

Also, Lauber and Reinhardt found the energy intake from human milk at 12 months averaged at 59kcal/kg/24 hours while at 18 months it was 44kcal/kg/24 hours (37). They concluded breast milk was still a valuable source of energy in the second year of life.

3. OTHER NUTRIENTS

The vitamin content of breast milk is very sensitive to maternal dietary intake, and to seasonal availability of foods (7). The studies that have analyzed the vitamin content of breast milk have focused on milk produced within the first year of life.

Vitamin A concentration is related to seasonality, and is often lower in poorer populations where maternal serum levels are below the recommended levels, such as in Sri Lanka (14) The vitamin C content of breast milk varies with dietary intake which in turn is influenced mainly by seasonal availability of fresh fruits and vegetables (14). Thiamin is directly related to maternal stores, and is low when the intake of polished rice is high (14). Riboflavin is related to the adequacy of riboflavin in the maternal diet (14). Vitamin B12 has even been found in the milk of poor vegetarian women (38). Vitamin D is also sufficient in breast milk, hence the rarity of cases of rickets in breast fed babies (14). Although breast milk is low in niacin, it can be synthesized from tryptophan (14).

In addition, in the review of breast milk composition it was concluded that the lactose concentration does not vary much between poorly nourished mothers and mothers in developing countries (14).

B. VOLUME OF BREAST MILK

The studies investigating the volume of breast milk produced past the first year of life are not consistent. In a review article it was concluded that breast milk volume of mothers in developing countries drops by 300 to 500 ml during the second year (14). In one study the average decline of breast milk from the first 5-12 months to 24-30 months was from 632 to 368g/day (39). In another study production of breast milk at 18 months was the same as that at 6 months (40). In this study, by Becroft, a positive correlation was found between the weight of the children and maternal breast milk production, in children up to forty-two months of age (40).

A study in Kenya found that when children get sick, mothers continue breast feeding (41). Average milk yield at 12-17 months was 440ml/24hr, and at 18-23 months it was 301ml/24hr. The within-individual variation was equivalent to the between-individual variation for all months. Breast milk yield was higher during the harvest season (41).

From the results of these studies it appears that maternal nutritional status influences breast milk yield. It also appears that the volume of breast milk produced during the second and third year of lactation may decrease anywhere from 100 ml (42) to 500 ml per day (4). It is unclear whether this decrease is due to decrease demand from the child or lack of output of the mother.

C. IMMUNOLOGICAL COMPONENTS OF BREAST MILK

There is some evidence for an important protective effect of breast-feeding against infection and illness past one year. For example, Lactobacillus bifidus is more common in the intestine of breast fed babies than bottle fed babies. Due to the production of acetic and lactic acid, the pH is lower, which inhibits the growth of Shigella, E. Coli, and yeast (5, 16). However, this changes with the introduction of solids where the conditions of the gut become more conducive to the growth of gram negative organisms, such as E. Coli.

All classes of immunoglobulins are also found in mature milk, with the concentration of IgA rising with gradual weaning at seven to nine months (16). IgA is stable at low pH, is resistant to proteolytic enzymes, and is involved in defense against gastro-intestinal infections (18).

The protective effect of breast feeding against diarrheal mortality is controversial. In one study breast feeding was reported to be protective against diarrhea into the third year of life (43). In another study there were fewer symptoms associated with enteropathogenic E. Coli in breast fed than in non breast fed children less than 30 months of age (44). Breast feeding was also protective against severe shigellosis (45, 46). Results from a study examining shigellosis showed that children who were at high risk for severe malnutrition or measles benefited most from breast feeding (45).

In a review, decreased frequency of breast feeding was associated with diarrhea mortality (47). However, partial breast feeding, which includes other foods in the diet, was not associated with diarrhea mortality (47). In this review, the effect of breast feeding over twelve months on respiratory infections was inconclusive.

In addition, in another review article, no protective effect of breast feeding on diarrheal morbidity above one year of age was found (48). However, a protective effect of full or partial breast feeding under one year of age was found.

D. SUMMARY

The quality of breast milk changes during the second and third years of a child's life, but breast milk remains a valuable source of nutrients to the older child. Breast milk provides a child with a high quality of protein. It is also a good source of energy, although the energy content may decrease after the first year of life or earlier. Along with providing energy and protein breast milk also supplies many vitamins. However, the changes in concentration of these nutrients in the second and third years of life have not been studied.

Breast milk also provides many immunological factors, although the decrease in diarrheal disease after the first year, due to breast milk, is under debate. The volume of breast milk does decrease in the second and third year of life but the decrease in quantity depends on individual factors. Breast milk, as a supplement to weaning foods, continues to be a source of energy, other nutrients, and immunological factors for the older child.

V. PROPOSED MODEL OF THE BIOLOGICAL LINK BETWEEN PROLONGED BREAST FEEDING AND NUTRITIONAL STATUS

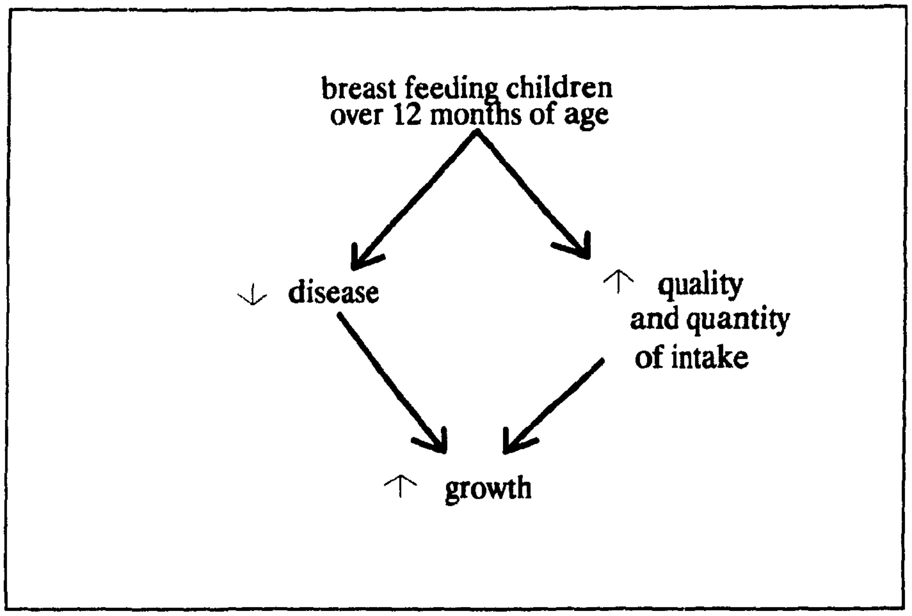
Evidence from many epidemiological studies suggests that prolonged breast feeding may be associated with increased malnutrition (12, 49, 50, 51, 52, 53). In these studies, prolonged breast feeding was defined as non-exclusive breast feeding for more than twelve months. Weaned, therefore, referred to an infant who was completely off the breast. However, there is no clear biological reason why breast fed children should be more malnourished than fully weaned children, especially if they receive supplementary foods (11, 12, 54, 55). No biological mechanism was presented in these studies to explain their findings.

Therefore, a proposed model for the link between breast feeding and growth is presented first. Then, the effects of energy intake, disease and illness, and confounding variables on the growth of breast fed children over twelve months of age are reviewed.

A. PROPOSED MODEL

What is the plausibility of study findings that identify a relationship between prolonged breast feeding and growth? There are three possible relationships. Although not discussed in the literature, the first possibility is that there is no association between prolonged breast feeding and the nutritional status of children. The second possibility is a negative relationship, associating prolonged breast feeding with malnutrition, that appears to have no biological basis. The third possibility, which appears to be the most plausible, is a positive relationship, longer breast feeding leading to better growth. A biological mechanism for this third possibility between prolonged breast feeding and growth is shown in Figure 2.2.

Figure 2.2: Proposed Model for the Association Between Prolonged Breast Feeding and Growth



Poor growth can result from two causes: increased infection or insufficient nutrient intake (54). For example, if the rates of diarrhea are the same in the breast fed and non breast fed groups then poor growth may be due to insufficient food intake leading to decreased growth. However, if breast milk is a supplement to other foods then breast feeding should provide increased food intake.

Therefore, prolonged breast feeding should have a positive effect on the growth of children.

B. ENERGY INTAKE

One of the factors affecting the growth of children is the quantity and quality of food intake. The start of weaning should depend on when the risk of malnutrition due to the inadequacy of breast milk becomes greater than the risk of diseases due to early supplementation (11). In an intervention trial, diarrhea had no effect on length, linear growth at 3 years of age, for children who were given nutritional supplementation from birth, however, it had a negative effect for children who were not supplemented (56).

A pathway to impaired growth is when caloric intake is lower in weaned than breast fed children leading to impaired growth. Also, the insufficiency of breast milk alone for growth has been well documented for children over one year of age (6, 7, 14).

The question is whether the continued supplementation from breast milk, after a child has started on other liquids or solids, is associated with poorer growth. In one study the energy intakes, excluding breast milk, of one to three year old Ugandan children were 30% less than their English counterparts but the children gained weight at a similar rate because they spent less time engaging in high energy activities (57). The relationship between prolonged breast feeding and growth, controlling for intake from supplemental foods, has not been addressed although most researchers recognize its importance.

C. DISEASE AND ILLNESS

Other factors that affect the growth of children are disease and illness. The rates of disease and illness are affected by exposure to pathogens.

The time spent breast feeding can result in nutritional and hygienic benefits (58). For example, it has not been distinguished whether it is human milk that is protective or the beneficial social influences that accompany breast feeding, such as a less frequent conveyor of pathogenic organisms (16, 58).

A child who is not breast fed may be more exposed to contaminated foods because all food intake is from prepared or fresh foods and may be on unclean dishes. Also, the risk of contamination of supplemental foods increases with time elapsed since preparation and with method of feeding (9).

In addition, the quantity and quality of water is closely related to the health of people. In the Kurunegala district of Sri Lanka the use of improved water sources may be associated with a substantial decrease in childhood diarrhea (60). In this area 60% of the population used protected wells, 30% used an unprotected source, and 10% used hand pumps or a piped source (61). In Kurunegala the use of improved water supplies was associated with a decrease in diarrhea, among children under the age of five (62).

D. CONFOUNDING FACTORS

It is also possible that a confounder is affecting the growth of children. A confounder is a risk factor for growth that is also associated with prolonged breast feeding. If the confounder is distributed unequally in the breast fed and non breast fed groups and independently affects growth, then it could be responsible for the difference in growth between the two groups.

For example, children from poorer families breast feed longer and poverty independently has a negative effect on growth. Therefore, poverty acts as a negative confounder because the observed relationship between breast feeding and growth may be lower than expected due to poverty and not breast feeding. So, a decrease in growth of the breast fed infant could be related to the effects of poverty that precipitate prolonged breast feeding.

Variables that have been identified as affecting growth, either positively or negatively, are age at weaning, gender, birth order, number of living and dead siblings, morbidity, socio-economic status, maternal education, neighborhood in which the home is located (60, 63, 64). Variables related to duration of breast feeding are socio-economic status and material wealth, area of residence, income, use of oral contraceptives, parity, maternal education, maternal work away from home and maternal age (10).

VI. REVIEW OF ASSOCIATION BETWEEN PROLONGED BREAST FEEDING AND NUTRITIONAL STATUS

An extensive review of all studies in the area of prolonged breast feeding and growth was conducted using a medline search, on Index Medicus, and a search on Agricola for the years 1979 to 1991. The key words used in the search were breast feeding, anthropometry, prolonged breast feeding, and nutritional status in many different combinations. Also, additional references from selected articles were identified and obtained. Authorities in the field were sought for help in identifying other references.

Of all the references identified, only eight primary research articles were found which examined a possible association between prolonged breast feeding and nutritional status. Of the eight, one was in a foreign language (Indonesian) and two were government of Kenya documents that were not available. This left a total of five articles that could be reviewed.

It is important to note that a review bias may be present as only published articles are included. Often, only studies that show statistical significance are published. This review, therefore, may not be a fair representation of all the research that has been conducted in this field.

A. EPIDEMIOLOGIC CRITERIA TO JUDGE STUDIES

The studies that have looked at the relationship between prolonged breast feeding and growth vary in design, sample size, control for covariates and outcome measures. Therefore, systematic criteria were applied to the selected studies to help assess their plausibility. Positive findings are identified as those in which prolonged breast feeding leads to adequate growth, with growth being the same as or better than the non breast fed group. Negative studies are those which show an effect in the opposite direction, poor growth.

Before evaluating studies certain information should be known, which include: the country where the study took place; the definitions used for prolonged breast feeding and for normal nutritional status; and the objectives of the study (Table 2.3). Also factors that describe the study need to be included, such as:

the type of sample. There can be many types of samples including census, random, and non-random, census sample. A census is when every person who is eligible for the study is included. A random sample is when each person who is eligible for the study has a calculable chance of being selected. It is possible to generalize the findings of a study to the population of interest, if it's a random sample or census.

the type of comparison made in each study. Was the comparison between supplemental breast fed and completely weaned or between some other groups.

the design of the study. The interpretations of the results from a cross sectional study are very different from those from a randomized study. For example, causation can be assessed from a randomized study while only association and plausibility can be assessed from a non randomized study. In examining the issue of prolonged breast feeding and nutritional status it is not possible to randomize children into breast feeding and non breast feeding groups. Within non randomized studies plausibility increases when the results are from a cohort study rather than a cross sectional study.

Many of the criteria are based on principles of designing epidemiologic research (66, 67).

Additional criteria related to the mechanism between breast feeding and growth, criteria related to negative studies, also needed to be addressed. Negative studies are those that show a negative effect of breast feeding on growth.

Table 2.3: Summary of Studies Assessing the Effect of Prolonged Breast Feeding on Growth of Children

Criteria	Studies				
	Al-Othai-meen(52)	Victora (49)	Brakohiapa (51)	Briend (12)	Victora (65)
Country	Saudi Arabia	Brazil	Ghana	Bangladesh	Brazil
Year Published	1988	1984	1988	1989	1991
Defn of Nutr. status	>90%NCHS	>-1SD NCHS	>90%NCHS wt/a >95% ht/a >80% wt/ht	>60%NCHS	>-2SD NCHS
Defn of Prolonged BF	>12mos	^{3}12mos	^{3}12mos	^{3}12mos	^{3}12mos
Type of Sample	non-random	cluster census	random non-random	census	census
Type of Comparison	not clear	wean vs breastfed	wean vs breastfed	wean vs breastfed	wean vs breasted
Study Design	survey	survey	intervention survey	cohort	cohort

There are two categories of additional criteria that are needed for interpreting results. The first category includes those criteria that are critical while the second category includes those that support the interpretation of results.

The six critical criteria are as follows:

1. The first criterion is whether there is sufficient malnutrition and prolonged breast feeding in the population that an effect can be measured, a measure of the adequacy of the study. For example if almost all children are well nourished it will be impossible to measure the effect of breast feeding on nutritional status. Also, if very few children are breast fed for more than twelve months it will be difficult to measure the effect of prolonged breast feeding on growth.

2. The second criterion is whether there the comparison groups are sufficiently different, i.e. range of data should be sufficiently wide. For example, one would not expect to see a difference when

comparing children breast fed for 13 months versus those breast fed for 12 months.

3. The third criterion is whether there is control for confounding factors. Inadequate control for confounders can result in the observed relationship, or lack of a relationship, between prolonged breast feeding and growth to be spurious. For example, the duration of breast feeding is lower in urban areas than in rural areas, but there are more health services in urban areas. Access to health services has an independent positive effect on growth. Therefore, children in urban areas may have better growth due to accessibility to health services, even though they may have decreased duration of breast feeding. All biologically important confounders, and those already identified in other studies -- maternal education, socio-economic status, area of residence -- need to be examined. Control of confounding variables identified from previous studies were included as criteria for evaluating the studies (10, 12, 49, 51, 52, 65, 68, 69, 70, 71).

4. The fourth criterion is the sample size. If the sample size is too small it is possible that a large difference between two groups will not be detected -- that the comparison will fail to reach statistical significance.

5. A fifth criterion is the analysis of data using the correct unit of comparison. The unit of comparison can be an individual child, child months, or a village. For example, if the unit of comparison is child months then the sample size is the sum of the number of months each child has been in the study. However, if the unit of comparison is the individual then the sample size is the number of children included in the study.

The two criteria that support the interpretation of results are as follows:

1. The first supporting criterion is whether measurements of intermediate events are made. These can help identify if the

postulated mechanism of action is correct. For example, if the quality and quantity of food intake, including breast milk, was greater in the breast fed group then the mechanism of action would be as postulated (see Figure 2.2).

2. The second supporting criterion is whether concomitant outcomes are measured. The plausibility will increase if several outcomes are in the same direction as predicted by the biological mechanism for the association. For example, if the levels of mortality are lower in the breast fed group than the non breast fed group the mechanism of action would be as postulated.

The above criteria are used in trying to objectively evaluate the plausibility of the study findings. Because of the small number of studies on this topic, only a single list of criteria for comparing observational studies has been developed. The design of the intervention trial, which was a part of one study, and the follow up study were evaluated within this framework. In addition, some criteria that only apply to these types of studies were also included. For example, comparability between groups for the follow up study and control of bias in the intervention trial, such as blinded randomization, were included as evaluation criteria. Each study is reviewed according to its design and then a summary of the studies is presented.

B. CROSS-SECTIONAL STUDIES

There were two cross-sectional studies that assessed the association between breast feeding and growth in children above twelve months of age. The first study, by Al-Othaimeen and Villanueva, in Saudi Arabia, did not meet sufficient criteria for inclusion in the discussion of better studies (52). Its authors stated that prolonged breast feeding led towards malnutrition, when in fact only the mean for males aged 0-12 months for weight-for-height was less than the cutoff for normal growth. Above this age the height-for-age and weight-for-height values were above 90% of the NCHS reference median, within the normal growth values. Together, these drawbacks in design and analyses make the results suspect.

The second study was conducted in Brazil in 1982 (49). This study had a non-random cluster sample, with a census of each cluster. There were only very small inter observer differences. The authors controlled for many confounders including maternal education, income, birth order, sex, age, district of residence, type of family, previous hospitalization, and the employment status of the head of the family.

The excess risk of mild malnutrition, as defined by weight for length, in breast fed children was present after adjusting for the above confounding variables. However, the mean weight for length was not significantly different in the two groups, indicating that there was not a complete shift in the distribution of breast fed children, just in the shape of the distribution.

C. INTERVENTION STUDIES

One study attempted to determine the relationship between breast feeding and growth. There were two separate studies that were reported as phase one and two (51). The first phase was a survey. The second phase was an intervention trial that included forced weaning.

In the second phase there were two groups: a control group of five normal weaned children and an experimental group of fifteen malnourished breast fed children. Ten of the fifteen children from the experimental group were weaned completely from the breast and five continued breast feeding. In the end there were three groups: a natural control; a forced control; and a breast fed group. Forced weaning for the sake of data collection seems highly unethical. All children were encouraged to eat more however, only the children who were forced to wean increased their intake (51). This suggests a possibility of unequal treatment of the two groups.

There were no orthogonal contrasts between the groups. For phase one, the sample was from an urban clinic, which itself introduces a lack of generalizability. For both phases there was no indication of control for confounders. The results showed that the energy and protein intakes, including breast milk, of the weaned group were higher than the breast fed group after three weeks The many flaws of this study make its results very questionable.

D. COHORT STUDIES

There were two cohort studies that assessed the relationship between prolonged breast feeding and growth.

The first, conducted in Bangladesh from October 1983 to October 1985, included a census of the community (12). The hypothesis for this study was that the breast fed group had better survival rates than the weaned group, although there might be more malnutrition in the breast fed group. In the analyses, age, weight-for-age and breast feeding were controlled in the survival analyses, and age in the analysis of malnutrition. A problem in this study was that children went from one group to the other during the time of the survival analysis.

The results of this study showed that mothers wean infants when their weight-for-age is higher than usual. It also showed that breast fed children had significantly lower weights for age (69.6 %), than weaned, (70.6 %), corresponding to a difference of about 118 grams. However, this difference, according to the authors, was not clinically very large and may have been due to confounders. In addition malnourished weaned children were found to have six times higher risk of dying than malnourished breast fed children. This indicates that breast feeding may continue to have a protective effect on risk of dying, but not malnutrition, into the third year of life.

The second cohort study included all children born in 1982 in the city of Pelotas in Brazil, and followed them until April of 1986 (65). The analysis was stratified by income groups, and adjusted for age, sex, maternal education, parity, and birth weight. The outcomes of this study were weight-for-age z-scores, height-for-age z-scores, and weight-for-height z-scores. Although there was some loss to follow up, over 80% of all children born in 1982 could be traced up to the third and final follow-up.

There was also some effect modification between income level of the family and prolonged duration of breast feeding. Prolonged breast feeding was associated with poorer anthropometric status in children from middle and high income families. There was no association between prolonged breast feeding and anthropometric status for children from low income families.

The conclusion from this study was a modified negative effect of breast feeding on growth by income level of the family, after adjusting for confounding variables.

E. CONCLUSIONS FROM REVIEW

Each of the five studies was evaluated using the criteria specified above. The studies were quite different in design and analyses and only one study assessed a concomitant outcome -- mortality. A summary of the five studies was presented in Table 2.3. No studies were perfect, however the cross-sectional study, in Brazil (49), and the cohort studies, in Bangladesh (12) and Brazil (65), were better than the other two. The results of the evaluation of these three better studies are presented in Table 2.4.

Table 2.4: Summary of Evaluation of the Better Studies Assessing the Effect of Prolonged Breast Feeding on Growth

Criteria	Studies		
	Victora(49)	Briend(12)	Victora(65)
Prolonged breast feeding	sufficient	sufficient	sufficient
Malnutrition	sufficient	sufficient	sufficient
Range of data	sufficient	sufficient	sufficient
<u>Control for Confounders</u>			
-socioeconomic factors	yes	yes	yes
-others	no	yes	yes
Sample Size	802	14919 months	1447-4700
Unit of Analysis	individual	child mos.	individual
<u>Intermed. Events</u>			
-diarrhea	no	no	no
-energy/prot intake	NA[b]	no	no
Concomitant Outcome	no	yes	no

a- breast fed, b- not applicable

The results of these three studies indicate that there may be more malnourished children in breast fed than weaned groups. However, the mechanism of this action is unclear. It was suggested that mothers may choose not to wean children if the children are thin, which may account for some of the association. Other suggestions in the literature are that inadequate supplementary foods may be given to breast fed children, and that frequent breast feeding may decrease appetite (4, 65).

All studies found a negative relationship between prolonged breast feeding and growth. Of these five studies the two by Victora and one by Briend, were better than the other two, by Al-Othaimeen and Brakiohapa. In the Al-Othaimeen study there was no difference in nutritional status between the comparison groups. In the Brakiohapa study children were forced to wean, with the intervention not truly between the breast fed and non breast fed.

The three better studies did not examine any intermediate events. No biological mechanism was given by the authors of the three better studies because they did not believe their results to reflect the true association between breast feeding children over twelve months of age and nutritional status. These three studies appeared to be good studies but did not adequately control for confounders, effect modifiers or examine intermediate outcomes. A better study may result in findings of positive or equal nutritional status between breast fed and non breast fed children over twelve months of age.

VII. OBJECTIVES OF THE PRESENT STUDY

The following objectives are a result of the review of literature and will be addressed in this research.

1. To determine whether children, 13-36 months of age, who are currently breast feeding have nutritional status that is similar or better than that of children not currently breast fed of the same age.

   a. To determine whether an intermediate event, diarrhea, attenuates the effect of breast feeding on nutritional status.

   b. To determine whether the intermediate events, age of introduction of supplemental foods, a proxy for food intake quantity and quality, attenuate the effect of breast feeding on nutritional status.

2. To determine whether the duration of breast feeding affects the nutritional status of children, 13-36 months of age, which is the next step after objective one. For example is there a difference in nutritional status between children thirty-five months of age who are breast fed for ten versus twenty months.

These objectives will be tested using the data collected in Sri Lanka Demographic and Health Survey. In the analyses there will be control for confounding factors previously identified. Income level was the only previously identified effect modifier. In addition, possible effect modifiers, from the list of confounders, will be considered.

CHAPTER THREE: METHODS

Chapter three is a description of the methods used to reach the objectives of this research. The goals and objectives of the Sri Lanka DHS are presented first, followed by the reasons why the results of this survey were used. Then, the research design, data collection and cleaning conducted by the DHS staff are presented. This is followed by definitions of variables used for the present study, and the data cleaning conducted for this study. Then, the methods for these secondary data analyses, including variable transformations, residual analyses, descriptive and multivariate statistics are presented.

I. SRI LANKA DEMOGRAPHIC AND HEALTH SURVEY (DHS)

A. OBJECTIVES OF DHS

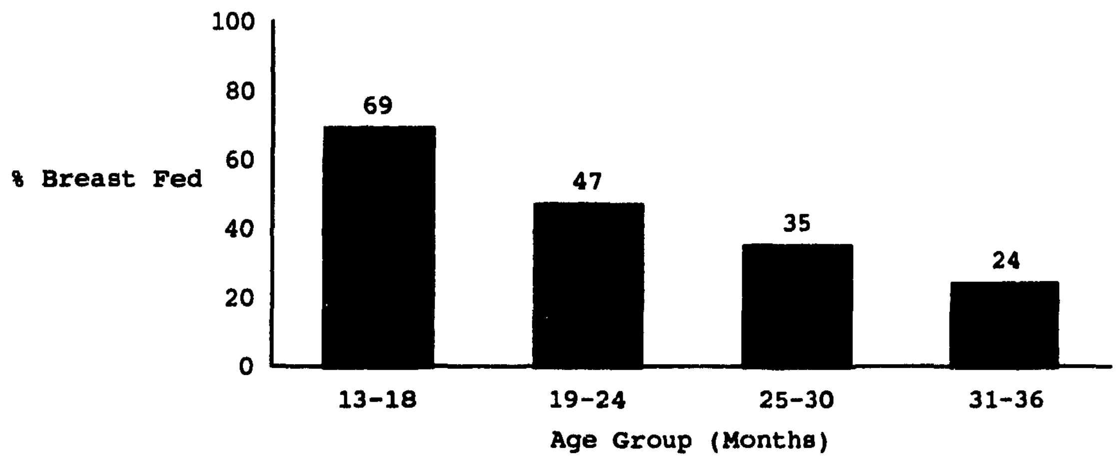
There were three objectives to the Sri Lanka Demographic and Health Survey (19):

1. to provide data for policy makers that can be used to plan new strategies,
2. to provide data for analyzing trends,
3. to provide data which can be used in cross country comparative studies.

B. REASONS FOR USING DHS

The Sri Lanka data set was chosen for many reasons. The first was that, in this survey, data on breast feeding children, over 12 months of age, and nutritional status was already collected, and was available in the public domain. The second reason was that there was more information on confounding variables than in previous studies, including food variables. Although this data set had no information on the quantity or quality of foods, there was data on the age of introduction of foods in the child's diet. The third reason was that there was sufficient breast feeding, in the 13 to 36 month age group, to study this issue (Figure 3.1). On average, 67% of the children were breast fed beyond twelve months of age, including 24% of children between 31 and 36 months of age, who were still being breast fed.

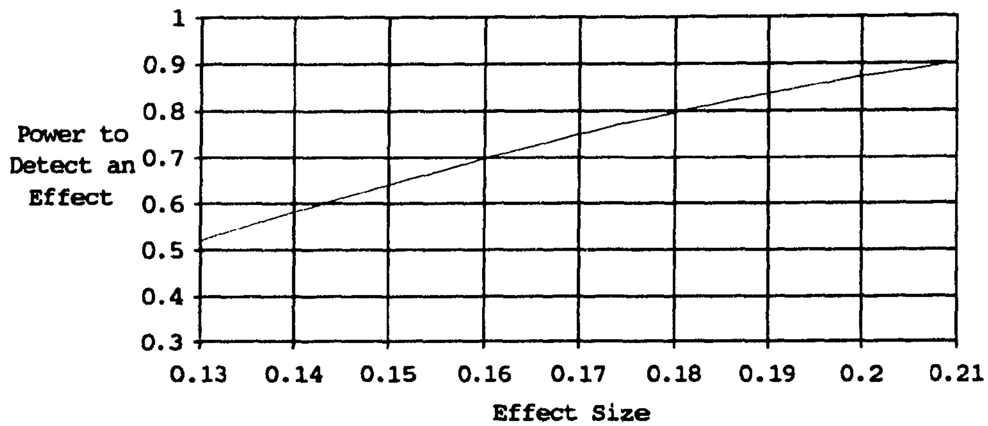
Figure 3.1: Percent of Children, 13-36 Months of Age, in Sri Lanka, Who Continue to be Breast Fed (Cross-sectional data)



A fourth reason was sufficient levels of malnutrition in this population to assess the association between breast feeding and nutritional status; 35% of the children were stunted, 15% were wasted, and 46% were underweight. This suggested that there could be improvements in levels of malnutrition if the correct intervention was implemented.

A fifth reason that the Sri Lankan DHS was chosen was that there was sufficient power to show a difference in malnutrition -- height-for-age z-scores -- between breast fed and non breast fed children (Figure 3.2). The dotted line in figure 3.2 was calculated using a two sided test for two independent groups, with an =0.05 (72). The variance used was 1.44, which was also the variance for height-for-age z-scores of children among 13-36 months of age. There was 80% power to show a difference of 0.18 height-for-age z-scores, for a sample of 1411 children.

Figure 3.2: Power Curve For a Two-Sided Test To Detect Various Differences In Height for Age Z-Scores Between Children Who Are and Are Not Breast Fed



C. RESEARCH DESIGN OF DHS

The Sri Lanka DHS was a one time, cross-sectional survey. A detailed description of the research design of the DHS is available elsewhere (19). The DHS was designed using socio-economic and ecological criteria and drew upon the experience of a previous survey, the Sri Lanka World Fertility Survey (SLWFS). Due to the large heterogeneity of the six zones in the SLWFS, the DHS was initially designed to included nine zones. However, because of civil disturbances in two zones, the number of zones in the DHS was reduced to seven. These two zones that were excluded contained a total of fourteen percent of the 1986 Sri Lankan population.

In addition, zone five, which had a high concentration of estates, which are commercial plantations, had a larger target sample than the other zones (19). There was an over representation from zone five because there were few estates and a sufficiently large sample was needed. The sampling fraction ranged from 2.3% to 5.5%, with the exception of the estates for which the sampling fraction was 7.0%.

1. ELIGIBILITY CRITERIA

Only private households were sampled, therefore, institutions were excluded. Ever married women between the ages of 15 and 49 years of age, who had slept in that household the previous night were interviewed (19). This was done to exclude people who were visiting.

2. HOUSEHOLD SAMPLING STRATEGY

Each zone, created to include homogeneous subgroups, was further divided into three strata: urban, rural, and estate. The selection of households was composed of three stages. In the first stage, sample units were taken based on probability proportional to the stratum's population. Thirty-six units were chosen in all zones other than zone five, which included fifty-four units. In the second stage two census blocks, with probabilities proportional to size, were selected from each of the units. The third stage included selecting each household with inverse probability proportional to size to ensure a self weighted sample in each stratum (19).

3. SURVEY ORGANIZATION

The survey in Sri Lanka was organized through the Department of Census and Statistics (DCS). The leader of the DHS was the director of the DCS, the Deputy Director and Assistant Director acted as the Project Manager and Assistant Project Manager, respectively. Statisticians and other support staff from the DCS also worked on the survey team. In addition, there was technical collaboration with the Institute for Resource Development (IRD)/ Westinghouse (19).

4. FIELD STAFF

Nine survey teams were composed of data collectors from the DCS. Each team had a supervisor, four to seven female interviewers, a length and weight measurer, and an assistant measurer. All members of the survey team were trained for ten days. The measurers were trained by a specialist from IRD Westinghouse, using the guidelines developed by the United Nations (19).

The measurers were given a standardization test, for precision and accuracy, following their training and again midway through the data collection. Only those who passed the standardization test were allowed to collect anthropometric data. One person did not pass the initial test and was assigned another duty. The results from the second test showed that 55 percent overestimated length, with an average error of 1.9 mm, 29 percent underestimated length, with an average error of 2.7 mm, and 16 percent showed no variation from the supervisor's measurements (19). The United Nations cut off is 5 mm for unsatisfactory measurements of length (19). Therefore, the measurement error was low and was well within the United Nations cut off. Weight measurements were accurate to within 100 grams (19).

D. DATA COLLECTION AND CLEANING

Data collection started in January of 1987 and was mostly completed by March of the same year, with the exception of a few areas that were completed by May. Each questionnaire was administered to all eligible women. The interviews averaged 35 to 40 minutes. Each interview was edited in the evening following the interview and again upon reaching Colombo, the capital of Sri Lanka. Data were then entered, edited and tabulated using the software program Integrated System for Survey Analysis (ISSA) (19).

The interviewers were instructed to verify age whenever possible, by using the National Identity Card or a birth certificate. If neither year nor month was given, an attributed age was assigned. The year and month of birth were given by 90 percent of the women, while six percent only gave the year, and four percent could not give year or month of birth. However, of all the children that were measured, only two did not have information on month of birth, and were therefore excluded. Sometimes there can be a problem of inaccurate ages because care takers only report ages at particular intervals resulting in clustering. However, in this data set, no clustering was apparent (19).

II. VARIABLES OF INTEREST

A. BREAST FEEDING

The independent variables of interest were related to breast feeding. Most other studies examine current breast feeding status but two of the better studies examined duration of breast feeding. Therefore, both current breast feeding status and duration of breast feeding were examined. These variables were expressed as:

1. current breast feeding status -- breast feeding at the time of the interview: yes or no,
2. the number of months the child had been breast fed up to the time of the interview, ranging from 0 to 36 months,

B. NUTRITIONAL STATUS

The variables that were a measure of nutritional status were constructed from the four variables: age, sex, weight, and length. From the values for these four it was possible to construct continuous variables -- standard deviation scores (z-scores) based on the National Center for Health Statistics (NCHS) data.

It was recommended by the WHO Working Group in 1986, and is now general practice, to use z-scores for comparing study samples with reference populations and for reporting all data on growth of children. Therefore, z-scores were used in these analyses to compare groups within a population.

Z-scores for three indicators of nutritional status were used as outcomes. Z-scores are calculated by subtracting the child's height-for-age value from the height-for-age value of the reference child and dividing this difference by the standard deviation for the reference value (67). The three indicators were weight for length, weight-for-age and length for age. Z-scores for these indicators were included as part of the DHS data set.

C. INTERMEDIATE EVENTS

The intermediate variables that were examined included retrospective data on whether the child had diarrhea in the two weeks before the interview and the number of months a child had been exposed to solids and milks, other than breast milk. These were variables that would be important if the mechanism relating breast feeding to growth was as proposed earlier (see Figure 2.2). If the mechanism proposed earlier was true then the incidence of disease should be lower in the breast fed group than the non breast fed group.

In addition, it was important to determine whether number of months of exposure to solids and milks was comparable in both the breast fed and non breast fed children. Number of months of exposure to solids and milks were used as proxies for quality and quantity of food intake. For example, if breast fed children had been exposed to solids for a shorter duration than non breast fed children, then breast milk may have been a substitute for solids rather than a supplement. Therefore, breast fed children may have a lower intake of foods, other than breast milk. In turn, this lower intake of solids could result in poorer nutritional status.

D. COVARIATES

Data related to socio-demographic information were gathered through interviews. All variables that, *a priori*, were thought to have a biological importance or served as a proxy for variables that would have a biological importance in the association between prolonged breast feeding and nutritional status were included in the analyses. These variables were:

area of residence
source of drinking water
source of non drinking water

type of toilet facilities available

type of floor in the home

electricity in the home

radio in the home

TV in the home

education level of the mother

whether the mother worked to earn money

whether the father is a professional

whether the family members were perceived wealthy enough to own a change of clothes

number of children in the household, aged 5 and under

birth order of the child

sex of the child

age of the child

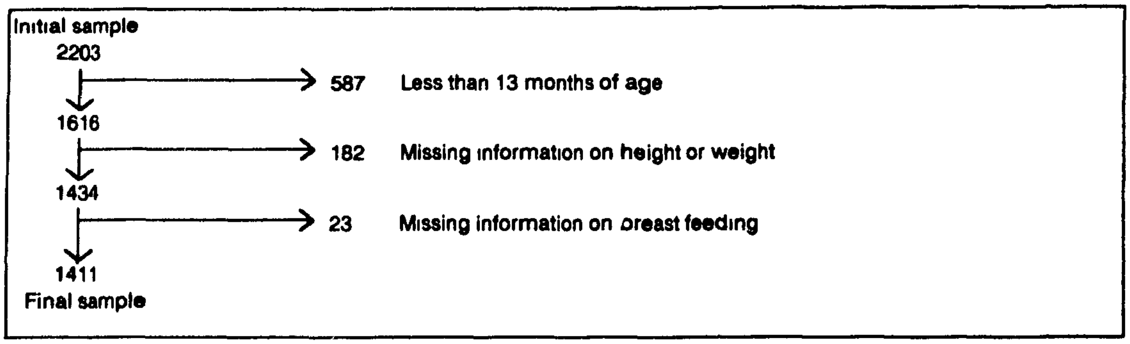
An example of why a variable was considered important, *a priori*, is for source of drinking water. In developing countries breast feeding is more prevalent in lower socio-economic groups. Also, people from lower socio-economic groups are more likely to have an unimproved water supply, which is associated with increased ingestion of pathogens resulting in increased levels of disease. Therefore, any differences found between breast feeding and non breast feeding children may be due to the source of drinking water rather than breast feeding status.

Appendix A includes a list of covariates thought to be biologically important, *a priori*, and the coding of the responses related to these variables.

III. DATA CLEANING

The original data set was in an ASCII format that can be readily converted to computer formats for other statistical packages. The original sample consisted of 2203 children, 3 to 36 months of age. However, only children whose age was between thirteen and thirty-six months were included in the analyses. Any children with missing information for height or weight were excluded, as were children with missing information for the number of months' breast fed (Figure 3.3).

Figure 3.3: Exclusions from the Sri Lanka DHS to Arrive at the Final Sample for These Analyses



Of the 1616 eligible children, 13 % were lost due to missing information. In addition, the entire data set was checked for any improbable values for length and weight and none were found.

IV. STATISTICAL ANALYSES

All analyses were performed on a personal computer using SYSTAT™ version 5.02, dated 1990 (74). The methods for initial, descriptive statistics are presented first. Variable transformations, based on the descriptive statistics, are then explained. Then, residual analyses are examined, to determine whether the age of the child in relation to height-for-age z-scores was linear or needed to be transformed. The final sections describe the methods for bivariate and multivariate statistics.

A. DESCRIPTION OF VARIABLES

To have an understanding of the distribution of breast feeding, nutritional status and covariates in the DHS data set descriptive, univariate statistics were performed on all variables. The means and standard deviations were calculated for all continuous variables (see Appendix B) and the frequency and percentage occurrence of each level for the categorical variables (see Appendix C).

B. VARIABLE TRANSFORMATIONS

Alterations were made to some variables based on the results of initial, descriptive statistics. For some categorical covariates, the number of levels within each covariate were reduced (see Appendix D for more details). This was done if there were too few cases in any level and if there was another biologically related level in that category. For example the covariate "source of dr'nking water" originally had nine levels and was collapsed to two levels, protected source and unprotected source of drinking water. Also, two discrete numerical covariates were made categorical (see Appendix E for more details).

An alternative strategy was used to reduce the number of levels for the number of other children in the household, as no logical combinations between the levels were apparent. In this case the mean height-for-age z-score and frequency were calculated for each level. From these results as shown below in Table 3.2 it appeared that the most obvious collapsing of levels would be to join no other and 1 other child into one level and more than one other child into another level.

Table 3.1: Discrete Numerical Variable for the Number of Other Children In the Household and Mean Height-for-age Z-Scores, in the Sri Lanka DHS

# of other children	mean ht/age z-score	frequency
0	-1.463	21
1	-1.420	535
2	-1.638	655
3	-1.960	172
4	-2.145	17
5	-1.425	4

Another strategy was used to transform the variables for the number of months a child had been exposed to solids and liquids. There were many solid food variables and milk variables that were collinear. The duration of exposure to solids was defined to be the greatest number of months a child had been exposed to any solid. This was so that the variables would be more meaningful in various comparisons and to remove multicollinearity between the variables (for further information see

Appendix F). The age of the child was included in the analyses as a covariate.

C. ANALYSES OF RESIDUAL

There is a special relationship between age and z-scores for height-for-age, weight-for-height, and weight-for-age. It is curvilinear in the first year of life. Residual analyses were performed to determine whether this curvi-linear relationship continued into the second and third year of life or became linear. Residual analysis can graphically show any violations of statistical assumptions such as homoscedasticity, and normality (67). For each outcome analysis of residuals was performed.

For example, height-for-age was the outcome for a regression with the age of the children as the independent variable. The residuals from this regression were saved and then plotted against the age of the children. From this plot it was clear that age was linear regarding z-scores and did not need to be transformed for further analyses (for residual plots see Appendix G).

D. BIVARIATE STATISTICS

Bivariate statistics, through correlations and associations between variables, were analyzed. Pearson correlations, Kendall's tau-b, t-tests, and Pearson chi-squares for associations and independence were used. The Pearson correlation measures the strength of the linear association between two quantitative variables (73). A Pearson Chi-square addresses independence and associations between two variables. However, Pearson Chi-square is not helpful if there are more than two levels within a variable (74). Therefore, Kendall's tau-b, a non-parametric test, was used. It is a measure of ordinal association -- rank correlation -- and can address the issue of independence between variables with more than two levels; it can address the symmetry in a table (74).

E. MULTIVARIATE STATISTICS

The multivariate analyses were separated into three sections, one each for height-for-age z-scores, weight-for-age z-scores, and weight-for-height z-scores.

All potential covariates were tested as possible effect modifiers because previous studies had not provided any insight as to possible effect modifiers, with the exception of income level. For each section, significant effect modifiers were determined with regressions containing the binary variable for current breast feeding status, the possible effect modifier, and an interaction term between these two. This was necessary because a regression having all possible interactions and covariates would result in some cells having too few cases. Testing for effect modifiers was done using each of the z-scores as the outcomes. Any interactions that had a p-value less than 0.20 were included in further multivariate analyses for that outcome.

Within each section, each of the two objectives was examined using Analysis of Variance (ANOVA). All statistically significant interactions and covariates, among those identified *a priori*, were entered into the ANOVA equation (results for the full ANOVA equations are given Appendix I). Those covariates and interactions that had a p-value less than 0.20 were included in reduced equations. Covariates not associated with the outcome were removed if the p-value for the coefficients were greater than 0.20, and if there were only very small changes to the coefficients of the remaining variables. Covariates were deleted only if the R squared term did not decrease and the mean square error did not increase between the full and the reduced equations.

For significant interactions involving a variable with more than two levels, orthogonal interaction contrasts were used to determine how breast feeding interacted with that covariate. Simple effects of breast feeding were tested for interactions that were statistically significant.

Parts a and b for the first objective were met by the addition of intermediate variables into the reduced equations -- whether the child had diarrhea in the last two weeks, the number of months a child had been exposed to solids and milks, other than breast milk.

In summary, the association between breast feeding and nutritional status was examined for each of the three outcomes, height-for-age z-scores, weight-for-height z-scores, and weight-for-age z-scores separately. For every outcome, each of the two objectives was examined separately.

The regression coefficients from the ANOVA are presented as in SYSTAT™ output. It should be noted that SYSTATä codes variables for analysis of variance (ANOVA) differently from some other programs. A categorical variable with two levels is coded as 1 and -1 (74). When there are more than two levels, the coding becomes more complex (74), for example,

Level	Code	
1	1	0
2	0	1
3	-1	-1

Also, when SYSTAT™ computes the adjusted cell means, coefficients for continuous variables are not included in the equation for computing estimates (74). Therefore the y-intercept of some graphs and the adjusted means in the results section appear higher than expected. Yet the comparison of groups is unaffected -- the difference between the groups remains the same.

CHAPTER FOUR: RESULTS

The first section in this chapter is a description of nutritional status, breast feeding, intermediate variables and covariates using univariate statistics. It is followed by bivariate results that are used to describe crude associations between the outcomes and breast feeding, breast feeding and other covariates, breast feeding and intermediate covariates, and among the covariates and intermediate variables. The final section, on multivariate results, is divided into three parts: height for age; weight for age; and weight for height. Each of the two objectives is analyzed within these three parts.

I. DESCRIPTION OF VARIABLES

A description of the nutritional status variables is first presented followed by a description of breast feeding variables, intermediate variables and then covariates.

A. NUTRITIONAL STATUS

Table 4.1 shows that the average z-score values for height for age, weight for height and weight for age were well below the reference median.

Table 4.1: Nutritional Status of Sri Lankan Children 13-36 Months of Age, as Measured by Z-Scores

Nutritional Status (z-scores)	Sample Size	Average	Standard Deviation
Height for age	1401	-1.6	1.2
Weight for height	1403	-1.2	0.8
Weight for age	1401	-1.9	0.9

There was sufficient malnutrition that differences in nutritional status could be found between breast feeders and non breast feeders, if any existed.

B. BREAST FEEDING VARIABLES

Sixty-three percent of children were reported to be currently breast feeding at the time of the interview and it was found that the average number of months a child was breast fed, the continuous variable, was 16.3 ± 8.3 months (one standard deviation), for a sample of 1411 children. The range of one standard deviation was approximately 8 to 24 months of breast feeding.

There was sufficient number of children breast feeding for more than twelve months that the objectives could be tested. Table 4.2 shows the distribution on number of months of breast feeding by age group as well as other distributions.

Table 4.2: Averages of Breast Feeding and Intermediate Variables for Three Month Age Groups of Sri Lankan Children 13-36 Months of Age

Age, (months)	Number	Percent: Currently bf[a]	with diarrhea	Avg duration of (months): bf	solids	milks
13-15	193	74	11	12	9	7
16-18	180	71	12	14	12	8
19-21	196	66	10	16	15	12
22-24	165	65	6	16	18	15
25-27	203	60	5	18	21	15
28-30	154	54	4	19	24	19
31-33	163	56	6	19	27	20
34-36	157	50	6	19	30	23

a-breast feeding

C. INTERMEDIATE VARIABLES

A description of the intermediate variables is presented in Table 4.3.

Table 4.3: Description of Intermediate Variables in the Sri Lanka DHS

Intermediate Variable	Sample Size	Average	Standard Deviation
Duration of exposure (months):			
- milks	1399	14.4	10.3
- solids	1404	19.1	7.4
% with diarrhea in last 2 weeks	1407	7.6	

Children, on average, were exposed to solids longer than to milks, other than breast milk. Also, most children did not have diarrhea in the two weeks prior to the interview. Only 7.6 % of children did have diarrhea in the two weeks before the interview.

D. COVARIATES

Covariates were those variables identified prior to the analyses as being related to breast feeding and to nutritional status (Table 4.4). Covariates were characteristics that described the children, their families, or their place of residence. The age of the child, in months, was the only continuous covariate included in the analyses. The average age of a child was 24 ± 6.8 (one standard deviation) months.

Table 4.4: Description of the Children and Their Families in the Sri Lanka DHS

Characteristic	Sample Size	Percent
Father a professional	1336	10.9
Mother working to earn money	1411	18.3
Perceived wealthy[a]	1410	89.6
Household with electricity	1411	18.9
Household with TV	1411	15.1
Household with radio	1411	69.3
2 or more other children	1411	60.5
Protected drinking water	1411	64.0
Protected non drinking water	1411	44.6
Adequate toilet facility	1411	36.9
Child is a female	1411	47.3
Permanent floor in house	1409	51.9
Mother's education	1411	
- primary		29.9
- secondary		35.9
- higher		23.3
Birth order of child	1411	
- 2nd born		27.9
- 3rd born		20.8
- 4th and 4th+		21.1
Sector of residence	1411	
- urban		13.5
- rural		73.7

a- perceived to be wealthy enough to own a change of clothes

Some covariates were proxies for socio-economic status. For example, the majority of the households had a radio and members were perceived wealthy enough to own a change of clothes. However, there were relatively few households with electricity or a television. Also, only a few mothers worked to earn money and even fewer fathers were professionals. However, most women did have some form of education. In addition, the majority of the children had two or more siblings.

Some covariates were proxies for hygiene. A third of the households had adequate toilet facilities, and almost half had a protected source of non drinking water, while over half had a protected source of drinking water.

II. CRUDE ASSOCIATIONS

A. ASSOCIATIONS BETWEEN BREAST FEEDING STATUS AND NUTRITIONAL STATUS

The means of the three outcomes were similar in the breast fed and non-breast fed groups (Table 4.5).

Table 4.5: Mean Height for Age, Weight for Age and Weight for Height Z-Scores in Breast Fed and Non Breast Fed Children, 13-36 Months of Age from the Sri Lanka DHS

Z-Scores	Currently Breast Feeding	Currently Not Breast Feeding	Z-Score Difference
HA[a]	-1.65 ± 1.16 (875)[d]	-1.51 ± 1.23 (526)	0.14
WA[b]	-1.94 ± 0.91 (875)	-1.81 ± 0.97 (526)	0.13
WH[c]	-1.20 ± 0.81 (877)	-1.12 ± 0.80 (526)	0.08

a-height for age, b-weight for age, c-weight for height
d-mean ± standard deviation (sample size)

B. ASSOCIATIONS BETWEEN BREAST FEEDING STATUS AND INTERMEDIATE VARIABLES

Those not currently breast feeding were exposed to solids and milks for a longer duration than those currently breast feeding. These relationships may appear obvious but were examined for thoroughness before these intermediate variables were included in further analyses.

The ordinal association between current breast feeding status and diarrhea in the two weeks prior to the interview was very low (Kendall's Tau-B=0.04). In addition, the relationship between current breast feeding status and diarrhea in the two weeks prior to the interview, for height for age z-scores was not significant.

C. ASSOCIATIONS BETWEEN BREAST FEEDING STATUS AND COVARIATES

The associations between current breast feeding status, at the time of the interview and categorical covariates were quite low; the largest association, 0.19, was between current breast feeding status and the presence of electricity in household (Kendall's Tau-B). Also, non breast fed children were significantly older than breast fed children (t-test).

As seen in Table 4.6 current breast feeding status was significantly related to most covariates with the exception of whether the members of the household were perceived wealthy enough to own a change of clothes, whether mothers were working to earn money and the sex of the child. Non breast fed children came from homes with better living conditions (Table 4.6). For example, approximately twice as many fathers of non breast fed children were professionals as compared to fathers of breast fed children. However, the unadjusted results showed nutritional status to be similar in the breast fed and non breast fed groups, even though breast fed children come from worse off socio-economic homes. If breast feeding had no effect on nutritional status then the breast fed children, who come from worse off socio-economic homes, should have poorer nutritional status. Therefore, breast feeding must be protective for the nutritional status to be similar in the two groups.

Table 4.6: Distribution of Each Characteristic in the Breast Fed and Non Breast Fed Children in the Sri Lanka DHS

Characteristic	% with this characteristic: non breast feeders	breast feeders	Chi-square
Father a professional	14.8[a]	8.6	20.5***
Mother working to earn money	20.3	17.1	2.2
Perceived wealthy[b]	90.3	88.8	2.4
Household with electricity	28.6	13.0	52.4***
Household with TV	20.6	11.8	20.3***
Household with radio	72.9	67.2	5.2*
2 or more other children	52.8	65.1	20.8***
Protected drinking water	69.2	60.9	9.6**
Protected non drinking water	51.9	40.2	18.3***
Adequate toilet facility	46.0	31.4	30.5***
Child is a female	47.7	47.0	0.1
Permanent floor in house	61.0	46.4	32.2***
Mother's education			
- primary	25.9	32.3	29.6***
- secondary	36.9	35.3	
- higher	29.7	19.4	
Birth order of child			
- 2nd born	28.2	27.7	8.2**
- 3rd born	21.6	20.3	
- 4th and 4th+	17.2	23.3	
sector of residence			
- urban	19.5	9.9	26.7***
- rural	69.1	76.4	

*p<0.05 **p<0.01 ***p<0.001

a - 14.8% of non breast fed children's fathers were professionals,

b - perceived wealthy enough to own a change of clothes

D. ASSOCIATIONS BETWEEN COVARIATES AND INTERMEDIATE VARIABLES

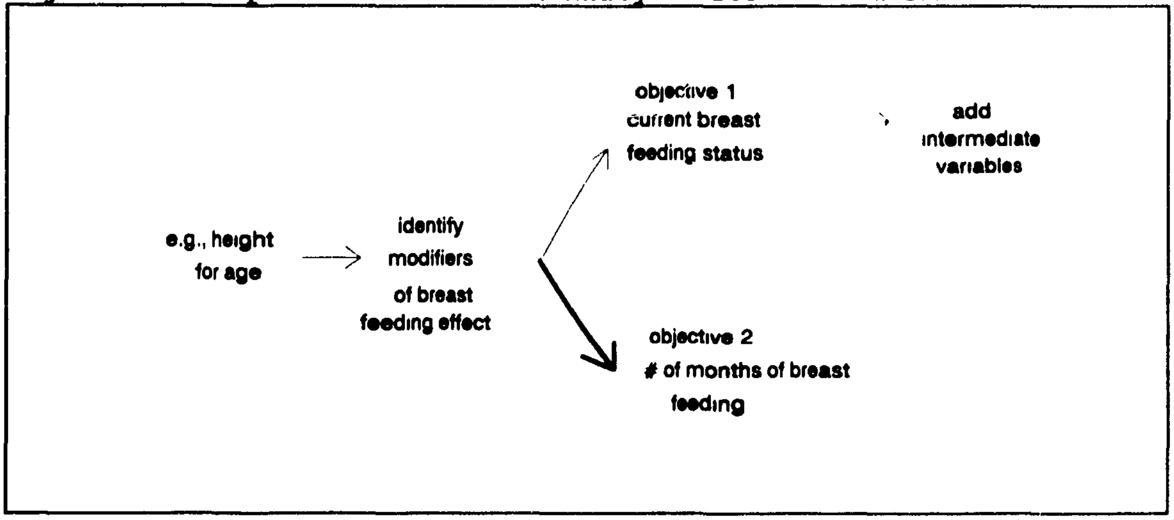
A correlation of 0.52 was found between the number of months a child had been exposed to milks, other than breast milk and the age of the child. A correlation of 0.89 was found between the number of months a child had been exposed to solids and the age of the child. All other correlations between covariates and intermediate variables, among the intermediate variables, and among the covariates were low.

All associations among categorical covariates, and between the intermediate variable for diarrhea and categorical covariates were very low, less than 0.19 (Kendall's Tau-B).

III. MULTIVARIATE RESULTS

The multivariate results are separated into three sections, one each for height for age z-scores, weight for age z-scores, and weight for height z-scores. For each section several steps were taken (Figure 4.1).

Figure 4.1: Steps for Multivariate Analyses for Each Indicator



A. HEIGHT FOR AGE

1. DIFFERENCES IN NUTRITIONAL STATUS BETWEEN BREAST FEEDERS AND NON BREAST FEEDERS THAT VARIED OVER LEVELS OF MODIFIERS

Seven statistically significant covariates, out of sixteen, modified the association between current breast feeding status and height for age z-scores. These seven effect modifiers (Table 4.7) had a p-value below 0.20 and were included in all initial, full regression equations for the outcome height for age z-scores.

Differences in nutritional status between breast feeders and non breast feeders depended on whether members of the family were perceived wealthy enough to own a change of clothes, whether the mother was working to earn money, the education level of the mother, source of non drinking water, the type of floor, presence of electricity in the house, and presence of radio in the house.

Table 4.7: Unadjusted Differences in Height for Age Z-Scores, Between Breast Fed and Non Breast Fed Children That Varied Depending on Level of Covariates, From the Sri Lanka DHS

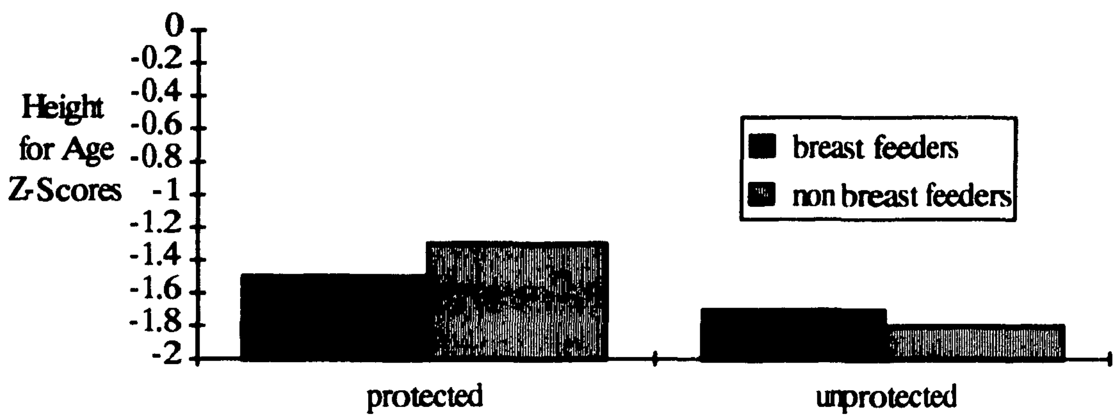
Variable	Not Breast Feeding	Breast Feeding
Non drinking water		
- protected	-1.3 ± 1.1(273)[a]	-1.5 ± 1.2(351)
- unprotected	-1.8 ± 1.3(253)	-1.7 ± 1.1(524)
Mother working to earn money		
- yes	-1.8 ± 1.4(107)	-2.2 ± 1.3(149)
- no	-1.4 ± 1.2(419)	-1.5 ± 1.1(726)
Mother's education		
- higher	-1.0 ± 1.1(157)	-1.3 ± 1.0(169)
- secondary	-1.5 ± 1.2(193)	-1.5 ± 1.1(311)
- primary	-1.9 ± 1.1(137)	-1.8 ± 1.2(283)
- none	-2.0 ± 1.4(39)	-2.4 ± 1.2(112)
Appear wealthy[b]		
- yes	-1.4 ± 1.2(476)	-1.6 ± 1.1(780)
- no	-2.1 ± 1.2(49)	-1.8 ± 1.3(95)
Floor		
- permanent	-1.2 ± 1.1(322)	-1.4 ± 1.1(407)
- temporary	-2.0 ± 1.2(202)	-1.9 ± 1.1(468)
Electricity		
- yes	-0.9 ± 1.1(375)	-1.1 ± 1.1(761)
- no	-1.8 ± 1.2(151)	-1.7 ± 1.2(114)
Radio		
- yes	-1.4 ± 1.2(385)	-1.6 ± 1.1(589)
- no	-1.9 ± 1.2(141)	-1.8 ± 1.2(286)

a - z-score standard deviation (sample size)
b - perceived wealthy enough to own a change of clothes

In general, the best levels of nutritional status were found among those children with better living conditions; the first line within each variable in Table 4.7. Children with better living conditions, whether breast fed or not, had better z-scores than those with not so good living conditions; the second line within each variable in Table 4.7. For example, children with better nutritional status were those whose families were perceived wealthy enough to own a change of clothes, mothers had higher education, family had a protected non drinking water supply, homes had a permanent floor, and homes had electricity and a radio. The exception was for children whose mothers worked to earn money, who had poorer height-for-age than those whose mothers did not work to earn money.

As seen by the results in table 4.7 the unadjusted differences in height-for-age z-scores due to the effects of breast feeding were smaller than those due to different levels of the covariates, and were not always in the same direction. For example, breast feeding was less protective than non breast feeding for children coming from homes with a protected source of non drinking water, but had a slightly protective effect for those with an unprotected source of non drinking water (Figure 4.2).

Figure 4.2: Unadjusted Association Between Breast Feeding Status and Height for Age Z-Scores, Depending on the Source of Non Drinking Water

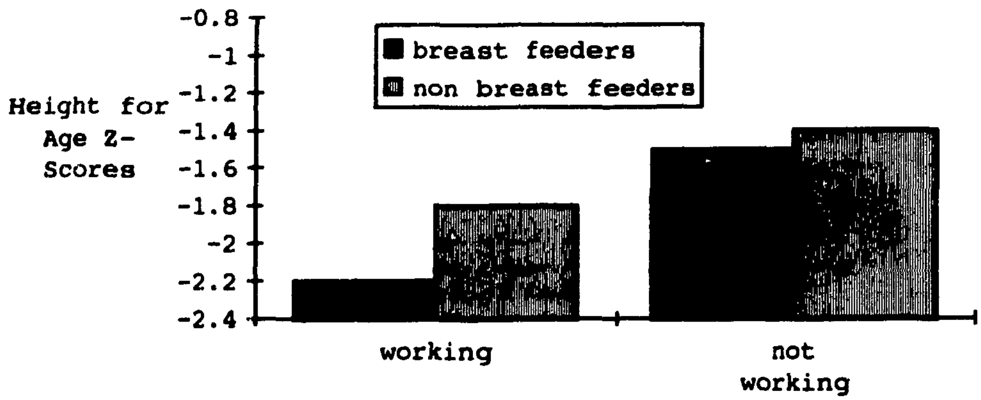


N.B. See table 4.7 for standard deviation and sample sizes

Another example is among children whose mothers did not work to earn money, those who were currently breast feeding were at a slight disadvantage. Also, when the mochers did work to earn money breast feeding was even more of a disadvantage (Figure 4.3).

Breast feeding was associated with better nutritional status than non breast feeding for children whose families did not appear wealthy enough to own a change of clothes. In addition, breast feeding was associated with slightly better nutritional status for children whose mothers had primary education, had a temporary floor, no electricity, and no radio.

Figure 4.3: Unadjusted Association Between Breast Feeding Status and Height for Age Z-Scores, Depending on the Work Status of the Mother



N.B. See table 4.7 for standard deviation and sample sizes

2. OBJECTIVE ONE: THE ASSOCIATION BETWEEN CURRENT BREAST FEEDING STATUS AND HEIGHT-FOR-AGE

a. HEIGHT-FOR-AGE Z-SCORES

A regression equation with current breast feeding status , significant interactions (identified in Table 4.7), and all covariates (listed in Table 4.4 and the age of the child in months) was used to predict height-for-age z-scores. Only one interaction maintained significance. The association between breast feeding and height-for-age z-scores was not the same for all levels of education of the mother.

To determine how mothers' education (4 levels) and breast feeding (2 levels) interacted, three orthogonal interaction contrasts for 2x4 tables were tested. The interaction between current breast feeding status and whether or not the mother had any education was significant (Table 4.8). The other two interactions were not significant. One tested the association between current breast feeding status by mothers with primary versus secondary and higher education. The other tested the association between current breast feeding status by mothers with secondary versus higher education (Appendix H).

Table 4.8: Differences Between Breast Feeders and Non Breast Feeders for Height-for-Age Z-Scores, Depending on Education of Mothers, Among Sri Lankan Children 13-36 Months of Age, Including All Covariates[a]

		Maternal Education (sample size)		Simple	95% CI[b]
		none	some	Effect	
Breast	No	-1.7 (39)	-1.7 (487)	0.1	(-0.3, 0.4)
Feeding	Yes	-2.1 (112)	-1.7 (763)	-0.4	(-0.6, -0.1)
Simple Effect		0.4	-0.0		
95% CI		(0.0, 0.8)	(-0.2, 0.1)		

Interaction Effect: 1.4 (0.1, 2.6)

a-due to rounding differences, values shown in Table 4.8 may be slightly different from those calculated.
b- confidence interval

Current breast feeding was negatively associated with height-for-age z-scores for children whose mothers were uneducated. These children had the lowest height-for-age z-scores. However, there were no differences in heights of currently breast fed and non breast fed children of educated mothers.

A reduced model that included only significant covariates and the interaction between breast feeding and mother's education was then examined to determine if the interaction remained significant. The interaction between breast feeding status and education level of the mother remained significant in the reduced model (Table 4.9).

Table 4.9: Differences Between Breast Feeders and Non Breast Feeders for Height for Age Z-Scores, Depending on Education of Mothers, Among Sri Lankan Children 13-36 Months of Age Including Only Significant Covariates[a]

		Maternal Education no educ[c]	Maternal Education some educ	Simple Effect	95% CI[b]
Breast Feeding	No	-1.7	-1.8	0.1	(-0.3, 0.4)
	Yes	-2.1	-1.7	-0.4	(-0.6, -0.1)
Simple Effect		0.4	-0.1		
95% CI		(+0.0, 0.8)	(-0.2, 0.1)		

Interaction Effect: 0.5 (0.0, 0.9)

a-due to rounding differences, values shown in Table 4.9 may be slightly different from those calculated.
b- confidence interval c-education

The unadjusted effect compared to multivariate analyses showed an attenuated interaction effect between breast feeding and education level of the mother on nutritional status (Table 4.10).

Table 4.10: Differences Between Breast Feeders and Non Breast Feeders For Height for Age Z-Scores, Depending on Education of Mothers, Among Sri Lankan Children 13-36 Months of Age, Including No Other Covariates[a]

		Maternal Education no educ[c]	Maternal Education some educ	Simple Effect	95% CI[b]
Breast Feeding	No	-2.0	-1.5	-0.6	(-0.9, -0.2)
	Yes	-2.4	-1.5	-0.8	(-1.1, -0.6)
Simple Effect		0.3	0.0		
95% CI		(-0.1, 0.7)	(-0.1, 0.2)		

Interaction Effect: 0.3 (-0.2, 0.7)

a-due to rounding differences, values shown in Table 4.10 may be slightly different from those calculated.
b- confidence interval c-education

Breast fed children whose mothers were uneducated had the lowest z-scores in all three regressions. The modifying effect of maternal education on the association between current breast feeding status and height-for-age z-scores was not affected by adjustment for other variables. Among those whose mothers were educated, there was no difference in heights between breast feeders and non breast feeders. In addition, there was some confounding that was important to control as shown by the changes in the cell means. The estimates of the cell means changed but the direction of simple effects did not change nor did the magnitude of the difference between breast feeders and non breast feeders.

The results of the reduced model were nearly the same as for the full model, which included all covariates and interactions. The mean square error and R squared terms for the reduced and the full models were not different (see Table 4.11 for results of the reduced equation for Analysis of Variance).

Ten covariates were significant in predicting height-for-age z-scores. Height-for-age was lower if children were older. However, children who were females, whose birth order was first or second, who lived in homes with less than two other children, came from homes with electricity, lived in the estates, had a protected source of non drinking water, whose families appeared wealthy enough to own a change of clothes, had a permanent floor and whose fathers were professionals had better height-for-age than their counterparts.

Table 4.11: Coefficients From Analysis of Variance for Testing the Association Between Current Breast Feeding Status and Height-for-Age Z-Scores of Children 13-36 Months of Age in Sri Lanka[a,b]

Variable	Coefficients
Constant	-1.5
Non breast feeders vs breast feeders	0.0
Mother's education	
- none vs higher	-0.1
- primary vs higher	0.0
- secondary vs higher	0.0
No education x no breast feeding	0.2**
Primary education x no breast feeding	-0.1
Secondary education x no breast feeding	-0.1
Electricity vs no electricity	0.2**
Age of child (months)	0.0**
Sector	
- urban vs estates	0.3**
- rural vs estates	0.2
Gender female vs male	-0.1*
Unprotected vs protected ndw[c]	-0.2*
Perceived wealthy[d] vs not wealthy	0.1**
Permanent vs temporary floor	0.2**
Birth order	
- 1st born vs 4th or higher	0.1**
- 2nd born vs 4th or higher	0.1
- 3rd born vs 4th or higher	-0.1
Father professional vs non professional	0.4**
2+ other kids in home vs less than two	-0.1*

a-SYSTAT codes a categorical variable with two levels as 1 and -1
b-covariates that did not contribute to the model and were deleted were: presence of television and radio in the household, whether the mother was working to earn money, the source of drinking water, and the type of toilet facilities available.
c-non drinking water, d-perceived wealthy enough to own a change of clothes
*- p-value less than 0.20, **- p-value less than 0.05,
***- p-value less than 0.01

b. DETERMINING THE EFFECT OF INTERMEDIATE VARIABLES ON HEIGHT FOR AGE Z-SCORES.

The effect of intermediate variables on height-for-age and on attenuating the joint effect of current breast feeding status and the education level of the mother was examined. Intermediate variables, diarrhea in the two weeks before the interview and the number of months a child had been exposed to solids and milks' were added separately and jointly to the reduced model which included all variables of interest that were significant.

The incidence of diarrhea, when added to the reduced model, was not significant (p=0.767). In addition, the age of introduction of solid food was not significant in predicting height-for-age (p=0.980). However, the age of introduction of milks, other than breast milk, was significant in predicting height-for-age (p=0.113).

When all three intermediate variables were added simultaneously to the reduced model only the number of months a child had been exposed to milks remained significant (p=0.113). A child who had been exposed to milks for a longer time had better height-for-age z-scores than a child who had been exposed to milks for a shorter time.

The number of months of exposure to milks did affect the interaction between current breast feeding status and the education level of the mother, but the interpretation or direction of the effect did not change. In addition, the values of the coefficients for each variable, and their interpretations, were similar before and after the addition of the milk variable to the reduced model (Table 4.12).

Table 4.12: Differences in Height for Age Z-Scores Between Breast Feeders and Non Breast Feeders, Depending on the Education of the Mother, After Controlling for Confounders and Number of Months of Exposure to Milks

		Maternal Education	
		no educ[c]	some educ
Breast Feeding	No	-1.8	-1.8
	Yes	-2.1	-1.7

3. OBJECTIVE TWO: THE ASSOCIATION BETWEEN THE NUMBER OF MONTHS OF BREAST FEEDING AND HEIGHT FOR AGE

An Analysis of Variance with all covariates, identified *a priori* (listed in Table 4.4 and the age of the child), and the seven previously identified interactions (Table 4.7) was used to assess the association between number of months of breast feeding and height-for-age z-scores.

Height for age z-score differences for the number of months of breast feeding depended on two variables -- the education level of the mother, and whether the mother worked to earn money (Table 4.13). In addition, six covariates were significant in predicting height-for-age z-scores.

Table 4.13: Coefficients From Analysis of Variance for Testing the Association Between the Number of Months of Breast Feeding and Height for Age Z-Scores of Children 13-36 Months of Age in Sri Lanka[a,b]

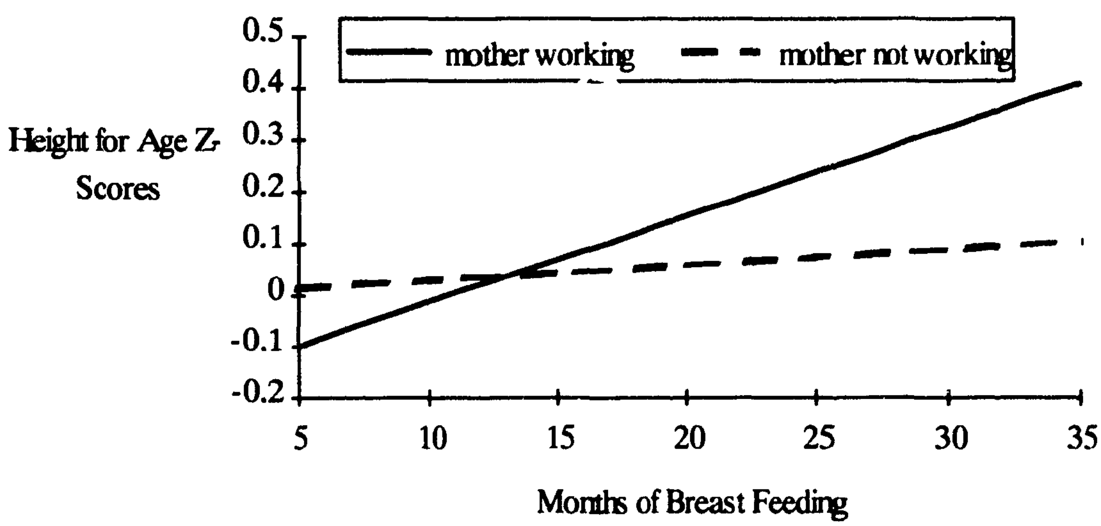
Variable	Coefficients
Constant	-1.1
Months of breast feeding	0.0
Mother's education	
- none vs higher	-0.2**
- primary vs higher	-0.2
- secondary vs higher	0.1
No education x months of breast feeding	-0.01**
Primary educ x months of breast feeding	0.01
Secondary educ x months of breast feeding	0.0
Mother working[c] vs not working	-0.2
Mother working x months of breast feeding	0.01*
Age of child (months)	-0.02**
Sector	
- urban vs estates	0.4**
- rural vs estates	0.2
Gender female vs male	-0.1*
Unprotected vs protected ndw[d]	-0.2**
Birth order	
- 1st born vs 4th or higher	0.2**
- 2nd born vs 4th or higher	0.05
- 3rd born vs 4th or higher	-0.1
Father a professional vs non professional	0.5**

a-SYSTAT codes a categorical variable with two levels as 1 and -1
b-covariates that did not contribute to the model and were deleted were: whether there was electricity, television, or radio in the home, type of toilet facilities, source of drinking water, type of material for the floor, whether the members of the household were perceived to be wealthy, and the number of other children in the home.
c- mother working to earn money
d- non drinking water
*- p-value less than 0.20, **- p-value less than 0.05,
***- p-value less than 0.01

The results from the reduced model that included only significant covariates and the effect modifiers -- education level of the mother and whether the mother worked to earn money -- were nearly the same as for the full model (see Table 4.13 for the results from the reduced equation for Analysis of Variance). Age was included in the Analysis of Variance equation and was a strong predictor of height-for-age, but even with age in the model the interactions were still significant.

Height-for-age differences for number of months of breast feeding were dependent on the work status of the mother and the education level of the mother. The first interaction was between the number of months of breast feeding and whether the mother was working (Figure 4.4). For children whose mothers were working versus those not working, the height-for-age z-scores were higher in those breast fed for a longer duration. Children who were breast fed for 13 months or less had better height for age z-scores if their mothers did not work than if their mothers did work. However, children breast fed over 13 months had better height for age z-scores if their mothers worked rather than if their mothers did not work.

Figure 4.4: The Effect of Number of Months of Breast Feeding on the Height for Age Z-Scores of Children, Between 13-36 Months of Age, in Sri Lanka, Depending on the Work Status of the Mother



NB: recall that the coefficients for continuous variables are not included in the equation for computing adjusted cell means in SYSTAT™ (74).

An example of the simple effects of number of months of breast feeding on height-for-age was calculated using 24 and 8 months. The difference in height-for-age z-scores for children whose mothers were working to earn money was + 0.3 more for children breast fed for 24 months versus 8 months (95% confidence interval; +0.0, 0.5). The difference in height-for-age z-scores for children whose mothers were not working for money was -0.2 (95% CI; -0.6, 0.2).

For the second interaction, between the number of months of breast feeding and the education level of the mother, the interpretation was similar to that reported for current breast feeding status. As number of months of breast feeding increased, the height-for-age z-scores of children whose mothers had primary, secondary, or higher education, increased. With each increase of a month of breast feeding, children whose mothers did not have education had lower z-scores than children whose mothers had higher education but this was not significant as for objective 1.

The difference between children breast fed for 24 months versus 8 months was: -0.1 for those whose mothers had no education (95%CI;-0.4, 0.3); 0.3 for those whose mothers had primary education (95%CI; +0.0, 0.5); 0.1 for those whose mothers had secondary education (95%CI; -0.1, 0.3); and 1.8 for those whose mothers had higher than secondary education (95%CI; 1.1, 2.4)

There were six covariates that contributed to the prediction of height-for-age z-scores. The height-for-age of children was lower if they were older and was higher if they were males, were first or second born, lived in urban or rural areas, had a protected source of non drinking water and if their fathers were professionals (Table 4.13)

B. WEIGHT FOR AGE

1. DIFFERENCES IN NUTRITIONAL STATUS BETWEEN BREAST FEEDERS AND NON BREAST FEEDERS DUE TO COVARIATES

Six covariates, out of sixteen, were statistically significant in modifying the association between current breast feeding status and weight for age z-scores (see Table 4.14 for the five categorical covariates). These six effect modifiers had a p-value below 0.20. Differences in nutritional status between breast fed and non breast fed children depended on the age of the child, the source of non drinking water, whether the family members appeared wealthy enough to own a change of clothes, type of floor, presence of electricity in the home, and the area of residence.

Table 4.14: Unadjusted Differences in Weight-for-Age Z-Scores Between Breast Fed and Non Breast Fed Children That Varied Depending on Level of Covariates, From the Sri Lanka DHS[a]

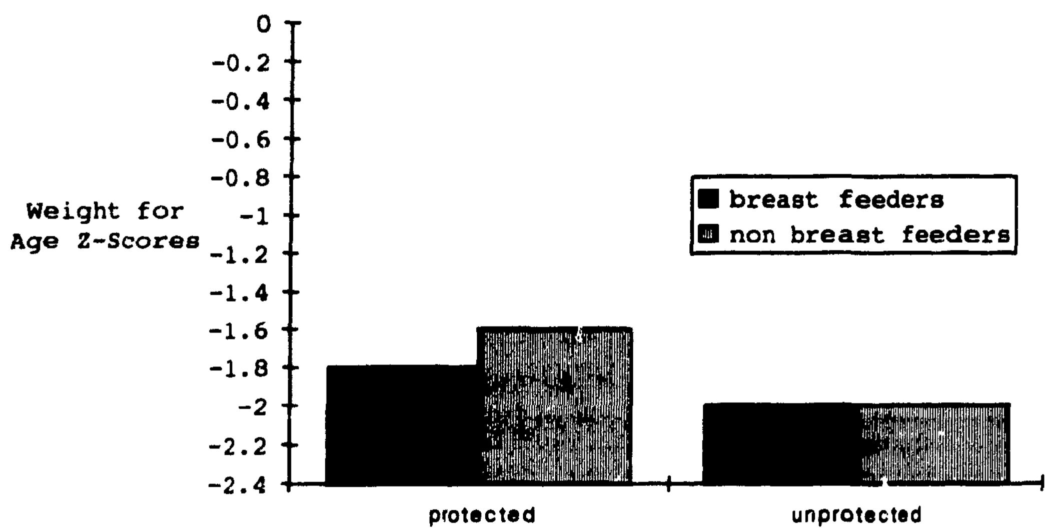
Variable	Not Breast Feeding	Breast Feeding
Non drinking water		
- protected	-1.6 ± 1.7(273)[a]	-1.8 ± 0.9(351)
- unprotected	-2.0 ± 1.6(253)	-2.0 ± 0.9(524)
Perceived wealthy[b]		
- yes	-1.8 ± 0.9(476)	-1.9 ± 0.9(780)
- no	-2.3 ± 0.9(49)	-2.1 ± 0.9 (95)
Floor		
- permanent	-1.6 ± 0.9(322)	-1.7 ± 0.9(407)
- temporary	-2.2 ± 0.9(202)	-2.1 ± 0.9(468)
Electricity		
- yes	-1.4 ± 0.9(151)	-1.5 ± 0.9(114)
- no	-2.0 ± 0.9(375)	-2.0 ± 0.9(761)
Sector of residence		
- urban	-1.6 ± 0.9(103)[a]	-1.5 ± 0.9(87)
- rural	-1.8 ± 0.9(364)	-1.9 ± 0.9(671)
- estates	-2.4 ± 0.9(59)	-2.3 ± 0.9(119)

a - z-score standard deviation (sample size)
b - perceived wealthy enough to own a change of clothes

In general the best levels of nutritional status were found among those with better living conditions; the first line within each variable in Table 4.14. Among those that were better off, the best levels of weight for age z-scores were among those not breast fed, with the exception of urban children.

The unadjusted differences in weight-for-age of children were larger due the levels of covariates than due to breast feeding status, and were not always in the same direction. For example, breast feeding was less protective than non breast feeding when children had a protected source of non drinking water, but made no difference for children with an unprotected source of non drinking water (Figure 4.5).

Figure 4.5: Unadjusted Association Between Current Breast Feeding Status and Weight for Age Z-Scores, Depending on the Source of Non Drinking Water

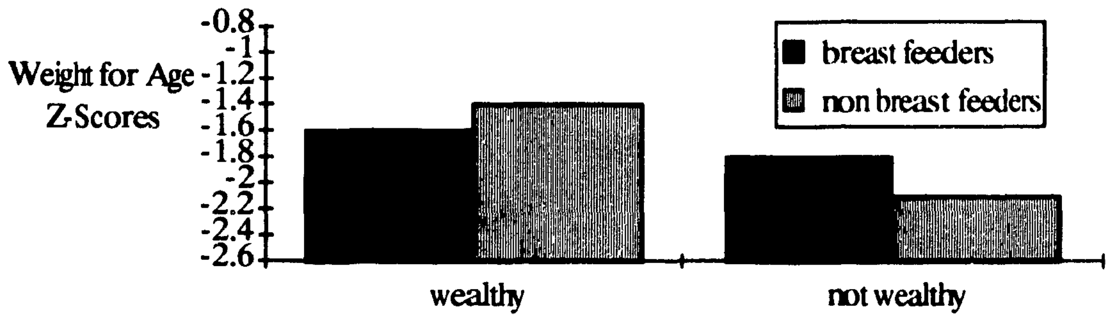


N.B. See table 4.14 for standard deviations and sample sizes

Another example was non breast feeding was more protective than breast feeding for children from families that were perceived to be wealthy enough to own a change of clothes. However, the opposite was true for children whose families were not perceived to be wealthy enough to own a change of clothes (Figure 4.6).

In addition, breast feeding as compared to non breast feeding was associated with better nutritional status when children lived in homes with a temporary floor, with electricity, and living in urban and estate areas.

Figure 4.6: Unadjusted Association Between Current Breast Feeding Status and Weight for Age Z-Scores, Depending on Whether Percieved to be Wealthy



N.B. See table 4.14 for standard deviations and sample sizes

There was a significant interaction between the age of the child in months, a continuous variable, and breast feeding status. This interaction indicated that weight-for-age z-scores were lower if the child was older and continued breast feeding.

2. OBJECTIVE ONE: THE ASSOCIATION BETWEEN CURRENT BREAST FEEDING STATUS AND WEIGHT-FOR-AGE

a. WEIGHT-FOR-AGE Z-SCORES

An Analysis of Variance equation with breast feeding status, significant interactions (identified in Table 4.14) and all covariates (listed in Table 4.4 and the age of the child in months) was used to predict weight-for-age z-scores. Only one interaction maintained significance; the association between breast feeding on weight for age was modified by the area of residence.

The results from the reduced model that included only significant covariates and the interaction between area of residence and breast feeding status were nearly the same as for the full model (see Table 4.15 for results of the reduced equation for Analysis of Variance).

Table 4.15: Coefficients From Analysis of Variance for Testing the Association Between Current Breast Feeding Status and Weight-for-Age Z-Scores of Children 13-36 Months of Age in Sri Lanka[a,b]

Variable	Coefficient
Constant	-2.2
Non breast feeders vs breast feeders	0.03
Sector:	
- urban vs estates	0.2**
- rural vs estates	0.1
Urban sector x non breast feeders	-0.1*
Rural sector x non breast feeders	0.1
Age of child (months)	-0.01**
Unprotected vs protected non drinking water	-0.1**
Perceived wealthy[c]	0.2**
Permanent vs temporary floor	0.2**
Birth order:	
- 1st born vs 4th or higher	0.1**
- 2nd born vs 4th or higher	0.1
- 3rd born vs 4th or higher	-0.1
Father professional vs non professional	0.2**
Television vs no television in house	0.3**

a-SYSTAT codes a categorical variable with two levels as 1 and -1
b-covariates that did not contribute to the model and were deleted were: gender of the child, education level of the mother, whether the mother worked to earn money, the number of other children in the home, presence of electricity and radio in the household, source of drinking water, and type of toilet facilities.
c-perceived wealthy enough to own a change of clothes
*- p-value less than 0.20, **- p-value less than 0.05,
***- p-value less than 0.01

The association between breast feeding and the weight-for-age z-scores of children was modified by the area of residence, however this was not significant at p=0.05 level (Table 4.16). Breast fed children in estates and urban areas had better weight for age z-scores than non breast fed children, but this difference was not significant. Breast fed children in rural areas, excluding estates, had slightly lower weight for age z-scores than non breast fed children; again this difference was not significant.

Table 4.16: Differences in Weight-for-Age Z-Scores Between Breast Feeders and Non Breast Feeders Depending on the Area of Residence, After Controlling for Confounders.

		Area of Residence		
		Urban	Rural	Estates
Breast	no	-1.6	-1.8	-2.4
Feeding	yes	-1.5	-1.9	-2.2
simple effect		-0.2	0.1	-0.1
95% CI		(-0.4, 0.1)	(-0.0, 0.2)	(-0.4,0.2)

Seven covariates were significant in predicting weight-for-age z-scores. Children coming from homes with a protected source of non drinking water, permanent floor, a television, whose birth order was first or second, whose families were perceived to be wealthy enough to own a change of clothes and whose fathers were professionals had better weight-for-age than their counterparts. However, older children had lower weight-for-age than younger children.

b. DETERMINING THE EFFECT OF INTERMEDIATE VARIABLES ON WEIGHT FOR AGE Z-SCORES

The effect of intermediate variables on weight for age z-scores and on attenuating the joint effect of current breast feeding status with area of residence was examined. Intermediate variables, incidence of diarrhea in the two weeks before the interview, and the number of months a child had been exposed to milks, other than breast milk, or solids, were added separately and jointly to the reduced model which included all variables of interest that were significant.

The incidence of diarrhea, added to the reduced model, was not significant (p=0.790). Also, the number of months a child had been exposed to solids was not significant (p=0.278). However, the number of months a child had been exposed to milks, other than breast milk, was significant in predicting weight-for-age z-scores (p=0.04).

When all three intermediate variables were added simultaneously to the reduced model only the number of months of exposure to milks remained significant, while the other two did not contribute to the model. A child who had been exposed to milks for a longer time had better weight-for-age than a child who had not been exposed to milks for as long a period.

The addition of number of months of exposure to milks into the regression equation did affect the interaction between current breast feeding status and the area of residence, but the interpretation or direction of the effect did not change. In addition, the values of the coefficients for each variable, and their interpretations, were similar before and after the addition of the milk variable to the reduced model (Table 4.17).

Table 4.17: Differences in Weight-for-Age Z-Scores Between Breast Feeders and Non Breast Feeders Depending on the Area of Residence, After Controlling for Confounders and Number of Months of Exposure to Milks.

		Area of Residence		
		Urban	Rural	Estates
Breast	no	-1.8	-1.9	-2.3
Feeding	yes	-1.6	-1.9	-2.2

3. OBJECTIVE TWO: THE ASSOCIATION BETWEEN THE NUMBER OF MONTHS OF BREAST FEEDING AND WEIGHT FOR AGE Z-SCORES

An Analysis of Variance with all covariates, identified *a priori* (listed in Table 4.3 and age of the child), and the six previously identified interactions (Table 4.14) was used to assess the association between number of months of breast feeding and weight-for-age z-scores.

Weight for age differences for the number of months of breast feeding depended on two variables -- source of non drinking water and area of residence (Table 4.18). Age was included in the Analysis of Variance equation and was a strong predictor of height-for-age, but even with age in the model the interactions were still significant. In addition, six covariates contributed to the reduced Analysis of Variance model.

Table 4.18: Coefficients From Analysis of Variance for Testing the Association Between the Number of Months of Breast Feeding and Weight-for-Age Z-Scores of Children 13-36 Months of Age in Sri Lanka[a,b]

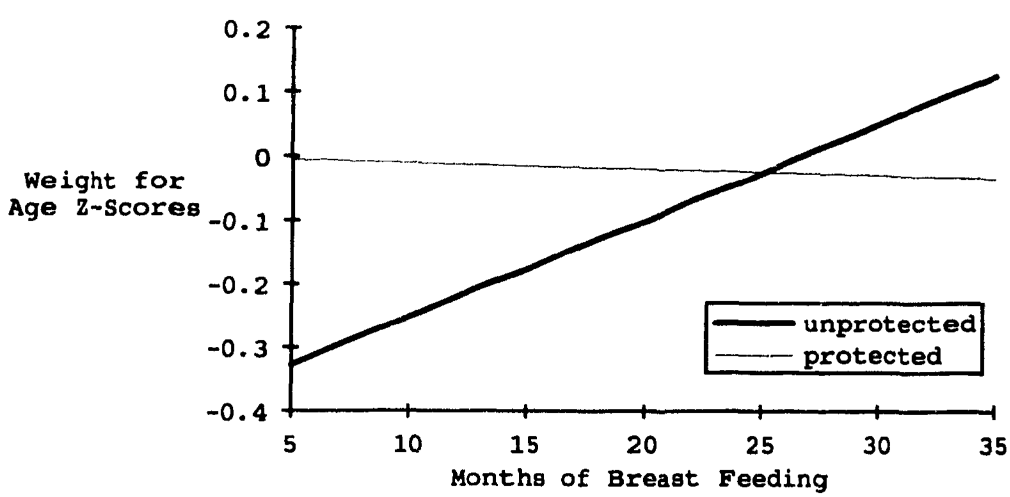
Variable	Coefficient
Constant	-2.2
Months of breast feeding	0.0
Unprotected vs protected non drinking water	-0.4**
Unprotected non drinking water x mos bf[c]	0.02**
Sector:	
- urban vs estates	0.1**
- rural vs estates	0.3
Urban sector x mos breast feeding	0.01**
Rural sector x mos breast feeding	-0.01
Education level of mother:	
- none vs higher than secondary	-0.2*
- primary vs higher than secondary	0.04
- secondary vs higher than secondary	0.03
Age of child (months)	-0.01**
Perceived wealthy[d]	0.2**
Birth order:	
- 1st born vs 4th or higher	0.2**
- 2nd born vs 4th or higher	0.1
- 3rd born vs 4th or higher	-0.1
Television vs no television in house	0.4**
Father a professional vs non professional	0.2**

a-SYSTAT codes a categorical variable with two levels as 1 and -1
b-covariates that did not contribute to the model and were deleted were: mother's work status, source of drinking water, type of toilet facility, type of floor in the home, electricity in the home, radio in the home, gender of the child, number of other children in the home.
c- months of breast feeding
d- perceived wealthy enough to own a change of clothes
*- p-value less than 0.20, **- p-value less than 0.05,
***- p-value less than 0.01

The results from the reduced model that included only significant covariates and the two effect modifiers -- source of non drinking water and area of residence -- were nearly the same as for the full model (see Table 4.18) for results of the reduced Analysis of Variance.

Weight for age differences for number of months of breast feeding were dependent on source of non drinking water and area of residence. For the first interaction, the weight-for-age of children from homes with an unprotected source of non drinking water were higher in those with a higher number of months of breast feeding. For children from homes with a protected source of non drinking water, the weight-for-age z-scores remained relatively unchanged for different durations of breast feeding (Figure 4.7). Children who breast fed for a longer duration were heavier if the home relied on an unprotected source of no drinking water.

Figure 4.7: The Association Between The Number of Months of Breast Feeding and the Weight for Age Z-Scores of Children, Between 13-36 Months of Age, in Sri Lanka, Depending on Source of Non Drinking Watar



NB: recall that the coefficients for continuous variables are not included in the equation for computing adjusted cell means in SYSTAT™ (74).

For example, children from homes with an unprotected source of non drinking water who were breast fed for 24 months versus 8 months had better weight-for-age z-scores, +0.2 (95%CI; 0.1, 0.4). However, for children from homes with a protected source of drinking water there was no association between months of breast feeding and weight-for-age z-scores; difference of -0.3 (95%CI; +0.0, -0.6).

The interpretation of the interaction of breast feeding with sector was very similar to that reported for current breast feeding status (see Table 4.16). However, unlike objective 1 the simple effects of number of months of breast feeding were significant for children from rural areas. There was no difference in weight-for-age z-scores for children from urban areas and estates who were breast fed for a longer versus a shorter duration. However, the weight-for-age z-scores for children from rural areas were significantly lower in those breast fed for a greater number of months. The difference between children breast fed for 24 months versus 8 months was: 0.1 for those from urban areas (95%CI;-0.2, 0.3); -0.3 for those from rural areas (95%CI; -0.4, -0.1); and 0.2 for those from estates (95%CI; -0.1, 0.4).

Weight-for-age z-scores were lower for older children. In addition children from better living conditions had better weight-for-age z-scores. Children with better weight-for-age came from homes where family members appeared wealthy enough to own a change of clothes, whose mothers had education, whose birth order was first or second, whose fathers were professionals, and who had a television.

C. WEIGHT FOR HEIGHT

1. DIFFERENCES IN NUTRITIONAL STATUS BETWEEN BREAST FEEDERS AND NON BREAST FEEDERS THAT VARIED OVER LEVELS OF MODIFIERS

Two covariates, out of sixteen, were statistically significant in modifying the association between current breast feeding status and weight-for-height z-scores (Table 4.19). These two effect modifiers had a p-value below 0.20. Differences in nutritional status between breast fed and non breast fed children depended on father's professional status, and the area in which the child lived.

Breast feeding children in urban areas and estates had better weight-for-height z-scores than non breast feeding children in these areas, in the unadjusted equations. However, breast feeding children from rural areas had the lowest weight-for-height z-scores. In addition, breast feeding children whose fathers were professionals had better weight-for-height z-scores than non breast feeding children.

Table 4.19: Unadjusted Differences in Weight-for-Height Z-Scores Between Breast Fed and Non Breast Fed Children That Varied Depending on Level of Covariates, From the Sri Lanka DHS

Variable	Not Breast Feeding	Breast Feeding
sector		
- urban	-1.1 ± 0.8(103)[a]	-1.0 ± 0.8(87)
- rural	-1.1 ± 0.8(364)	-1.3 ± 0.8(671)
- estates	-1.2 ± 0.8(59)	-1.0 ± 0.8(119)
Father Professional		
- yes	-1.1 ± 0.9(78)	-1.0 ± 0.8(74)
- no	-1.1 ± 0.8(410)	-1.2 ± 0.8(766)

a-mean standard deviation(sample size)

These two significant effect modifiers were included in all initial, full regression equations for the outcome weight-for-height z-scores.

2. OBJECTIVE ONE: THE ASSOCIATION BETWEEN CURRENT BREAST FEEDING STATUS AND WEIGHT-FOR-HEIGHT

a. WEIGHT FOR HEIGHT Z-SCORES

An Analysis of Variance equation with current breast feeding status, the two significant effect modifiers (identified above) and all covariates (listed in Table 4.4 and the age of child in months) was used to predict weight-for-height z-scores. The interaction between professional status of the father and current breast feeding status maintained significance ($p<0.2$). The other interaction between current breast feeding status and the sector of residence failed to retain statistical significance.

The results from the reduced model that included only significant covariates and the interaction between father's professional status and breast feeding status were nearly the same as for the full model (see Table 4.20 for results from reduced equation for Analysis of Variance).

Table 4.20: Coefficients From Analysis of Variance for Testing the Association Between Current Breast Feeding Status and Weight-for-Height Z-Scores of Children 13-36 Months of Age in Sri Lanka[a,b]

Variable	Coefficients
Constant	-1.8
Not breast feeders vs breast feeders	0.04*
Father a professional vs non professional	-0.1
Father a professional x not breast feeding	-0.1**
Age of child (months)	0.01**
Perceived wealthy vs not wealthy[c]	0.1**
Permanent vs temporary floor	0.1**
Birth order	0.1**
- 1st born vs 4th or higher	
- 2nd born vs 4th or higher	0.1
- 3rd born vs 4th or higher	-0.1
2+ other kids in home vs less than two	0.1*
Television vs no television	0.3**
Mother working vs not working	0.2**

a-SYSTAT codes a categorical variable with two levels as 1 and -1
b-covariates that did not contribute to the model and were deleted were: gender of the child, education level of the mother, sector of residence, presence of electricity in home, radio in home, source of drinking and non drinking water, and type of toilet facilities.
c-perceived wealthy enough to own a change of clothes
*- p-value less than 0.20, **- p-value less than 0.05,
***- p-value less than 0.01

The association between current breast feeding status and weight-for-height z-scores was modified by the professional status of the father, however, the simple effects of breast feeding were not significant at p=0.05 (Table 4.21). Children of professional fathers who were breast fed had slightly better weight-for-height z-scores than those who were not breast fed, but this was not significant at p=0.05. However, children of non professional fathers who were breast fed had slightly poorer weight-for-height z-scores than those who were not breast fed; again this was not significant at p=0.05.

Table 4.21: Differences in Weight-for-Height Z-Scores Between Breast Fed and Non Breast Fed Children, Depending on the Professional Status of the Father, After Controlling for Confounders

		Father Professional	
		no	yes
Breast	no	-1.1	-1.3
Feeding	yes	-1.2	-1.1
Simple Effects		0.1	-0.2
95% CI		(-0.0, 0.2)	(-0.5,+0.0)

Seven covariates were significant in predicting weight-for-height z-scores. Weight-for-height z-scores were better for older children. In addition, children whose birth order was first or second, who lived in homes with two or more children, whose family appeared wealthy enough to own a change of clothes, came from homes with a permanent floor and a television, and whose mothers worked to earn money had better weight-for-height z-scores than their counterparts.

b. DETERMINING THE EFFECT OF INTERMEDIATE VARIABLES ON WEIGHT FOR HEIGHT Z-SCORES

The effect of intermediate variables on weight-for-height z-scores and on the joint effect of current breast feeding status with the occupation of the father was assessed. Intermediate variables, incidence of diarrhea in the two weeks before the interview, and the number of months a child had been exposed to milks or solids, were added separately and jointly to the reduced model, which included all variables of interest that were significant.

The incidence of diarrhea, added to the reduced model, was not significant (p=908). Also, the number of months a child had been exposed to milks, other than breast milk, was not significant (p=0.246).

However, the number of months a child had been exposed to solids was significant in predicting weight-for-height z-scores (p=0.165).

The number of months of exposure to solids remained significant when all three intermediate variables were added simultaneously to the reduced model, while the other two intermediate variables did not contribute to the model. A child who had been exposed to solids for a longer time had better weight-for-height z-scores than a child who had been exposed to solids for a shorter time.

The addition of number of months of exposure to solids into the regression equation had a slight affect on the interaction between current breast feeding status and whether the father was a professional. But, the interpretation and direction of the interaction did not change. The values of the coefficients for the covariates were similar before and after the addition of the age of introduction of solids (Table 4.22).

Table 4.22: Differences in Weight For Height Z-Scores Between Breast Fed and Non Breast Fed Children, Depending on the Professional Status of the Father, After Controlling for Confounders and Months of Exposure to Solids

		Father Professional	
		no	yes
Breast Feeding	no	-1.1	-1.4
	yes	-1.2	-1.1

3. OBJECTIVE TWO: THE ASSOCIATION BETWEEN THE NUMBER OF MONTHS OF BREAST FEEDING AND WEIGHT FOR HEIGHT Z-SCORES

An Analysis of Variance with all covariates, identified *a priori* (listed in Table 4.4 and the age of the child), and the two previously identified interactions (Table 4.19) was used to assess the association between number of months of months of breast feeding and weight-for-height z-scores.

Weight-for-height differences for the number of months of breast feeding depended on area of residence (Table 4.23). Age was included in the Analysis of Variance equation and was a strong predictor of height-for-age, but even with age in the model the interaction was still significant. In addition, six covariates contributed to the reduced Analysis of Variance model. The results of the reduced model were nearly the same as the results for the full model.

Table 4.23: Coefficients From An Analysis of Variance for Testing the Association Between Number of Months of Breast Feeding and Weight-for-Height Z-Scores of Children 13-36 Months of Age in Sri Lanka[a,b]

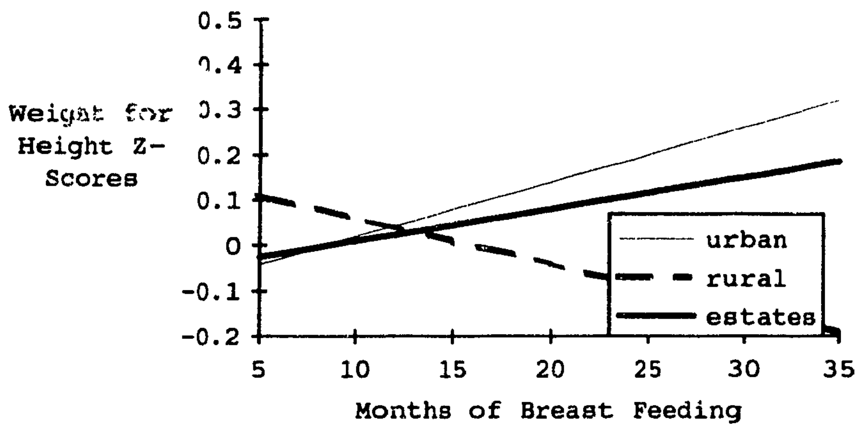
Variable	Coefficients
Constant	-1.8
Months of breast feeding	0.00
Sector:	
- urban vs sector	-0.1**
- rural vs sector	0.2
Urban sector x months of breast feeding	0.01**
Rural sector x months of breast feeding	-0.01
Age of child (months)	0.01**
Perceived wealthy[c]	0.1**
Permanent vs temporary floor	0.1**
Birth order:	
- 1st born vs 4th or higher	0.04**
- 2nd born vs 4th or higher	0.1
- 3rd born vs 4th or higher	-0.1
Television vs no television in house	0.2**
Mother working vs not working to earn money	0.1*

a-SYSTAT codes a categorical variable with two levels as 1 and -1
b-covariates that did not contribute to the model and were deleted were: the gender of the child, the education level of the mother, whether or not the father was a professional, the number of other children in the home, electricity in the home, radio in the home, source of drinking and non drinking water, and type of toilet facilities.
c-perceived wealthy enough to own a change of clothes
*- p-value less than 0.20, **- p-value less than 0.05,
***- p-value less than 0.01

Children from homes where the family was perceived to be wealthy enough to own a change of clothes, had a permanent floor, had a television, whose mothers worked to earn money, and whose birth order was first or second had better weight-for-height z-scores than their counterparts. Also, weight-for-height z-scores were better for older children.

Weight-for-height differences for number of months of breast feeding were dependent on the area of residence (Figure 4.8). Weight-for-height z-scores of children from urban and estate areas were higher in those breast fed for a higher number of months. However, weight-for-height z-scores for children from urban areas were lower for those breast fed for a higher number of months.

Figure 4.8: The Association Between the Number of Months of Breast Feeding and th Weight-for-Height Z-Scores of Children, Between 13-36 Months of Age, in Sri Lanka, Depending on the Area of Residence



NB: recall that the coefficients for continuous variables are not included in the equation for computing adjusted cell means in SYSTAT™ (74).

The interaction between the number of months of breast feeding and the area of residence was significant at p=0.05. The height-for-age z-scores of children from urban or estate areas were not significantly higher for those breast fed for a longer duration versus those breast fed for a shorter duration. However, the height-for-age z-scores of children from rural areas was significantly lower for those breast for a greater number of months.

The differences in weight-for-height z-scores between children breast fed for 24 months versus 8 months were: +0.0 for those from urban areas (95%CI;-0.0, 0.0); -0.2 for those from rural areas (95%CI: -0.3, -0.1); and 0.1 for those from estates (95%CI; -0.1, 0.3).

D. SUMMARY OF THE ASSOCIATIONS BETWEEN BREAST FEEDING AND NUTRITIONAL STATUS

The association between breast feeding and nutritional status was modified by other factors, and was statistically significant. Breast feeding was advantageous in certain groups and not advantageous in other groups with regards to the nutritional status of children (Table 4.24).

Table 4.24: Significant Modifiers of the Association Between Breast Feeding and Nutritional Status and Direction of the Association, in Children 13-36 Months of Age in Sri Lanka

	Height-for-age	Weight-for-age	Weight-for-height
	(direction of association)		
Effect of current breast feeding in:			
uneducated mothers	-	∅	∅
Effect of number of months of breast feeding in:			
educated mothers	+	∅	∅
mother working money	+	∅	∅
unimproved non drinking water	∅	+	∅
rural areas	∅	-	-

Breast feeding status was negatively associated with height-for-age z-scores of children whose mothers did not have an education. However, the height-for-age z-scores were positively associated with greater number of months of breast feeding for children whose mothers had primary or higher than secondary education. Also, a greater number of months of breast feeding was positively associated with the height-for-age z-scores of children of mothers who worked to earn money, and with weight-for-age z-scores for children who came from homes with an unimproved source of non drinking water. For children from rural areas a greater number of months of breast feeding was negatively associated with weight-for-age and weight-for-height z-scores.

The intermediate food variables did contribute to the Analysis of Variance equations, but the intermediate variable for disease -- incidence of diarrhea -- did not contribute to the equations. The number of months of exposure to milks, other than breast milk, was significant in predicting height-for-age z-scores and weight-for-age z-scores. The number of months of exposure to solids was significant for weight-for-height.

CHAPTER FIVE: SUMMARY AND DISCUSSION

Simple unadjusted results showed no differences between breast feeders and non breast feeders, yet those that did not breast feed had better living conditions, suggesting that breast feeding may be protective in some way. Adjusted results showed breast feeding to be advantageous for the nutritional status of children over 12 months of age for children whose mothers worked to earn money, who came from homes with an unprotected source of non drinking water, and whose mothers had primary or higher than secondary education. The positive results contradict all previous studies examining the relationship between prolonged breast feeding and nutritional status. Breast feeding was also found to be negatively associated with nutritional status for children whose mothers were uneducated and for children who lived in rural areas.

A summary of findings is presented, with the effect of each modifying factor reviewed in light of other studies. Subsequently, the control of intermediate variables on nutritional status is presented. This is followed by a discussion of the strengths and limitations of this study. Finally, the implications and recommendations for future research are discussed.

I. SUMMARY OF FINDINGS

Children breast feeding for a long duration had better nutritional status than those breast fed for a short duration if their mothers worked to earn money or if they came from homes with an unprotected source of non drinking water. Those breast fed for a longer duration had poorer nutritional status than those breast fed for a shorter duration if they came from rural areas. Also, children of uneducated mothers had poorer nutritional status if they were currently breast fed than if they were not currently breast feeding. The results of each of these effect modifiers will be discussed below.

A. Work Status of the Mother

Among children whose mothers worked to earn money, those breast fed for a greater number of months were taller than those breast fed for a shorter number of months (see Figure 4.4). In homes where mothers worked to earn money, the difference among 28 month old children breast fed for 24 months versus 8 months (one standard deviation range for months of breast feeding) was 0.9 centimetres (95% Confidence Interval; +0.0, 1.8). This corresponds to approximately one fifth of the observed height for age deficit. However, for children of non working mothers the difference in height-for-age z-scores for longer versus shorter durations of breast feeding was not significant.

Working women who breast feed their children for a greater number of months versus fewer number of months may have taller children for two reasons. The first is that the incidence of disease may be lower in children breast fed for a longer period than in children breast fed for a shorter period. Breast milk has been shown to be protective against disease into the second and third year of life (5, 15, 43, 45, 46). It is also protective against disease in the first year of life, during infancy, so that breast fed children have a better start in life. The second reason is that breast milk is a valuable source of energy and nutrients during the second and third year of life (37, 55). If breast milk is a supplement to other foods then it would be an added source of nutrients in the child's diet, which would facilitate increased growth. However, if breast milk was a substitute for other foods then breast fed children may receive lower quantity and quality of foods, which would result in poor growth.

Children who were breast fed for greater than 13 months, at any particular age (13 months of age or over) had better height-for-age z-scores if their mothers were working than if they were not working. For example, children, 35 months of age, who were breast fed for 30 months were 0.9 cm taller if their mothers worked to earn money than if their mothers did not work to earn money. Children breast fed for greater than 13 months of working mothers may be taller than children of non working mothers because working mothers have more income to obtain a larger quantity and quality of food (80).

The unadjusted results from a study in the Philippines showed that working mothers provided their children, 1-71 months of age, with more calories and protein, excluding breast milk, than non working mothers(81). However, after controlling for confounding, such as family income (excluding the mother's income), the work status of the mother did not significantly increase the dietary intake of children. If work status was to affect quantity and quality of food available, it would not affect infants who may be exclusively breast fed but would affect children when they start on weaning foods -- during the later half of infancy and into the second and third years of life (Figure 4.4).

The height-for-age z-scores of children, who were breast fed for thirteen months or less, at any particular age (age, of course, being equal or greater than the number of months of breast feeding), were better if their mothers were not working than if they were working. For example, children, 35 months of age, of non working mothers who were breast fed for 5 months, were 0.5 cm taller than children of working mothers.

An explanation for improved height-for-age z-scores of children, thirteen months of age or younger, of non working versus working mothers may be related to time. Women are the primary caretakers of children in early infancy (82). However, women who work need to divert time from child care to their work (83). The amount of time a mother has available to care for her children greatly affects child nutrition, through food preparation and attention to feeding (84). If this is the case then non working mothers would have more time for their children, leading to better growth as compared to children of working mothers (see biological model in Chapter 2).

B. Source of Non Drinking Water

Childre , from homes with an unprotected source of non drinking water, breast fed for a greater number of months were heavier than those breast fed for a shorter number of months (see Figure 4.7). In homes with an unprotected source of non drinking water, the difference among 28 month old children breast fed for 24 months versus 8 months (one standard deviation range for months of breast feeding) was 420 grams (95% CI; 140, 690). This corresponds to approximately one seventh of the observed weight for age deficit. However, for children from homes with a protected source of non drinking water the difference in height-for-age z-scores for longer versus shorter durations of breast feeding was not significant.

This difference associated with duration of breast feeding, for children from homes with an unprotected source of drinking water, may be because breast milk continues to be protective against disease into the second and third years of life (5, 12, 15, 43, 45, 46). In addition, breast fed children from homes with an unprotected source of non drinking water may be heavier than their non breast fed counterparts because breast milk continues to be a valuable source of energy and nutrients after the first year of life (37, 55). Also, this survey was conducted during a time of food shortage, in which breast milk would become an even more valuable source of nutrients in the child's diet. However, food shortages do not affect the composition of mother's milk (5, 14)

The weight-for-age z-scores of children from homes with a protected source of non drinking water remained relatively unchanged for children breast fed for a greater number of months as compared to those breast fed for a shorter number of months (see Figure 4.7). For example, in a home with a protected source of non drinking water, a 35 month old child was only 30 grams lighter if breast fed for 30 months rather than 5 months.

It is likely that if a family used an improved source of non drinking water they would use an improved source for their drinking water. It has been reported that exclusive use of improved water supply for drinking and cooking results in improved growth of children one to four years of age, regardless of breast feeding status (86).

There was also a difference in weight-for-age z-scores between children from homes with a protected versus a non protected source of non drinking water. Children breast fed for less than 26 months weighed more if they came from homes with a protected source of non drinking water than if they came from homes with an unprotected source of non drinking water. However, the opposite was true for children breast fed for more than 26 months. For example, 35 month old children who were breast fed for the first 5 months from homes with a protected source of non drinking water were 500 grams heavier than children with similar characteristics coming from homes with an unprotected source of non drinking water.

C. Education of the Mother

Education modified the difference between breast feeders and non breast feeders, and the number of months of breast feeding for height-for-age z-scores. This was statistically significant (p=0.05) for both current breast feeding status (objective 1) and for the duration of breast feeding (objective 2).

Children whose mothers had primary, or higher than secondary education had better height-for-age z-scores if they were breast fed for a greater number of months than if they were breast fed for a shorter number of months. Among 28 month old children whose mothers had higher than secondary education, the difference between children breast fed for 24 months versus 8 months was 6.0 cm (95% CI; 3.8, 8.4). This corresponds to the observed height for age deficit. Among 28 month old children whose mothers had primary education, the difference between children breast fed for 24 months versus 8 months (one standard deviation range for months of breast feeding) was 0.9cm (95% CI; 0.1, 1.7). This corresponds to approximately one sixth of the observed height for age deficit.

People with more education consume more nutritious diets because they can purchase, prepare, and distribute foods more efficiently (78). Many studies show that maternal education is associated with improved child nutrition, even after controlling for the effect of education on income and other confounding variables (79).

Children breast fed for a longer duration were taller if their mothers had primary or higher than secondary education. If education level is a proxy for income -- more educated coming from higher income levels -- then the results comparing differences in children, of educated mothers, breast fed for a longer versus a shorter duration do not support the results of a previous study. In the previous study from Brazil (see review in Chapter 2) prolonged breast feeding was associated with poorer nutritional status in children from middle and upper income levels (65), the opposite from results of this study. The difference between the results of these studies could be explained if breast milk was used as a substitute for other foods rather than a supplement in higher income groups in Brazil but not in Sri Lanka.

However, breast fed children of uneducated mothers were the shortest (statistically significant at p=0.05 for current breast feeding status). A difference of 0.4 z-scores was found between breast fed and non breast fed children of uneducated women. This translates to 1.3 cm for a 24 month old male. This is equivalent to one quarter of the height for age deficit from the NCHS reference median.

There could be two reasons for the poor height-for-age z-scores of currently breast feeding children of uneducated mothers: increased levels of disease or poor food intake (54). For children of non educated mothers the levels of disease were expected to be the same or better for those who were breast fed than those who were not. In agreement, the percentage of children with diarrhea was similar in the breast fed and not breast fed groups for those children whose mothers were uneducated.

D. Area of Residence

Children from rural areas were shorter for their age, and shorter for their heights' if they were breast fed for a greater number of months than if they were breast fed for a shorter number of months. The modifying effect of area of residence was similar for the associations between number of months of breast feeding and weight-for-age and weight-for-height z-scores. Therefore, only the results for the weight-for-age outcome will be described and discussed in detail. Rural in this discussion refers to all rural areas, excluding estates. Estates are commercial plantations of tea, rubber, coconut, and spices.

Breast fed children in estates and urban areas had better weight for age z-scores than non breast fed children, however this was not significant at p=0.05. Breast fed children in rural areas had significantly lower weight-for-age z-scores than non breast fed children. In rural areas, the difference among 28 month old children breast fed for 24 months versus 8 months (one standard deviation range for months of breast feeding) was 340 grams (95% CI; 140, 560). This corresponds to approximately one seventh of the observed weight for age deficit.

In rural areas, the differences in nutritional status of children breast fed for a long versus a short duration could be due to quality or quantity of intake. Breast milk is an energy dense food (9, 14, 37). Therefore, if the quality of supplemental foods is similar in the two groups, the overall quality of intake should be better in the breast fed group resulting in better growth. However, mothers who breast feed for a long period may give inadequate weaning foods (75). Many traditional weaning foods have been shown to be nutritionally inadequate (37, 76, 77).

Also, the quantity of food intake may be greater in non breast fed versus breast fed children. Breast milk may suppress appetite and thereby decrease the demand for other foods (13). No direct measures of food intake were recorded (see discussion of intermediate variables).

In general, regardless of duration of breast feeding, children from the estates had the poorest nutritional status. On average, a 24 month old breast fed child from the estates was 900 grams lighter than a breast fed child from urban areas, of the same age. This may be because conditions in estates are not as good as in rural or urban areas. For example, the facilities available in estates, such as water pumps, are poorly maintained, often out of use, and shared by many households (85). The access to health care may also be lower in the estates than in rural or urban areas. However, the low nutritional status of children from estates was not due to diarrhea; 5% of children from rural areas had diarrhea in the two weeks before the interview while less than 1% of children from estates had diarrhea in this time period.

Children in rural areas had poorer nutritional status than those in urban areas possibly because they too may have less access to health services. For example, Colombo, the capital city of Sri Lanka, and surrounding urban feeder areas have more specialized hospitals, such as a pediatric hospital, which are used mainly by residents of that area (85).

In addition, this survey was conducted during the months when food shortages have been reported to occur (21). Therefore, in the short term, children in rural areas and estates may have poorer nutritional status than those living in urban areas because food shortages may be more widespread in rural areas and estates. This may be why the associations between breast feeding and weight-for-age and weight-for-height were affected by area of residence but height-for-age, a measure of long term nutritional status, was not modified by area of residence.

However, there must be some means of catch-up growth that allows children from estates and rural areas to attain similar height-for-age z-scores as for children from urban areas. But, the number of months of exposure to milks and solids was greater in the urban group than in the rural group. And, the number of months of exposure to solids was greater in the urban group than in the estate group.

II. ADDITION OF INTERMEDIATE VARIABLES

In all previous studies analyzing the association between breast feeding over 12 months and nutritional status, there was a lack of assessment of intermediate variables. In the analyses for these thesis there was an attempt to control for intermediate variables but the variables were not defined as precisely as possible.

The intermediate variables included in this study were related to both reasons for poor nutritional status: increased levels of disease and poor food intake (54). The intermediate variable related to disease was if the child had diarrhea in the two weeks before the interview. The intermediate variables related to food intake were the number of months of exposure to solids and milks, other than breast milk.

The intermediate variable of whether or not the child had diarrhea, in the two weeks before the interview, was not a significant predictor of nutritional status. There were three methodological problems with using diarrhea (19):

1. it was not defined for the mother, and therefore the interpretation of it may not be consistent. Mothers may respond differently depending on the severity of the diarrhea.

2. mothers may forget about a child having diarrhea two weeks ago, therefore the actual rates of diarrhea may be higher than those reported. However, under reporting is not expected to be different in the breast fed or non breast fed group, although the incidence of diarrhea may be higher in the non breast fed versus breast fed group, due to the immunological factors against diarrhea in breast milk.

3. diarrhea in this study was not measured during the monsoon season when rates are high. Lack of findings for wasting may be due to season. Current diarrhea is a good proxy for recurrent diarrhea.

Therefore, if there is control for diarrhea and there is still a difference in nutritional status then something other than diarrhea must be the reason for the difference.

Another problem was when this variable was added to a regression equation. The majority of the children did not have diarrhea in the two weeks before the interview, leaving very little variability in the sample. However, if the effect of diarrhea was large, it would have been found. In addition, it has been suggested that the effect of diarrhea on the length of children is small, if children have adequate nutrient intakes (56). However, if diarrhea rates are low and levels of malnutrition are high, it suggests that food intake is insufficient.

The numbers of months that children had been exposed to milks and solids were significant contributors (p-value<0.20) of nutritional status. However, the addition of these two intermediate variables did not affect the interpretation of estimates for breast feeding or the interactions between breast feeding and other variables. In addition, the mean square error of the model and the R squared terms were not greatly affected by the addition of these intermediate variables.

There was no consistency in nutritional outcomes for the number of months of exposure to milks, or solids. In general, children who had been exposed to milks or solids for a longer time had better nutritional status than those exposed to milks or solids for a shorter time, after controlling for confounders and effect modifiers. The height-for-age z-scores and weight-for-age z-scores increased when children had been exposed to milks, other than breast milk, for a long time. The weight-for-height z-scores were better for children who had been exposed to solids for a long time. On average, children were exposed to solids for 19 months, which was much longer than the average exposure to milks, which was 14 months.

A problem of using number of months of exposure to milks or solids is that duration may not be a good reflection of quality or quantity of food intake. The quality of supplemental foods may be lower in the breast fed group because mothers who breast feed for a long period may give inadequate weaning foods (75). However, quantity of food is not always equivalent to quantity of nutrients.

In addition, there can be a problem with mothers having difficulty recalling when certain foods were introduced into the child's diet. This happened in a pilot survey resulting in the researchers abandoning the questions in the final survey (49). Also, there may be other foods, not included in the survey, that may be important sources of energy in a child's diet.

There was no quantitative information on foods consumed. The duration of exposure to solids and milks does not provide the same support for the hypothesized mechanism, as do actual dietary intakes of children.

III. STRENGTHS OF STUDY

The question of whether the nutritional status of children, over 12 months of age, who are breast fed is the same as or better than that of non breast fed children had not been adequately examined or clearly explained in previous studies. Previous studies showed that prolonged breast feeding had a negative effect on growth. However, these studies did not assess intermediate variables, and only one examined effect modification. Therefore, the Sri Lanka Demographic and Health Survey, which included intermediate variables, was used to analyze this issue further.

The approach to the definition of breast feeding was also a strength. Current breast feeding status and duration of breast feeding were used separately to examine nutritional status. The results from each of these breast feeding variables were different, indicating a need to describe prolonged breast feeding more accurately in future studies (Table 4.24).

The data set used in these analyses contained many covariates of interest, making it possible to control for many more biolcgically important covariates than in previous studies. All together there were eighteen covariates that were added initially to each of the analyses (see Table 4.4), although not all were significant predictors of nutritional status. These covariates included proxies for maternal, paternal and household characteristics. Covariates that were controlled here and not in previous studies examining the association between breast feeding children over 12 months of age and nutritional status were:

type of toilet facility
source of drinking water
source of non drinking water
work status of the mother
electricity in home
television in home
radio in home
type of floor
number of other children in the home

Covariates that were not controlled here but were controlled in other studies were:

income
ethnic background
type of family (nuclear or extended)
previous hospitalization

Another strength of this study was that first order interactions between breast feeding and each covariate were examined, while only one previous study reported interactions. It was through these interactions that the positive effects of breast feeding were realized.

Some other strengths were related to the data set itselr. There was a large sample of children, 1411, between the ages of 13 and 36 months. The sample size was within the range of sample sizes in previous studies. There were also high levels of malnutrition, and this ensured that if there was a difference it could be adequately assessed. There was a problem of insufficient malnutrition in one of the previous studies (52). This was also one of the criterion to avoid negative results. In addition, there were a large number of children that were breast fed well into the third year of life, another criterion to avoid negative results. There was sufficient prolonged breast feeding in all previous studies. The interviewers collecting the data were all trained. The inter and intra examiner error was low for measuring heights and weights -- within the recommendations of the United Nations -- still another criterion to avoid negative results.

IV. LIMITATIONS OF STUDY

Along with the strengths, there were some limitations to this study. The first was that data were not collected to assess this hypothesis. Therefore, these secondary data analyses were limited to information already collected.

Another limitation was that all covariates were initially tested as possible effect modifiers. However, in trying to find effect modifiers there is a risk of finding effects that may be due to chance. Therefore, a p-value of 0.05 was used to determine statistically important modifiers of the association between breast feeding and nutritional status, rather than a p-value of 0.20, which was the initial cut-off.

For some subgroups there may not have been enough power to detect a difference. For example, breast feeding status was positively associated with weight-for-height z-scores of children whose fathers were professional at p=0.2 but not at p=0.05. In this data set only 152 children's fathers were professionals. With this sample size there was 85% power to detect a difference of 0.60 but only 17% power to detect a difference of 0.20 weight-for-height z-scores, with 95% confidence.

Also, some recall error may be present for number of months of breast feeding, when other foods were introduced and diarrhea in the two weeks before the interview. Recall error could introduce bias in the sample, thereby decreasing the ability to find a difference in nutritional status between breast fed and non breast fed children. However, a difference in nutritional status between breast fed and non breast fed children was found in this study, therefore this was not a problem. Children from lower socio-economic groups may be more likely to be adversely affected by recall error and these are also the children that are more likely to be breast fed. Therefore, the association between breast feeding and nutritional status would be more positive than that found in this study.

It is also possible that the association between breast feeding and nutritional status could be due to other effects not measured here that may have confounded the results.

Yet another limitation of this study was that a survey of 13 to 36 month old children may only be representative of healthy survivors. This is especially important when examining the effects of breast feeding because breast feeding is known to be protective in the first year. Therefore, infants who come from poor families and are not breast fed are less likely to survive to their first birthday than breast fed infants. The non breast feeding survivors may be the healthy, well off (those from higher socio-economic groups) children, introducing sample bias. The non beast feeding children who are the survivors would not be true representatives of all non breast feeding children. However, the removal of sample bias, if it exists, would result in the true difference between breast fed and non breast fed children being more positive than found.

The sixth limitation of this study was that information on quality of food in the child's diet and quantity of food consumed by the child was not available. This limitation was discussed in detail in the section on "Addition of Intermediate Variables," earlier in this chapter.

The seventh limitation of this study was that it was not a cohort study. No causal relationships could be established or refuted. However, the associations between breast fed children over 12 months of age and nutritional status were plausible and are of value for future research.

V. RECOMMENDATIONS

Three recommendations can be made that would decrease the negative association and enhance the positive association between prolonged breast feeding and the nutritional status of children.

1. Children of educated mothers have much better nutritional status if they are breast fed for a longer rather than a shorter duration. Therefore, educated mothers should be encouraged to breast feed as long as possible. In addition, uneducated mothers only comprise three percent of the entire population, which may not be of public health importance, but is a group that can be easily targeted. Therefore, weaning programs should focus on uneducated mothers who are breast feeding their children, as these children are shorter than non breast fed children of uneducated mothers. Maternal education, without changing household income was found to have a positive effect on child nutrition, in Indonesia and Bangladesh(83)

2. Working mothers should be encouraged to breast feed their children well into the second and third years of life. Access to children during work hours could be accomplished through (87):

   mobile crèches at the work site where care for children is provided by trained women,

   community day care programs where mothers rotate responsibility,

   co-operatives where women are given work credits for breast feeding.

3. Mothers of children from homes with an unprotected source of non drinking water should be encouraged to breast feed as long as possible. Weaning programs and other programs aimed at decreasing disease should also target these children so that they do not start, in infancy, with much lower weights than children from homes with a protected source of non drinking water. Use of unprotected non drinking water is reported to be associated with poor nutritional status in children between 1-60 months of age (86).

VI. FUTURE RESEARCH

Findings from this study for certain subgroups contradict previous studies. The results of this study suggest that the associations between breast feeding and nutritional status are mainly positive and depend on other factors. Future research could corroborate these results with better measurement, design, sampling and analyses.

Identifying the presence or absence of modifying factors would decrease the likelihood of making erroneous conclusions. For example, the effect of breast feeding is dependent on the work status and education level of the mother. It would also be important to include covariates of interest, identified in this and other studies, that may contribute to predicting nutritional status.

Studies that are designed to evaluate the impact of prolonged breast feeding need to meet the criteria to avoid negative results, as listed in chapter two. This includes an adequate sample size, sufficient malnutrition and prolonged breast feeding in the population, the measurement of intermediate outcomes, such as rates of disease and intakes of foods, and concomitant outcomes, such as mortality. However, due to the limitations of qualitative data on food it is strongly encouraged that quantitative data be used.

The above recommendations could be met through a cohort study that would make it possible to identify causal relationships, if any, between children breast fed beyond 12 months and nutritional status. In addition, changes in dietary intake of children, including quality and quantity of foods, could be measured in a cohort study. Survival bias could be measured if data on all children between birth and 36 months of age was collected longitudinally.

These issues need to be evaluated more carefully in a longitudinal study.

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APPENDIX A

DEFINITION OF VARIABLES THAT WERE NOT TRANSFORMED

Variable name in original data set received from the DHS is included in brackets.

sector (xssector) : urban, rural, or estate

1	urban
2	rural
3	estates

electric (xv119) : does the house have electricity ?

0	no
1	yes

radio (xv120) : does the house have a radio ?

0	no
1	yes

tv (xv121) : does the house have a tv ?

0	no
1	yes

poor (xs803) : members of the household appear wealthy enough to own a change of clothes

1	no
2	yes

edlevel (xv106) : mothers education level

0	no education
1	primary
2	secondary
3	higher

sex (xb4) : sex of child

1 male

2 female

mwork (xv714) : whether the respondent is currently working

0 no

1 yes

bfyn (xv404) : child currently being breast fed

0 no

1 yes

xcaseid : identifies each respondent

xv005 : sample weight 8 digit variable with 6 decimal places

xv006 : month of interview

agemnth : age of the child, in months

bfmos (xm5) : months of breast feeding

weight (xhw2) : weight in kilograms

height (xhw3) : height in centimetres

stunted : less than minus two standard deviations for height for age

underwt : less than minus two standard deviations for weight for age

wasted : less than minus two standard deviations for weight for height

htagez : height for age z-score

wtagez : weight for age z-score

wthtz : weight for height z-score

APPENDIX B

Table A1: Descriptive Statistics for all Continuous Variables

VARIABLE	SAMPLE SIZE	MEAN	STANDARD DEV
AGEMNTH	1411	24.017	6.836
BFMOS	1411	16.306	8.397
NMILKCR	1405	9.790	11.528
NCREAM	1410	10.112	9.433
NCOWMILK	1401	2.984	6.986
NCUNGEE	1408	15.619	9.520
NEGGS	1408	13.966	9.016
NPOTATO	1410	16.087	8.030
NFRUIT	1408	17.536	8.230
NMILKLK	660	15.720	7.766
NSOLIDLK	1190	15.610	7.412
NFOOD	1410	19.718	7.401
MILKCR	1410	52.557	46.388
CREAM	1410	37.191	40.535
COWMILK	1410	78.697	34.456
CUNGEE	1410	19.635	32.967
EGGS	1410	21.016	31.424
POTATO	1410	11.225	18.752
FRUIT	1410	10.248	20.287
MILKLK	660	8.297	4.637
SOLIDLK	1190	8.384	3.657
FOOD	1410	4.352	3.761
MILK	1399	14.443	10.342
SOLID	1404	19.128	7.495

APPENDIX C

Table A2: Descriptive Statistics for all Categorical Variables

VARIABLE	VALUE	FREQ	PERCENT	VARIABLE	VALUE	FREQ	PERCENT
WATER24	.	771	54.64	BORDER	1	427	30.26
	0	18	1.28		2	394	27.92
	1	622	44.08		3	293	20.77
JUICE24	.	771	54.64		4	130	9.21
	0	423	29.98		5	82	5.81
	1	217	15.38		6	33	2.34
PMILK24	.	771	54.64		7	26	1.84
	0	345	24.45		8	16	1.13
	1	295	20.91		9	6	0.43
MILK24	.	771	54.64		10	1	0.07
	0	604	42.81		11	3	0.21
	1	36	2.55	SEX	1	744	52.73
LIQUID24	.	772	54.71		2	667	47.27
	0	294	20.84	FLOOR2	.	2	0.14
	1	345	24.45		0	677	47.98
SOLID24	.	772	54.71		1	732	51.88
	0	109	7.73	DIAR2	.	4	0.28
	1	530	37.56		0	1300	92.13
DIAR	.	4	0.28		1	107	7.58
	0	1293	91.64	BFMOS2	0	464	32.88
	1	34	2.41		1	947	67.12
	2	73	5.17	BFMOS3	.	947	67.12
	8	7	0.5		0	177	12.54
POOR	.	1	0.07		1	287	20.34
	1	146	10.35	AGEGRP	0	373	26.44
	2	1264	89.58		1	361	25.58
					2	357	25.3
					4	320	22.68

Descriptive Statistics for all Categorical Variables (cont.)

VARIABLE	VALUE	FREQ	PERCENT	VARIABLE	VALUE	FREQ	PERCENT
FLOOR	1	14	0.99	MWORK	0	1153	81.72
	2	718	50.89		1	258	18.28
	3	4	0.28	BFMOS4	0	14	0.99
	4	668	47.34		1	163	11.55
	5	5	0.35		2	160	11.34
	6	2	0.14		3	1074	76.12
DWATER2	0	903	64.	BFYN	0	528	37.42
	1	508	36.		1	883	62.58
NWATER2	0	629	44.58	UNDERWT	.	10	0.71
	1	782	55.42		0	753	53.37
TOIL	0	891	63.15		1	648	45.92
	1	520	36.85	FWORK	.	2	0.14
TOIL2	0	343	24.31		1	352	24.95
	1	1068	75.69		2	16	1.13
BIRTHNO	1	427	30.26		3	157	11.13
	2	394	27.92		4	145	10.28
	3	293	20.77		5	113	8.01
	4	297	21.05		6	132	9.36
FOCCUP	.	75	5.32		7	121	8.58
	0	1182	83.77		8	123	8.72
	1	154	10.91		9	10	0.71
SECTOR	1	190	13.47		10	4	0.28
	2	1040	73.71		11	16	1.13
	3	181	12.83		12	7	0.5
DWATER	1	77	5.46		13	5	0.35
	2	29	2.06		14	126	8.93
	3	211	14.95		15	73	5.17
	4	37	2.62		24	7	0.5
	5	549	38.91		25	1	0.07
	6	398	28.21		98	1	0.07
	7	95	6.73				
	9	15	1.06				

Descriptive Statistics for all Categorical Variables (cont.)

VARIABLE	VALUE	FREQ	PERCENT	VARIABLE	VALUE	FREQ	PERCENT
ELECTRIC	0	1145	81.15	STUNTED	.	10	0.71
	1	266	18.85		0	909	64.42
TV	0	1198	84.9		1	492	34.87
	1	213	15.1	WASTED	.	8	0.57
RADIO	0	433	30.69		0	1195	84.69
	1	978	69.31		1	208	4.74
NWATER	1	76	5.39	EDLEVEL	0	154	10.91
	2	24	1.7		1	422	29.91
	3	119	8.43		2	507	35.93
	4	29	2.06		3	328	23.25
	5	381	27.	CHILDREN	0	21	1.49
	6	440	31.18		1	536	37.99
	7	321	22.75		2	661	46.85
	8	1	0.07		3	172	12.19
	9	20	1.42		4	17	1.2
TOILET	0	343	24.31		5	4	0.28
	1	36	2.55	KIDS	0	557	39.48
	2	484	34.3		1	854	60.52
	3	513	36.36				
	4	2	0.14				
	5	33	2.34				

APPENDIX D

DEFINITION OF CATEGORICAL VARIABLES PRIOR TO AND AFTER BEING CHANGED

ORIGINAL VARIABLE		CHANGED VARIABLE
dwater (xv113): source of drinking water		DWATER2
1 piped into residence	0	(protected): piped into residence
2 piped into premises		piped into premises
3 public tap		public tap
4 tube well/abesin pump		tube well/abesin pump
5 protected well		protected well
6 unprotected well	1	(unprotected): unprotected well
7 river/canal/tank		river/canal/tank
8 rainwater		rainwater
9 other		other

ORIGINAL VARIABLE		CHANGED VARIABLE
nwater (xv114): source of non-drinking water		NWATER2
1 piped into residence	0	(protected): piped into residence
2 piped into premises		piped into premises
3 public tap		public tap
4 tube well/abesin pump		tube well/abesin pump
5 protected well		protected well
6 unprotected well	1	(unprotected): unprotected well
7 river/canal/tank		river/canal/tank
8 rainwater		rainwater
9 other		other

floor (xv127) : main floor material		FLOOR2
1 terrazo floor tiles	0	(temporary) : wood
2 cement		dung/mud
3 wood		sand
4 dung/mud		other
5 sand	1	(permanent) : terrazo
6 other		floor tiles
		cement
toilet (xv116) : type of toilet facility		TOIL
0 no facilities	0	(inadequate) : no
1 flush		facilities
2 water seal		pit
3 pit		bucket
4 bucket		other
5 other	1	(adequate): flush
		water seal
diar (xh11) : whether the child had		DIAR2
diarrhea in the last 24 hours	1	(yes) : last 24
or within the last two weeks		hours
0 no		last 2-14 days
1 last 24 hours	0	(no): no diarrhea
3 last 2-14 days		don't know
8 don't know		

fwork (xv704) : partner's most		FOCCUP
recent occupation	0	(non-professional):
1 farming		farming
2 fishing/hunting		fishing/hunting
3 estate worker		estate worker
4 unskill self employed		unskill self employed
5 unskilled employee		unskilled employee
6 skilled self employed		skilled self employed
7 skilled employee		skilled employee
8 petty trader		petty trader
9 cottage industry		cottage industry
10 domestic worker		domestic worker
11 teacher primary/secondary		other
12 teacher university/other		retired
13 health worker		don't know
14 technical-profession	1	(professional):
24 other		teacher:
25 retired		primary/secondary
98 don't know		university/other
		health worker
		technical-profession

APPENDIX E

DEFINITION OF CONTINUOUS VARIABLES PRIOR TO AND AFTER BEING CHANGED

ORIGINAL VARIABLE		CHANGED VARIABLE
children (xv137) : number of children in household, aged 5 and under		KIDS
	0	1 other or no other child
	1	2 or more other children
border (xbord) : birth order number of this child		BIRTHNO
	1	first born
	2	second born
	3	third born
	4	three or more older siblings

APPENDIX F

DEFINITION OF FOOD VARIABLES PRIOR TO AND AFTER BEING CHANGED

STEP 1:

To have a better understanding of how the age of introduction of certain foods may affect the differences in anthropometric data between breast fed and weaned children, data was transformed so that comparisons would have more biological meaning. The following food variables were changed from the age at which each food was first introduced to the number of months the food had been available to the child. This was done by subtracting the age at which the food was first introduced from the current age of the child. An example to illustrate the necessity of this transformation is the significance of a solid in growth between a child who is 14 months of age and was introduced to solids at 13 months vs a child who is 36 months of age and was also introduced to solids at 13 months. The duration of exposure would therefore be the important factor in assessing the effect of these food variables on growth.

There was no information in this data set on whether these foods were offered during the whole time after they were first introduced and whether they were actually consumed.

ORIGINAL VARIABLE	CHANGED VARIABLE
milkcr (xs415a) : age given powdered milk-half cream	nmilkcr
cream (xs415b) : age given powdered milk-full cream	ncream
cowmilk (xs415c) : age given cow milk	ncowmilk
cungee (xs415d) : age given cungee	ncungee
eggs (xs415e) : age given eggs	neggs

potato (xs415f) : age given potatoes npotato

fruit (xs415g) : age given fruit nfruit

milklk : age first given milk- 1/2, 1/2, cow nmilklk

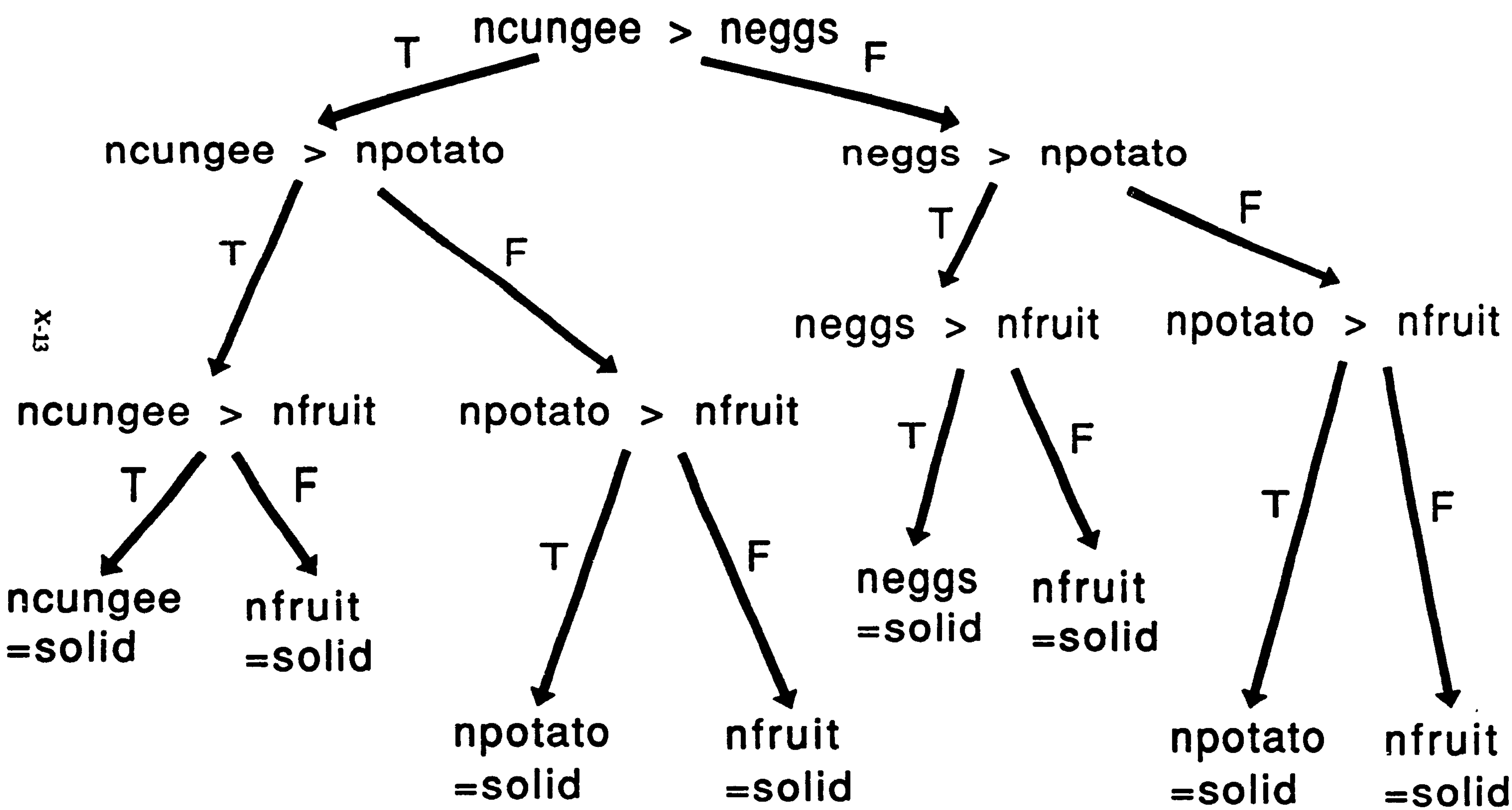
solidlk : age first given solids- cungee, eggs, potatoes, fruits nsolidlk

food (xs416) : age started food on a daily basis nfood

STEP 2:

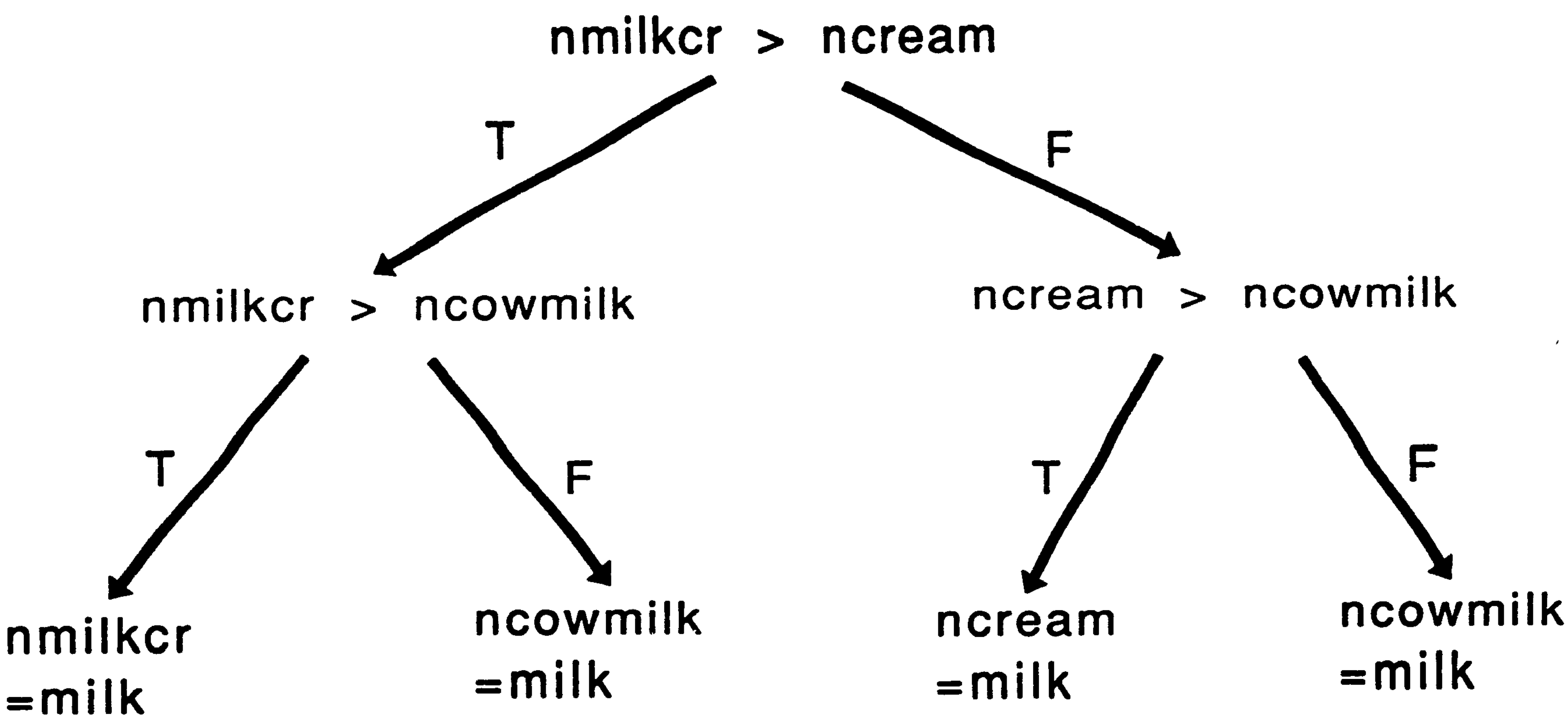
Pearson correlations showed a large association between the solid foods and between the different types of milks (see Table). Therefore new variables were created from the information contained in the existing ones. The variable 'SOLID' was formed by taking the greatest duration of months a child had been exposed to either cungee, eggs, potato, or fruit (see Figure A.1):Step 2-Forming the Variable SOLID). For example if a child had been exposed to cungee longer than potatoes, eggs or fruits then that child had a value for solid that was equal to the value for the variable ncungee. The variable 'MILK' was formed in a similar manner by taking the greatest duration of months a child had been exposed to any of the following: powdered milk, full or half cream, or cow's milk (see Figure A.2): Step 2-Forming the Variable MILK).

Figure A1 : Step 2-Forming the variable SOLID



T=true
F=false

Figure AQ: Step 2-Forming the variable MILK



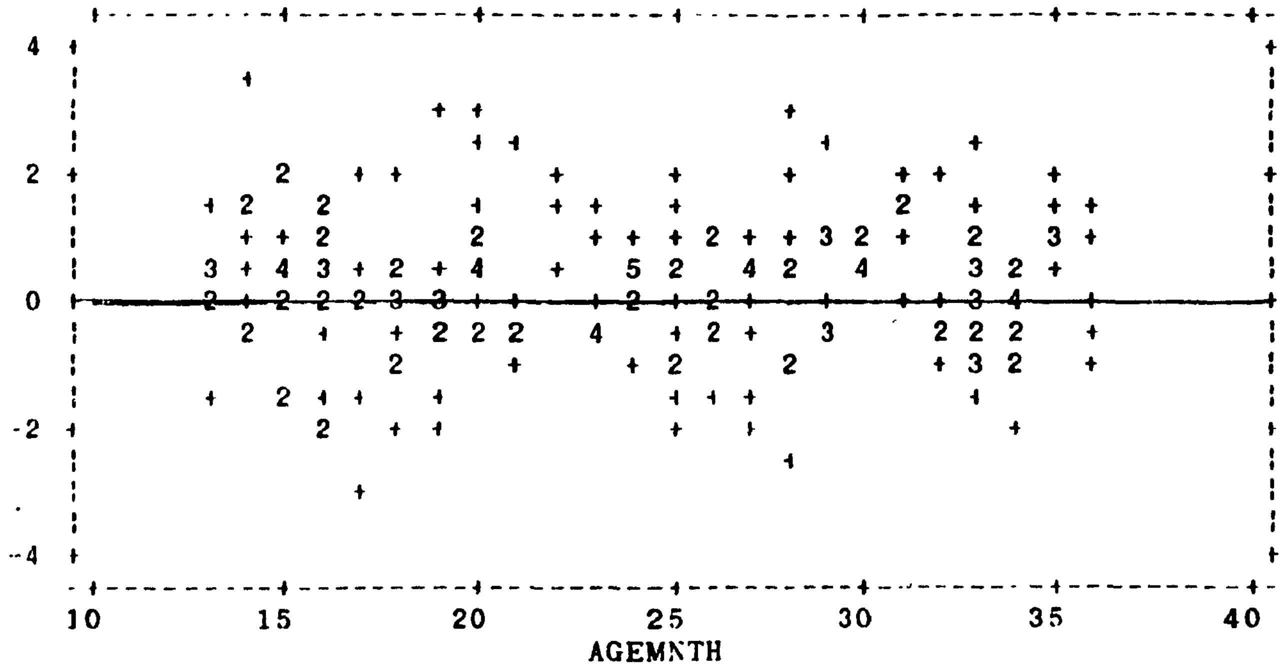
X-14

T=true
F=false

APPENDIX G

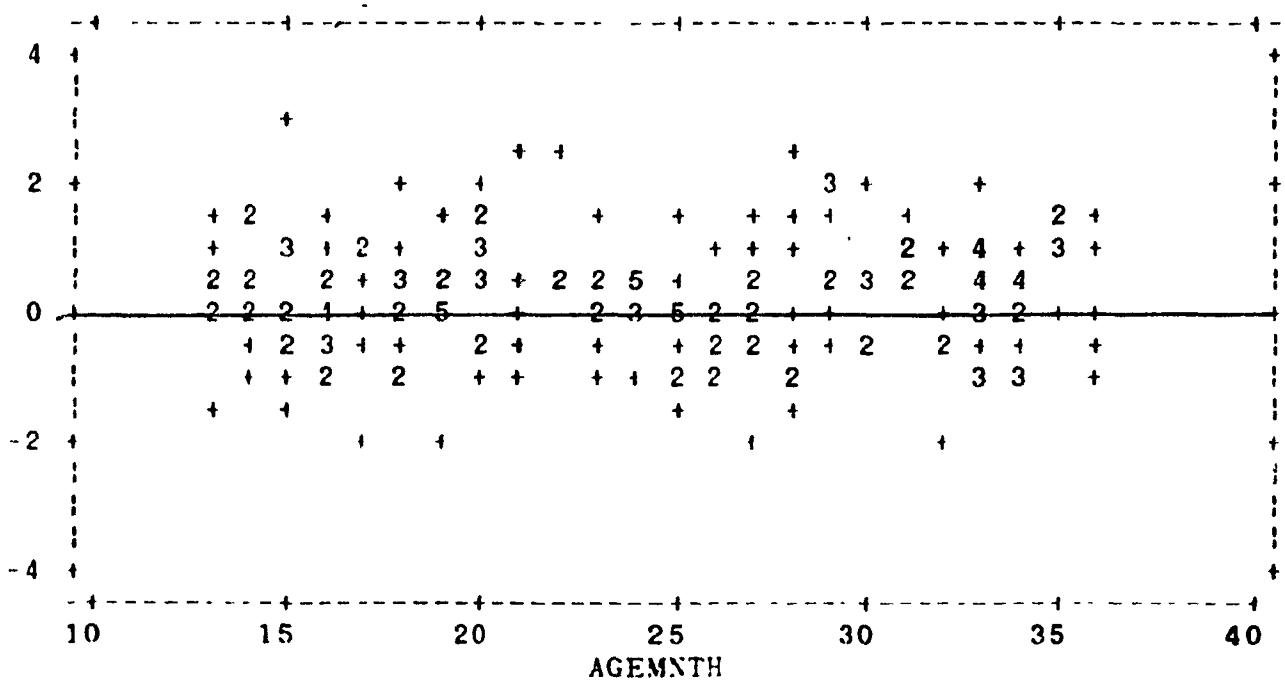
RESIDUAL ANALYSES

RESIDUAL HTAGEZ



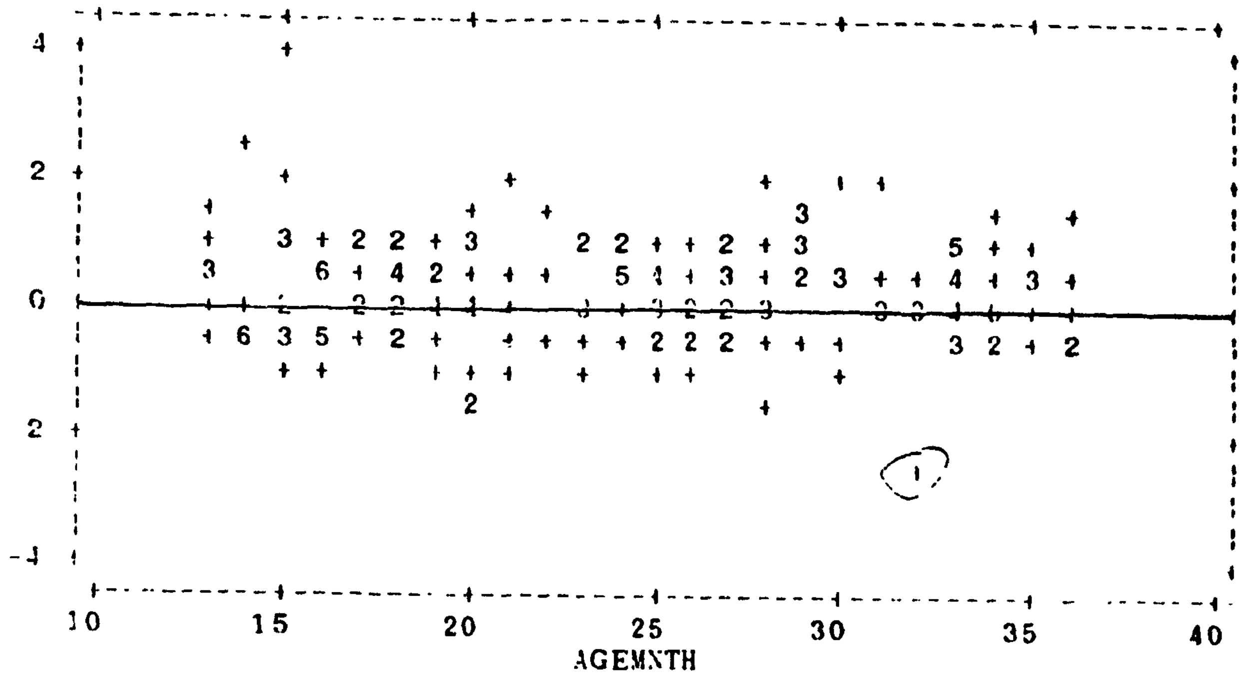
3 CASES WITH MISSING VALUES EXCLUDED FROM PLOT
3 CASES DELETED DUE TO MISSING DATA.

RESIDUAL WTAGEZ



3 CASES WITH MISSING VALUES EXCLUDED FROM PLOT
2 CASES DELETED DUE TO MISSING DATA.

RESIDUAL WTHT7



2 CASES WITH MISSING VALUES EXCLUDED FROM PLOT

APPENDIX H

ORTHOGONAL CONTRASTS FOR THE INTERACTION BETWEEN CURRENT BREAST FEEDING AND EDUCATION LEVEL OF THE MOTHER - REDUCED MODEL

Table A.3: Adjusted Least Square Means for the Association Between Current Breast Feeding Status and Education Level of the Mother

	no educ	primary	secondary	higher
bf=no	-1.700	-1.893	-1.828	-1.604
bf=yes	-2.107	-1.726	-1.696	-1.753

a. Orthogonal Contrast One

	no educ	some educ	simple effect	95 % CI
bf=no	-1.700	-1.775	0.075	(-0.292,0.442)
bf=yes	-2.107	-1.725	-0.382	(-0.617,-0.148)
simple effect	0.407	-0.050		
95 % CI	(0.011, 0.803)	(-0.185, 0.085)		

Interaction: 0.457 (0.041, 0.873)

This first contrast is significant because the 95 % CI does not cross zero. This indicates that breast feeding has a different effect depending on whether or not the mother has education.

b. Orthogonal Contrast Two

	primary educ	secondary + higher educ	simple effect	95 % CI
bf=no	-1.893	-1.716	-0.177	(-0.414,0.060)
bf=yes	-1.726	-1.725	-0.001	(-0.197,0.195)
simple effect	-0.167	0.009		
95 % CI	(-0.394, 0.060)	(-0.167, 0.185)		

Interaction: -0.176 (-0.454, 0.102)

This contrast is not significant. The four cells are not very diff 'ent.

c. Orthogonal Contrast Three

	secondary educ	higher educ	simple effect	95 % CI
bf=no	-1.828	-1.604	-0.224	(-0.475,0.027)
bf=yes	-1.696	-1.753	0.057	(-0.159,0.273)
simple effect	-0.132	0.149		
95 % CI	(-0.332, 0.068)	(-0.108, 0.406)		

Interaction: -0.281 (-0.600, 0.039)

This contrast is also not significant. Again the four cells are not very different from each other.

APPENDIX I

RESULTS OF ANALYSIS OF VARIANCE, FULL AND REDUCED EQUATIONS

Table A4: Coefficients From Full and Reduced Analysis of Variance Equations for Testing the Association Between Current Breast Feeding Status and Height-for-Age Z-Scores of Children 13-36 Months of Age in Sri Lanka[a]

Variable	Full Coef	Reduced Coef
Constant	-1.5	-1.5
Non breast feeders vs breast feeders	-0.1	0.0
Mother's education		
- none vs higher	-0.1	-0.1
- primary vs higher	-0.0	0.0
- secondary vs higher	+0.0	0.0
No education x no breast feeding	0.2	0.2
Primary education x no breast feeding	-0.1	-0.1
Secondary education x no breast feeding	-0.1	-0.1
Electricity vs no electricity	0.2	0.2
Age of child (months)	-0.0	0.0
Sector		
- urban vs estates	0.3	0.3
- rural vs estates	0.2	0.2
Gender female vs male	-0.1	-0.1
Unprot vs prot non drinking water	-0.2	-0.2
Perceived wealthy vs not wealthy	0.2	0.1
Permanent vs temporary floor	0.2	0.2
Birth order		
- 1st born vs 4th or higher	0.1	0.1
- 2nd born vs 4th or higher	0.1	0.1
- 3rd born vs 4th or higher	-0.1	-0.1
Father professional vs non professional	0.4	0.4
2+ other kids in home vs less than two	-0.1	-0.1
Television vs no television in home	0.1	
Radio vs no radio in home	+0.0	
Mother working vs not working to earn money	+0.0	
Unprotected vs protected drinking water	+0.0	
Adequate vs inadequate toilet facility	-0.1	
Working mother x no breast feeding	-0.1	
Perceived wealthy x no breast feeding	0.1	
Permanent floor x no breast feeding	-0.1	
Unprot non drinking water x no breast feeding	-0.1	
Electricity x no breast feeding	0.1	
Radio x breast feeding	-0.01	

a-SYSTAT codes a categorical variable with two levels as 1 and -1

Table A5: Coefficients From Full and Reduced Analysis of Variance Equations for Testing the Association Between the Number of Months of Breast Feeding and Height for Age Z-Scores of Children 13-36 Months of Age in Sri Lanka[a]

Variable	Full Coef	Reduced Coef
Constant	-0.9	-1.1
Months of breast feeding	-0.0	0.0
Mother's education		
- none vs higher	-0.1	-0.2**
- primary vs higher	-0.2	-0.2
- secondary vs higher	+0.0	0.1
No education x months of breast feeding	-0.0	-0.01**
Primary educ x months of breast feeding	+0.0	0.01
Secondary educ x months of breast feeding	0.0	0.0
Mother working vs not working to earn money	-0.2	-0.2
Mother working x months of breast feeding	+0.0	0.01*
Age of child (months)	-0.0	-0.02**
Sector		
- urban vs estates	0.3	0.4**
- rural vs estates	0.2	0.2
Gender female vs male	-0.1	-0.1*
Unprot vs prot non drinking water	-0.3	-0.2**
Birth order		
- 1st born vs 4th or higher	0.2	0.2**
- 2nd born vs 4th or higher	0.1	0.05
- 3rd born vs 4th or higher	-0.1	-0.1
Father professional vs non professional	0.4	0.5**
Electricity vs no electricity in home	0.1	
Perceived wealthy vs not wealthy	-0.1	
Permanent floor vs temporary	0.1	
2+ other kids in home vs less than two	-0.1	
Television vs no television in home	0.1	
Radio vs no radio in home	+0.0	
Unprotected vs protected drinking water	+0.0	
Adequate vs inadequate toilet facility	-0.0	
Perceived wealthy x mos breast feeding	+0.0	
Permanent floor x mos breast feeding	+0.0	
Unprot nondrinking water x mos breast feeding	+0.0	
Electricity x mos breast feeding	+0.0	
Radio x breast feeding	-0.0	

a-SYSTAT codes a categorical variable with two levels as 1 and -1

Table A6: Coefficients From Full and Reduced Analysis of Variance Equations for Testing the Association Between Current Breast Feeding Status and Weight-for-Age Z-Scores of Children 13-36 Months of Age in Sri Lanka[a]

Variable	Full Coef	Reduced Coef
Constant	-2.2	-2.2
Non breast feeders vs breast feeders	-0.1	0.03
Sector:		
- urban vs estates	0.2	0.2
- rural vs estates	0.1	0.1
Urban sector x non breast feeders	-0.1	-0.1
Rural sector x non breast feeders	0.1	0.1
Age of child (months)	-0.0	-0.01
Unprotected vs protected non drinking water	-0.1	-0.1
Perceived wealthy[c]	0.2	0.2
Permanent vs temporary floor	0.2	0.2
Birth order:		
- 1st born vs 4th or higher	0.1	0.1
- 2nd born vs 4th or higher	0.1	0.1
- 3rd born vs 4th or higher	-0.1	-0.1
Father professional vs non professional	0.2	0.2
Television vs no television in house	0.3	0.3
Education level of mother:		
- none vs higher	-0.1	
- primary vs higher	0.1	
- secondary vs higher	+0.0	
Electricity vs no electricity in home	0.1	
Gender: female vs male	-0.0	
2+ other kids in home vs less than two	+0.0	
Radio vs no radio in home	+0.0	
Mother working vs not working to earn money	0.1	
Unprot vs prot drinking water	+0.0	
Adequate vs inadequate toilet facility	-0.1	
Age of child x no breast feeding	-0.0	
Perceived wealthy x no breast feeding	0.1	
Permanent floor x no breast feeding	-0.0	
Electricity x no breast feeding	0.1	
Unprot non drinking water x no breast feeding	-0.0	

a-SYSTAT codes a categorical variable with two levels as 1 and -1

Table A7: Coefficients From Full and Reduced Analysis of Variance Equations for Testing the Association Between the Number of Months of Breast Feeding and Weight-for-Age Z-Scores of Children 13-36 Months of Age in Sri Lanka[a]

Variable	Full Coef	Reduced Coef
Constant	-2.1	-2.2
Months of breast feeding	-0.0	0.0
Unprotected vs protected non drinking water	-0.4	-0.4
Unprot non drinking water x mos breast feeding	+0.0	0.02
Sector:		
- urban vs estates	0.1	0.1
- rural vs estates	0.3	0.3
Urban sector x mos breast feeding	+0.0	0.01
Rural sector x mos breast feeding	-0.0	-0.01
Education level of mother:		
- none vs higher than secondary	-0.1	-0.2
- primary vs higher than secondary	0.1	0.04
- secondary vs higher than secondary	0.0	0.03
Age of child (months)	-0.0	-0.01
Perceived wealthy[d]	0.2	0.2
Birth order:		
- 1st born vs 4th or higher	0.1	0.2
- 2nd born vs 4th or higher	0.1	0.1
- 3rd born vs 4th or higher	-0.1	-0.1
Television vs no television in house	0.3	0.4
Father a professional vs non professional	0.2	0.2
Permanent vs temporary floor	0.2	0.2
Electricity vs no electricity in home	0.1	
Gender: female vs male	-0.1	
2+ other kids in home vs less than two	+0.0	
Radio vs no radio in home	+0.0	
Mother working vs not working to earn money	0.1	
Unprot vs prot drinking water	+0.0	
Adequate vs inadequate toilet facility	-0.1	
Age of child x no breast feeding	0.0	
Perceived wealthy x no breast feeding	-0.0	
Permanent floor x no breast feeding	0.0	
Electricity x no breast feeding	0.0	

a-SYSTAT codes a categorical variable with two levels as 1 and -1

Table A8: Coefficients From Full and Reduced Analysis of Variance Equations for Testing the Association Between Current Breast Feeding Status and Weight-for-Height Z-Scores of Children 13-36 Months of Age in Sri Lanka[a]

Variable	Full Coef	Reduced Coef
Constant	-1.8	-1.8
Not breast feeders vs breast feeders	+0.0	0.04
Father a professional vs non professional	-0.0	-0.1
Father a professional x not breast feeding	-0.2	-0.1
Age of child (months)	+0.0	0.01
Perceived wealthy vs not wealthy	0.2	0.1
Permanent vs temporary floor	0.1	0.1
Birth order		0.1
- 1st born vs 4th or higher	0.1	
- 2nd born vs 4th or higher	0.1	0.1
- 3rd born vs 4th or higher	-0.1	-0.1
2+ other kids in home vs less than two	0.1	0.1
Television vs no television	0.3	0.3
Mother working vs not working	0.2	0.2
Education level of the mother		
- none vs higher	+0.0	
- primary vs higher	0.1	
- secondary vs higher	-0.0	
Electricity vs no electricity in home	+0.0	
Area of residence		
- urban vs estates	0.1	
- rural vs estates	-0.0	
Urban sector x not breast feeding	-0.0	
Rural sector x not breast feeding	0.1	
Adequate vs inadequate toilet facility	-0.0	
Prot vs unprot drinking water	0.0	
Gender:female vs male	+0.0	
Prot vs unprot non drinking water	-0.0	
Radio vs no radio in home	+0.0	

a-SYSTAT codes a categorical variable with two levels as 1 and -1

Table A9: Coefficients From Full and Reduced Analysis of Variance Equations for Testing the Association Between Number of Months of Breast Feeding and Weight-for-Height Z-Scores of Children 13-36 Montns of Age in Sri Lanka[a]

Variable	Full Coef	Reduced Coef
Constant	-1.9	-1.8
Months of breast feeding	+0.0	0.00
Sector:		
- urban vs estates	-0.1	-0.1
- rural vs estates	0.2	0.2
Urban sector x months of breast feeding	+0.0	0.01
Rural sector x months of breast feeding	-0.0	-0.01
Age of child (months)	+0.0	0.01
Perceived wealthy	0.2	0.1
Permanent vs temporary floor	0.2	0.1
Birth order:		
- 1st born vs 4th or higher	0.1	0.04
- 2nd born vs 4th or higher	0.1	0.1
- 3rd born vs 4th or higher	-0.1	-0.1
Television vs no television in house	0.3	0.2
Mother working vs not working to earn money	0.2	0.1
Father a professional vs non professional	-0.0	
Father a professional x mos breast feeding	-0.0	
2+ other kids in home vs less than two	0.1	
Education level of the mother		
- none vs higher	+0.0	
- primary vs higher	0.1	
- secondary vs higher	-0.0	
Electricity vs no electricity in home	+0.0	
Adequate vs inadequate toilet facility	-0.1	
Prot vs unprot drinking water	+0.0	
Gender:female vs male	+0.0	
Prot vs unprot non drinking water	-0.0	
Radio vs no radio in home	+0.0	

a-SYSTAT codes a categorical variable with two levels as 1 and -1