BREASTFEEDING PRACTICES, ANEMIA AND VITAMIN A DEFICIENCY OF SOUTH AFRICAN MOTHERS AND THEIR YOUNG INFANTS

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Dedicated to my parents David and Elizabeth Sibeko, the inspiration for my African journey; your spirits continue to provide the light of guidance.

ABSTRACT

The prevalence of sub-clinical vitamin A deficiency (VAD) and anemia of lactating women (n=113) and their breastfed infants aged 1-6 months was measured among a peri-urbanite South African sample. Mother's mean hemoglobin (Hb) was 12.4 ±1.3 g/dL with 32% anemia (Hb<12g/dL). Retinol in serum was 49.8 ±13.2 μg/dL and 66.0 μg/dL (median) in breast milk; no evidence of sub-clinical VAD. Infants, 62% ≤ 3 months, had mean Hb of 10.9 ±1.1 g/dL (with anemia present (< 11g/dL), in 50%). Mean infant serum retinol was 26.9 ±7.2 μg/dL (10% prevalence of marginal VAD). No infants were exclusively breastfed. Weaning foods and breast milk substitutes were introduced early and infant intake of traditional medicines was common (52%). Our data suggest that anemia was present in both mothers and infants while VAD was evident only in infants. This early occurrence of micronutrient deficiencies may be attributed to less than optimal breastfeeding practices.

RÉSUMÉ

La prévalence de déficience en vitamine A (DVA) sous-clinique et de l'anémie chez des femmes qui allaitent (n=113), ainsi que chez leurs nourrissons allaités, âgés de 1-6 mois, a été mesurée dans un échantillon péri-urbain de l'Afrique du Sud. Chez les mères, le taux moyen d'hémoglobine (Hb) était de 12.4 ±1.3 g/dL, et l'anémie (Hb<12g/dL) atteignait 32%. La moyenne du rétinol sérique maternel était 49.8 ±13.2 μg/dL et la médiane du rétinol dans le lait maternel était 66.0 μg/dL. Aucune DVA sous-clinique n'a été observée chez les mères dans cet échantillon. Chez les nourrissons, dont 62% étaient âgés de 3 mois ou moins, le taux moyen d'Hb était de 10.9 ±1.1 g/dL et l'anémie (Hb < 11g/dL) atteignait 50%. Le rétinol sérique moyen des nourrissons était 26.9 ±7.2 μg/dL (prévalence de DVA marginale à 10%). Aucun des nourrissons n'était exclusivement allaité. L'introduction des aliments de sevrage et des substituts au lait maternel se faisait en bas âge et l'ingestion de plantes médicinales était fréquente (52%) chez les nourrissons. Nos données suggèrent que les mères et leurs nourrissons présentent de l'anémie, mais que la DVA est évidente seulement chez les nourrissons. Cette déficience précoce en micronutriments peut être attribuée à des pratiques non-optimales d'allaitement.

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CHAPTER I

INTRODUCTION

Globally, more than 2000 million people suffer from one or more micronutrient deficiencies (WHO, 1991). Both vitamin A deficiency (VAD) and iron deficiency anemia (IDA) are prevalent in most developing countries thereby contributing to serious burden of disease in many areas of the world and consequently declared public health problems of great magnitude (U.N., 1990).

Post-apartheid South Africa is a country undergoing tremendous transformation, a process that has served as a critical catalyst for initiating major reform in all areas of the public sector, including health care. As a result, marginalized groups of the population have been identified as a priority for receiving essential health care services. Providing a body of evidence for action are data sets such as the 1991 national household survey of health inequalities in South Africa, the results of which indicated that the under 5 age group accounted for approximately six million children, with African children making up the largest fraction (84%). Many of these children live in conditions of overcrowded households with poor sanitation, often lacking electricity and piped water and living in families subsisting on very low incomes (Segal & Hirschowitz, 1991). All these factors place children at significant risk for early death with the current child mortality rate for this age category estimated at 66 per 1000 births, ranking South Africa 69th globally from the top, out of 189 countries (UNICEF, 1998). Accordingly, the government has identified maternal and child health as a priority health issue, with the South African constitution now guaranteeing basic health services for all children under eighteen (Landman & Henley, 1998).

Contributing to the country's high child morbidity and mortality rates are micronutrient deficiencies. A national study of children aged 6 to 71 months found that one in ten South African children are iron deficient and estimates that one in 20 children have IDA. With respect to VAD, 33% of the surveyed children suffered from sub-clinical VAD which according to WHO criteria identifies South Africa as having a serious public health problem of VAD (SAVACG, 1996).

The Declaration on Children endorsed by many countries at the 1990 World Summit for Children (1990) called for an elimination of VAD (Underwood, 1994) as well as a reduction of iron deficiency in women of child bearing ages by 33 % of the 1991 level, both goals to be attained by the year 2000 (WHO, 1994). Evidently, these goals have not been achieved by many developing nations. However, South Africa seems committed to focusing on maternal and child nutritional health as a priority area for action.

Public health policy and intervention program planning are often based on research identifying key issues pertaining to vulnerable groups. Population based nutrition research can provide valuable information on the nutritional status of at risk groups, in this case lactating women and infants under six months of age.

CHAPTER II
LITERATURE REVIEW

2.1 IRON DEFICIENCY ANEMIA

2.1.1 Epidemiology

Anemia has been declared a public health problem throughout the developing and developed world with iron deficiency being considered the most prevalent nutritional deficiency in the world (de Benoist, 2001). It has been estimated that anemia is three to four times more prevalent in developing countries than in developed countries. Globally, pregnant women are at the highest risk for anemia with the prevalence estimated as high as 56 % in developing countries and 18% in industrialized countries (WHO, 1998). While it is well understood that pregnant women and young children are the most vulnerable age groups, anemia does however affect all age groups. Figure 2.1 illustrates the prevalence of anemia throughout the life cycle in both developing and industrialized countries (ACC/SCN, 2000). According to WHO's Global Database on Anemia (1998), anemia is most prevalent in Africa and Asia.

Since occurrence of anemia is generally attributed to iron deficiency, particularly in parts of the world where anemia is prevalent (Stoltzfus & Dreyfuss 1998), anemia prevalence is often used as a proxy for estimating iron deficiency anemia (IDA). Prevalence (8%), with an estimated 2.15 billion people throughout the world suffering from IDA (FAO/WHO, 1992).

Men have lower iron requirements and therefore do not tend to suffer from IDA even in areas where iron deficiency and anemia are prevalent. It is believed that this gender differential in iron deficiency is strong evidence that dietary iron intake is the main determinant for the IDA seen in women (Yip, 1994).

Caution should be exercised in using anemia as an indication of IDA in settings where the anemia is mild (Khusun, 1999). Anemia is an approximation of IDA, particularly in developing countries where many other factors may contribute to the development of anemia. Malaria, other parasitic infections, human immunodeficiency virus (HIV), other infections and nutrient deficiencies (i.e. folate, vitamin A) are examples of factors that can lead to anemia; in many situations these factors co-exist or interact (Gillespie & Johnston, 1998).

2.1.2 Consequences of IDA

The primary role of iron is in the production of hemoglobin which delivers oxygen to the lungs and body tissue (Bothwell *et al.* 1979). Iron is involved in a large number of other functions in the body besides hemopoiesis including acting as a co-enzyme for various cellular function, cellular mitosis, DNA, RNA and protein synthesis. Similar to vitamin A, iron is also involved in the body's immune function, where a deficiency may lead to an impairment in immune activity, resulting in increased susceptibility to infections (Srikantia *et al.* 1976).

Iron balance is determined by the body's iron absorption, iron loss and iron stores. Approximately two thirds of body iron is functional iron existing as hemoglobin in red blood cells, myoglobin in muscle cells and as part of iron-containing enzymes. The extra body iron is stored as ferritin and haemosiderin (Bothwell *et al.* 1979).

The three main stages involved in the development of IDA are outlined in Figure 2.2. The initial stage involves a decrease in the amount of storage iron in the liver, followed by complete depletion of iron stores in the second stage, leading to IDA in the final stage which is indicated by a decrease in hemoglobin, hematocrit and red cell indices (Gibson, 1990).

Consequences of IDA are numerous including impaired cognitive development and psychomotor function in infants and children (Lozoff *et al.* 1991; Soewondo *et al.* 1989), a decrease in work productivity and maternal or child mortality in cases of severe anemia (Stoltzfus, 2001). Therefore IDA is a multi-level problem affecting the health, education and economical viability of afflicted individuals. The extent and serious consequences of IDA renders this an important deficiency to investigate particularly in high risk population groups.

2.1.3 Hemoglobin as indicator of anemia

The presence of IDA is most commonly measured by levels of hemoglobin concentrations within a specified population (WHO, 1994). Hemoglobin measurements are relatively inexpensive and simple to perform at the field level, thus their popularity as indicators of IDA. These measurements are then compared to established cut-off values (Table 2.1), thereby helping to identify the probability of IDA existing within a specific population group. To define anemia, the cut-off value used is 2 standard deviations from the mean or the 2.5th percentile of the normal distribution of a healthy iron-replete population (Khusun *et al.* 1999).

WHO cut-off values are the conventional standards used for classifying IDA in various population groups. Universal use of these values implies that the distribution of 'normal' hemoglobin levels is similar throughout the world, providing factors such as age, gender, pregnancy and altitude, have been taken into consideration. However it has not yet been established if these normal values are optimum levels for health (Baker & DeMaeyer, 1979). Nonetheless, it should be noted that there is currently a debate on the appropriateness of using these cut-off levels since it is not clear that hemoglobin distributions are the same among different races and ethnic groups throughout the world (UNICEF, 1999). Some studies indicate a variation in hemoglobin distribution among different racial groups (Williams 1981; Yip 1996). Johnson-Spear and Yip (1994) were able to show from their analysis of the National Health and Nutrition Survey (NHANES) II data that individuals from the African Diaspora in the U.S. have mean hemoglobin concentrations that are 8 g/L lower than those of European background. This observation could not be attributed to differences in iron status. Hence the authors propose that hemoglobin cut-off points used for individuals of African background should be 10 g/L lower than those for individuals of European background. Other studies have arrived at similar conclusions. Results of a survey conducted in Vietnam indicated that in a healthy Vietnamese population, mean hemoglobin levels were 10 g/L lower than from those of European extraction. This finding lead to a lowering of the cut-off values by 10 g/L (Yip, 1996). Alternatively, a study comparing the hemoglobin distribution of a healthy young

Indonesian population group with that of a U.S. population illustrated that the WHO criterion for anemia was applicable in the Indonesian population (Khusun *et al.* 1999).

Even though other tests are necessary to confirm iron deficiency, it is acceptable to assume that a high prevalence of anemia within a population indicates the strong possibility of an equally high prevalence of iron deficiency (Yip, 1994). Additional indicators of iron are required in situations where several causes of anemia co-exist (Stotzfus, 2001). Additional biochemical indicators of iron status are outlined in Table 2.2.

2.1.4 Breast milk as a source of iron

In general, maternal intake of vitamins affects the concentration of vitamins in breast milk. Most affected are the water soluble vitamins. Conversely, maternal dietary intake and stores, with minor exceptions, do not affect the concentration of minerals secreted in breast milk (WHO, 1998). Overall nutrients during lactation can be classified into two groups, those affected by maternal status and those not as described in Table 2.3. It should, however, be noted that in the case of nutrients that are affected by maternal intake there is a threshold above which intake will not result in increased concentration of the nutrient in breast milk (Allen, 1994).

At birth, full term newborns generally have an adequate iron store, somewhere in the order of 75 mg/kg (Calvo *et al.* 1992). As the infant matures, iron is mobilized to support red blood cell synthesis and infant growth. Consequently, there is a decline of hemoglobin and iron stores within the initial six months of an infant's life (Dellman *et al.* 1980). Furthermore, rapid infant weight gain has been found to be associated with a depletion of iron stores (Lartey *et al.* 2000).

Full term infants who are exclusively breastfed have been found to have minimal risk of IDA prior to nine months of age, although biochemical indicators may show depleted iron levels (not to the extent of anemia) between 6 and 9 months of age (Lönnerdal & Hernell 1994).

The concentration of iron in breast milk is relatively low, estimated at 0.30 ± 0.10 mg/L, ≥ 21 days postpartum (Institute of Medicine,1991). However, iron from human milk is highly absorbable, a phenomenon attributed to the infant's gut mucosa having specific receptors that bind lactoferrin (major iron binding protein in breast milk) thus contributing to iron absorption (Kawakami & Lönnerdal, 1991). However, in breastfed infants iron bioavailability is substantially reduced by intake of foods other than breast milk (Oski & Landaw 1980) with a 20% to 30% IDA prevalence among such infants (Pizarro *et al.* 1991, Calvo *et al.* 1992). Maternal iron deficiency during pregnancy (Bhargava *et al.* 1991) and premature clamping of the umbilical cord at the time of delivery are additional factors that can influence an infant's iron status (Grajeda *et al.* 1997). Infants at greatest risk for IDA are low birth weight infants due to being born with inadequate iron stores.

2.1.5 Dietary iron and bioavailability

A number of factors influence the hemoglobin status of a woman including nutritional history, illness, pregnancy, lactation, supplements and genetic factors. Parasitic infections, menstural bleeding are additional factors that can exacerbate the deficiency (Bhargava *et al.* 2001). Predictably, intake of poor dietary sources of iron coupled with low bioavailability of dietary iron contribute to the development of IDA (Tatala *et al.* 1998). The level of iron in the body is determined by absorption from the gastrointestinal tract, which is in turn influenced by the nutritional needs of the individual and by iron bioavailability (Rao, 1981). The bioavailability of iron is influenced by inhibitors such as phytates, tannins and dietary fiber which inhibit non-heme iron. Conversely, iron absorption is promoted through the presence of enhancers such as vitamin C and flesh foods (heme iron) (Morck & Cook, 1981)

2.2 Vitamin A

2.2.1 Role and function

Micronutrients are essential nutrients required in the body in micro-quantities to perform fundamental biological functions such as regulating enzymes and hormones, gene expression, cellular proliferation and differentiation, growth and development, immune action and for metabolism and utilization of macronutrients. These micronutrients, namely vitamins and minerals, are provided through dietary intake (Bhaskaram, 1995).

Vitamin A is a fat soluble micronutrient belonging to the retinoid class of compounds, with the active form referred to as retinol or preformed vitamin A and found only in animal food sources. Vitamin A is stored mostly in the liver as retinyl palmitate; a more stable form of the vitamin than retinol (McLaren & Frigg, 1997). Alternatively, the provitamin A carotenoids are naturally-occurring red, orange or yellow pigments found mostly in plants and function as precursors of vitamin A. The carotenoid with the highest vitamin A activity is ß-carotene (Olsen, 1994).

Vitamin A is transported in blood via retinol binding protein (RBP) and transthyrethrin. Circulating RBP combined with vitamin A is referred to as holo-RBP, and apo-RBP if the vitamin is not bound to the transporting protein (McLaren & Frigg, 1997). Approximately 85-90% of circulating vitamin A in blood is bound to holo-RBP (Krasinski *et al.* 1989).

Vitamin A is well-known for its physiological role in vision, where it is responsible for maintaining the concentrations of rhodospin in the retina, a vital requirement for dark adaptation. Maintenance of the integrity of the epithelial lining of conjunctiva and the cornea are the other ocular functions of vitamin A. In addition, vitamin A plays a crucial role in cellular differentiation, and on growth and reproduction in animals (McLaren & Frigg, 1997). Retinol metabolites such as retinoic acid are involved in stimulating the immune response consequently enhancing the body's defense against pathogens. Although the mechanism involved is not yet elucidated, the evidence seems to indicate cellular rather than humoral immunity is involved (McLaren & Frigg, 1997). A study of VAD Indonesian children demonstrated that vitamin A supplementation of the deficient children lead to an increase in the ratio of CD4+ to CD8+ T-cells as well as the proportion of CD4+ T-lymphocytes (Semba *et al.* 1993).

2.2.2. Clinical and sub-clinical vitamin A deficiencies

Vitamin A deficiency is defined as the level at which tissue concentrations of vitamin A are low enough to cause adverse health consequences even in the absence of clinical deficiency (i.e. Xerophthalmia) (Underwood, 1998). There are two types of vitamin A deficiencies: clinical and subclinical or marginal VAD, which occur when serum retinol levels fall below 0.35 μ mol/l (or < 10 μg/dL) and 0.70 μ mol/l (or < 20 μg/dL) respectively.

Clinical VAD is a more severe form of VAD affecting a smaller proportion of the world's population. The consequences of clinical VAD are ocular in nature and collectively described as xerophthalmia, resulting in partial or total blindness. Beginning with night blindness the condition may progress to conjunctival xerosis, Bitot's spots, corneal xerosis, corneal keratomalacia and scarring. (McLaren & Frigg 1997).

Sub-clinical VAD is more prevalent than clinical VAD and is estimated to affect 251 million children in over sixty countries worldwide with 2.8 million of deficient children being in the preschool age category (West *et al.* 1995). These figures underestimate the extent of VAD on a global scale (due to insufficient available data), especially when considering that sub-clinical VAD is a significant problem in both pregnant women and school aged children throughout the developing world. It is important to note that prevalence of VAD not only differs between countries but also within countries and across regions (ACC/SCN, 2000). Current estimates indicate that more than sixty countries have VAD of public health significance (WHO, 1996).

Marginal VAD deficiency is manifested through compromise of the immune system, which is believed to play a major role in the increased susceptibility of children to a variety of infections and consequently contributing significantly to the morbidity and mortality of children (Sommer and West, 1996).

2.2.3 Indicators of vitamin A deficiency

A variety of indicators can be used to assess either the extent of vitamin A deficiency or to detect the differences in vitamin A status of a population, following an intervention. These indicators include: breast milk vitamin A concentration (expressed as per volume or per gram of milk fat), serum retinol concentration, relative-dose-response (RDR), the modified-relative-dose-response (MRDR), conjunctival impression cytology and night blindness (McLaren & Frigg 1997).

In the body, serum retinol is in a state of homeostasis over a wide range of body stores thus reflecting stores only when levels are very high or greatly depleted, both RDR and MRDR are more accurate indicators of liver stores. However, serum retinol is relatively easy to measure in a field setting and is useful for illustrating the frequency distribution of a specified population group (Pilch, 1987). A clear disadvantage of using serum retinol as an indicator of deficiency is that it can decrease as a result of infections since it is involved in the acute phase response (Rice *et al.*2000).

Breast milk vitamin A is also a useful indicator of sub-clinical VAD for both mother and infant with studies showing significant correlation between the concentration of vitamin A in maternal serum and breast milk . In the field, breast milk has been found to be relatively easy to collect and seems to be acceptable to study participants from diverse cultures (Stoltzfus & Underwood, 1995). Consequently the WHO now recommends use of breast milk concentrations for monitoring global elimination of VAD (WHO, 1994).

Measuring retinol in human milk can be challenging since vitamin A is found in the fat portion of the milk and fat content of milk varies between each woman and within the same woman throughout the day. Variables to be considered include time of day of feed, beginning and end of feed, time since last feed and age of the infant, all essential factors when using the 'full volume' milk expression method. However, these variations are not an issue when breast milk vitamin A concentration is expressed per gram of fat, as is the case in the 'casual' breast milk sampling procedure (Rice *et al.* 1996). The other benefits of this method of breast milk vitamin A determination is that it only requires small (5-10 ml) amounts of breast milk, can detect differences between groups and is less sensitive to sampling errors than the total volume method (Rice *et al.* 1996). Samples collected from women who are at least at the 1 month postpartum stage are preferred since an earlier sample will be quite high in vitamin A content reflecting colostrum and transitional milk vitamin A levels (Stoltzfus & Underwood 1995). Correction for milk fat is achieved through the use of a creamatocrit, which determines milk fat by measuring the volume of fat relative to total milk volume of each sample (Lucus *et al* 1978).

In their comparisons of different indicators of response to postpartum vitamin A supplementation of deficient Bangladeshi women, Rice *et al.*(2000) were able to demonstrate, through the use of receiver operating characteristic analyses (ROC), that 'casual' breast milk samples (taken 3 and 6 months postpartum) were a better indicator of vitamin A status than 'full' breast milk samples. Moreover, their results indicated that MRDR ratio outperformed serum retinol in both women and infants, but overall measurement of breast milk vitamin A per gram of fat in casual breast milk samples was the best indicator of all, especially in women with marginal vitamin A deficiency.

For determining prevalence of sub-clinical VAD, the WHO (1996) recommends the use of cut-off values for both serum retinol and breast milk concentrations (Table 2.5) and suggests that a public health problem of VAD exists when at least two biological indicators are met.

2.2.4. Deficiency in infants under 6 months of age

Wahed *et al.* (1997) studied a population of young infants (5.9 ± 2.3 months) in Bangladesh and found that 64% of the infants were vitamin A deficient. Furthermore, it was determined that 18% of the infants in the study had retinol levels < 0.35 μ mol/l, which is considered a serious public health problem level. Although study participants were breastfed, maternal malnutrition in Bangladesh is common, implying that the women had low vitamin A concentration in their breast milk. The authors concluded that sub-clinical vitamin A deficiency is prevalent among young infants living under conditions where malnutrition and poverty are common. These results challenge the commonly held belief that vitamin A deficiency is rare among young infants; it is possible this is not the case within a deprived environmental setting. Other studies have confirmed that VAD is a concern in children less than 6 months of age (Rice *et al.* 1999; Katz *et al.* 1995).

There is little known about the vitamin A status of infants under 6 months of age in the South African population (Bourne *et al.* 1994). A recent study assessed the nutritional status of rural South African children ages 4 to 24 months and found that 37.3 % had low vitamin A status (serum retinol < 20 μg/dl). Breastfeeding was initiated by 99% of the study participants and 80% of the 4 to 12 month year olds were still being breastfed with the mean age for introduction of solids being 3.6 ± 0.8 months. The study also found that the children's diet (including the complementary foods in the younger group) was deficient in vitamin A rich foods. Instead, dietary intake was found to be high in staple carbohydrates with irregular fruit and vegetables intake and a rare consumption of animal foods (Faber & Benade, 1999).

2.2.5. Vitamin A and infant morbidity and mortality

For infants, a serious risk factor for increased morbidity is associated with inadequate length of breastfeeding and early introduction of complementary foods, which under poor sanitation conditions may lead to increased infections such as measles, frequent diarrhea and acute respiratory infections, all important causes of VAD (Gillespie & Mason, 1994).

Early signs of VAD include growth failure, loss of appetite, impaired immune response and lowered resistance to infections (Underwood & Arthur, 1996). Dudley *et al.* (1997) investigated the association between vitamin A status and acute respiratory infection (ARI) in South African children between the ages of 2-60 months. The study was able to show that children with severe ARI had lower vitamin A levels than children with milder infections and that both groups (with differing severity of ARI) had significantly lower levels of vitamin A than the control group (with no ARI). Low weight for age, previous diarrhoeal disease and poor housing were other factors associated with poor vitamin A status. The study did not assess breastfeeding patterns.

Several investigations have shown that improving the vitamin A status of children does help resolve many illnesses. In China the risk for respiratory infection and diarrhea was 3.4 and 2.5 fold higher respectively, in vitamin A unsupplemented children than in their supplemented counterparts (Lie *et al.* 1993), while a study from India (Bhandri *et al.* 1994) found an 8 to 30% reduction in the incidence of diarrhea following supplementation of deficient children in different age groups. These findings have been confirmed by other studies, which also note a reduction in the incidence of severe diarrhea following supplementation (VAST 1993, Barreto *et al.* 1994).

Diarrheal infections are a significant contributor to infant deaths in developing countries. How diarrhea infection impacts on vitamin A status is still a poorly understood mechanism; several lines of thought exist including increased metabolic requirements (Compos *et al,* 1987) and decreased absorption of retinol (Mahalanabis, 1991). Also implicated are increased urinary excretion of retinol (Stephensen *et al.* 1996) and decreased synthesis of retinol binding protein (Rosales *at al.* 1996).

Overall, improved vitamin A status has a positive impact (in deficient populations) on mortality with some data indicating a 20-30% protective effect (Underwood & Arthur, 1996).

2.2.6 Vitamin A in Breast Milk

At birth most infants are born with marginal stores of vitamin A and reserves can maintain optimum vitamin A status for only a few weeks. Infants who are improperly nourished are at an increased risk for developing VAD (West, 1991).

During lactation retinol is transferred from the RBP-retinol complex in the blood (Figure 2.3) to breast milk where it is re-esterified in the mammary glands to retinyl esters (mostly retinyl palmitate) (Valquist & Nilsson, 1979). The retinol in human milk is well absorbed, partly due to the presence of lipase in breast milk. Feeding practices that promote colostrum and early milk intake are beneficial since a significant amount of vitamin A is available to the newborn during that stage of lactation. Colostrum also contains high levels of β-carotene and retinol, providing a rich source of vitamin A (approximately 7 μ mol/l) in the first days of life (Chappell *et al.* 1985). Within 4-8 weeks postpartum the concentration of vitamin A in breast milk decreases by about 50% compared to the level in the immediate postpartum period (Underwood, 1994).

In developing countries the average retinol level of mature milk from mothers delivering at term was found to be approximately 330 RE/L, half the level of women in developed countries (660 RE/L). The FAO/WHO recommends a minimum intake by infants of 180 RE per day to meet basal needs, however concentrations in the range of 350-375 RE per day are suggested to promote normal liver storage (Newman, 1994). South African recommended intakes of vitamin A (figure 2.4) are slightly higher. The breast milk retinol concentrations cited above are averages and may not apply to some vulnerable sub-population groups. Lactating women within these particular sub-groups may have compromised vitamin A status which would contribute to poor infant stores prior to six months of age, thus placing the infant at risk for deficiency (DeMayer, 1986).

In predominantly breastfed infants, milk vitamin A concentration is a strong indicator of vitamin A dietary intake. Results of a study from Bangladesh found that breast milk was the most significant source of vitamin A in children up to 27 months of age (Zeitlin *et al.* 1992). The high bio-availability of vitamin A suggests that the concentration of vitamin A in breast milk would be highly correlated with infant stores of vitamin A . However, this relationship between breast milk vitamin A levels and infant vitamin A status has not been studied extensively. In Java it was observed that young breastfed infants whose mothers had milk concentrations >1.4 μ mol/l had higher serum retinol levels than infants whose mothers had lower breast milk concentrations. Additionally, only 13% of the infants whose mother's milk had >1.4 μ mol/l concentration had depleted liver stores compared to 26% of infants whose mothers had lower levels of vitamin A (Stoltzfus *et al.* 1993).

2.2.7 Vitamin A status of lactating women

Even though vitamin A concentration in breast milk is well maintained in situations of mild to moderate malnutrition (Gebre-Medhin *et al.* 1976), breast milk vitamin A concentrations are largely determined by the vitamin A status of the lactating woman. Breastfeeding women are therefore at high risk for developing VAD (Rice *et al.* 1999). This elevated risk has the potential of increasing further due to the large amount of retinol transferred from the mother to the infant via breast milk; consequently an additional demand of vitamin A stores is placed on the lactating mother.

In terms of dietary intake of vitamin A, the BRISK (1994) study conducted on the urban African population of the Cape Peninsula found that micronutrient intake in general tended to be low, with 81% of the study participants having intakes below 67% of the Recommended Daily Intake (RDA) for vitamin A. More specifically, the mean daily intakes of vitamin A for women in the childbearing years were found to be 452 (SD 948, median 231) RE in the 15- 18 year age group and 558 (SD 1141, median 244) RE for women in the 19-44 age category. In comparison estimates of intakes by women from developed countries are approximately 1540 RE. The FAO/WHO recommends that women consume 450 RE per day for basal needs and 850 RE as a safe range (Newman, 1994). South African recommendations match these global suggestions (figure 2.4).

There is some evidence to indicate that BMI is positively associated with maternal serum retinol and therefore with milk retinol levels. In Indonesia well-nourished heavier women had higher retinol levels in breast milk than their thinner, less nourished counterparts (Stoltzfus, 1993).

2.2.8. Food sources and bioavailability of vitamin A

Ideally, vitamin A requirements can be met through consumption of a variety of animal and plant foods. As illustrated in Table 2.5, livers from a variety of animal sources are excellent sources of preformed vitamin A while moderate sources are found in eggs and milk products. Alternatively, rich sources of ß-carotene are found in green leafy vegetables and yellow and red fruits and vegetables with red palm oil and the blue green algae spirulina, identified as excellent sources of ß-carotene (Ong & Tee, 1992).

In practice, animal products are often unaffordable to many in the developing world. Furthermore, data seems to indicate that consumption patterns in regions of the world with the highest prevalence of VAD (Africa and Asia) are comprised of very little animal sources of vitamin A. Instead there is greater reliance on plant sources of the vitamin (FAO/WHO, 1988). Such a dietary pattern may be of great concern since the conventional belief that ß carotene is converted to vitamin A in the intestine at a ratio of 6 : 1 is currently under question (McLaren & Frigg, 1997). It is now believed that the bioavailbility of carotenoids is dependent on a complex interplay of various factors including the utilization of appropriate meal preparation methods that preserve the vitamin. Presence of a source of fat in the meal is also an essential component since it leads to the formation of micelles which aid in the absorption of vitamin A from the meal. Additional factors to be considered include an adequate protein and zinc status, both nutrients essential in the maintenance of adequate vitamin A status. The presence of vitamin E is also key, since this antioxidant protects vitamin A from oxidization (de Pee & West, 1996). The matrix of the carotenoid food source as well as the presence of absorption enhancers and inhibitors all influence the bioavailability of carotenoids (Olson, 1994). It is important to note that the ß-carotene in dark green leafy vegetables is less bioavailable than in fruit, which is believed to be due to the easier extraction of carotenoids in yellow-orange fruits during digestion (Castenmiller & West 1998).

Notwithstanding the above caveats, food based approaches are strongly advocated as sustainable approaches for the improvement of vitamin A status of deficient populations in developing countries (Underwood, 2000). A recent study in Zimbabwe was successful in improving the vitamin A and iron status of lactating women through supplementation with pureed papaya and grated carrots. The authors conclude that bioavailability of carotene was greatly enhanced through the addition of oil to the meal and in the processing (pureeing and grating) of the foods used to supplement their subjects (Ncube *et al* 2001).

2.3 VITAMIN A and IRON INTERACTION

Vitamin A deficiency in adults has been shown to contribute to the development of anemia in spite of adequate iron intake (Hodges *et al.* 1978). This inter-relationship between iron and vitamin A has also been observed in children with studies documenting an association between serum retinol and hemoglobin concentration (Palafox *et al.* 1996) or iron deficiency anemia (Mejia *et al.* 1977). One study of children in Thailand illustrated a strong relationship between serum retinol , serum iron and ferritin (Bloem *et* *al.* 1989). Stronger evidence of this relationship was illustrated in a study of vitamin A supplementation of deficient children, which lead to a significant rise in hemoglobin, hematocrit and serum iron levels (Mohanram *et al.* 1977). Additionally, consumption of foods fortified with vitamin A has demonstrated an improvement of vitamin A and iron status of the deficient population group (Mejia *et al.* 1982, Muhilal *et al.* 1988). Moreover, it has been illustrated that a combination of vitamin A and iron supplementation has greater efficacy in increasing hemoglobin levels than when iron is supplemented alone (Angeles, 1996). This phenomenon was demonstrated in a study of pregnant women where supplementation with a combination of the two micronutrients resolved anemia in 97 % of the women, while iron alone eliminated anemia in 68% of the women (Suharno *et al.* 1996). Other work has shown that vitamin A supplementation of individuals with low vitamin A and hemoglobin status resulted in increased packed-cell volume and hemoglobin concentrations (Bloem *et al.* 1990).

These findings imply that an improvement of vitamin A status impacts on iron utilization, resulting in a correction of pre-existing IDA deficiency. The mechanism involved in the modification of iron status by vitamin A is still poorly understood. Observations from studies indicate that a deficiency in vitamin A does not decrease iron absorption, instead it results in a decreased synthesis of hemoglobin (Sijtsma *et al.* 1993). Furthermore, impaired mobilization of iron stores has also been implicated since VAD deficient animals exhibit an accumulation of iron in both the liver and spleen (Roodenburg *et al.* 1996).

It should be noted that adequate vitamin A status does not resolve IDA in all situations, particularly where infections such as malaria and hookworms are involved

(Stoltzfus, 1997). Although a positive Vitamin A status can be of great benefit on iron status, the vitamin cannot, however, overcome severe IDA (IVACG 1998).

2.4. NUTRITIONAL STATUS OF SOUTH AFRICAN CHILDREN

The South African national nutritional status survey of 18,219 households provided data on a sample of children between the ages of 6-71 months whose results served as a powerful illustration of the impact of the Apartheid system on the health status of the most vulnerable segment of the population, namely the African people. The poverty rate (a powerful health determinant) for the African population has been estimated at 60% while that for the Asian and European South Africans population is 5 % (Steyn, 2000).

Overall (Table 2.6) a third of the children surveyed had sub-clinical vitamin A deficiency. The hardest hit were children from rural areas, particularly those with poorly educated mothers. Twenty-one percent of the children were anemic, with anemia and poor iron status occurring mostly in the 6-23 month age group. It was also determined that children with sub-clinical vitamin A status were at a significantly higher risk of having anemia and IDA (Labadarios *et al* 1995).

The anthropometric data (Table 2.8) illustrates that 23 % of the children were stunted, an indication of chronic malnutrition. Wasting, an indicator of acute malnutrition, was not prevalent at 3%, however, 9% of the children were found to be underweight. Anthropometric data seem to show a consistent pattern of a higher prevalence of under-nutrition in the non-urban population.

With regards to dietary intake of children, recently a national dietary survey has been undertaken in South Africa for which data is yet to be published. However, a metaanalysis of dietary survey data from South African studies was conducted by the South African National Survey Study (SANNSS) group (Voster *et al.* 1995). Although limited in scope, the analysis does provide some crude information on children 2-6 years of age. Rural African children had the lowest energy and macronutrient intakes, which may explain the high prevalence of stunting in this population. With regards to micronutrients, it was found that urban African children, within this age group, had inadequate intakes of both iron (Fig.2.5) and vitamin A (Fig 2.6) in addition to other micronutrients. Furthermore the urban children had mean iron intakes that were half of the recommended amount, thus the higher prevalence of anemia in this group of children.

2.5. BREASTFEEDING PRACTICES

2.5.1 Benefits of breastfeeding

It is well-recognized that breast milk is perfectly suited for a newborn, hence exclusive breastfeeding for the first six months of a child's life is considered to be the gold standard for nourishment and protection from infections. Not only is breastfeeding beneficial to a child's health, but the benefits extend to the mother, providing advantages such as child spacing, minimization of postpartum bleeding and emotional and psychological gains, to mention a few (UNICEF, 1998). The risk of nutritional deficiencies in exclusively breastfed infants is negligible (Mahalanabis, 1991).

One of the largest health risk for children is recurrent diarrhea, resulting in death of an estimated 2.2 million of the world's children per year (UNICEF, 1998). In an economically deprived area of Cape Town it was determined that gastroenteritis accounted for 2 out of 3 deaths of infants under the age of one (Hoffman *et al.* 1984). Children in developing countries have been found to have on average 6 to 12 episodes of diarrhea per year. Furthermore, diarrheal diseases are often exacerbated by poverty, malnutrition and poor sanitation. There is strong evidence that breastfeeding, particularly exclusive breastfeeding, protects infants against acute and prolonged diarrhea (Heinig and Dewey 1996). Severe diarrhea occurs mainly among bottle fed infants with breast-fed babies having the lowest risk (Brown *et al.* 1990, Popkin *et al.* 1990, Howie *et al.* 1998). A review of breastfeeding literature revealed that under six months of age, the median relative risk of death was 25 when comparing exclusively breastfed infants to non-breastfed infants. Comparisons with partial breastfeeding showed a relative risk of 8.6 for bottle feeding (Feachem & Koblinsky, 1984). A Brazilian study described a dose-response relationship with each additional daily breastfeed being associated with a significant reduction in risk of death from diarrhea (Victora *et al.* 1987). Breastfeeding duration is also important, since infants breastfed for less than 3 months seem to lose the advantages of breast milk, exhibiting instead diarrhea rates that are similar to bottle-fed infants (Hessain *et al.* 1995). It is clear that breastfeeding is strongly associated with decreased risk for diarrhea related morbidity and mortality risk in children, with exclusive breastfeeding exhibiting the lowest risk (Davis-Adetugbo, 1997). Finally, it has been illustrated that risk of morbidity from diarrhea increases 2-13 fold when complementary foods are introduced to breastfed infants prior to six months of age (Popkin *et al.* 1990, Brown *et al.* 1989).

Respiratory infections also pose a significant threat to a child's health status. The mortality risk from respiratory infection is significantly higher among non-breastfed infants, particularly those living in urban environments (Wright *et al.* 1989). When respiratory infections do occur in infants who are breastfed, they tend to be less severe. In Rwanda it was observed that case fatality for partially breast fed infants with respiratory infections was half that of weaned infants (Lepage *et al.* 1981). Overall, the benefits of breastfeeding have been found to have their greatest impact during the first six months of an infant's life with some evidence that the advantages can last into the second year (WHO, 1998).

2.5.2 South African breastfeeding patterns

In South Africa breastfeeding incidence is highest in the African population, particularly in rural communities (91 % versus 83 % in urban areas). Notably though, South African breastfeeding prevalence rates are some of the lowest in Africa (Rossouw & Jansen 1990). Furthermore, current initiation rates indicate a decrease from the once high rates of 90-100% (Hall *et al.* 1976, Power *et al.* 1979) to the recent estimates of around 88% (SAVACG, 1996).

As indicated on Table 2.8 there are a number of categories that describe the various breastfeeding patterns observed among lactating women. Exclusive breastfeeding (EBF) is defined as a feeding pattern whereby the infant is receiving all fluids, energy and nutrients via breast milk thus excluding any other liquids and solids. Comparatively EBF, particularly in a non-affluent populations, is strongly associated with positive outcomes with regards to morbidity and mortality in the growing infant

(WHO, 1998). The prevalence of EBF in South Africa is unknown, but there is an indication that the practice is uncommon (Westphal *et al.* 1981; Ross *et al.* 1983). Most infant feeding studies have found that approximately 35-50% of lactating women discontinue breastfeeding before 3 months postpartum and that introduction of complementary foods is common, sometimes occurring as early as 6 weeks of age (Styen 1993; Ross *et al.* 1983). Richter (1989) found that along with breast milk, 70% of the children in her sample received a combination of foods and beverages that included items like grain based gruel, commercial infant cereals, breast milk substitutes and water. These items were often introduced to an infant as young as two months of age. In another study examining feeding practices of Venda women in South Africa, it was found that 60% of their breastfed infants under 3 months received complementary foods on a daily basis (Zollner & Carlier, 1993).

In developing countries, early introduction of complementary foods poses a significant health risk for children. Infants who are fed these foods, including breast milk substitutes, are at increased risk of exposure to high pathogenic loads due to sanitation factors. The infections arising from contamination of weaning foods have been identified as a major influence of under nutrition in children living under low socio-economic conditions (Savage King & Burgess, 1993). A common reason given for offering complementary foods is women's beliefs that breast milk alone is an insufficient source of energy for a growing child or that they have an inadequate production of breast milk (Dettwyler & Fishman, 1992). Milk insufficiency has been reported as a common concern of breastfeeding women, throughout the world (Van Steenbergen et al. 1984).

An important feature of breastfeeding behaviour is a group's beliefs and practices regarding colostrum. Colostrum is the initial breast milk available to a newborn for a period of 3 to 5 days, after which the mature milk "comes in". Although colostrum has been shown to have significant immunological properties, and is therefore of great benefit to the newborn, many cultures around the world discard this part of breast milk. Colostrum has a different appearance to mature milk and therefore is often perceived as "weak milk", or worse, poisonous to the infant (Dettwyler & Fishman, 1992). South African beliefs surrounding use of colostrum are not clearly understood.

It is important to keep in mind that infant feeding practices are strongly influenced by cultural and social beliefs (Dudley *et al.* 1997; Richter, 1989). Therefore, the understanding of breastfeeding patterns practiced in conjunction with an examination of traditional and cultural beliefs and how these values impact on childcare, including infant feeding, is essential. When mothers from Soweto were interviewed on their infant feeding practices, there was a tendency for the women to discuss the feeding of their infants in the context of general childcare issues, concerns and values. It was also clear that once traditional feeding practices were discussed in a non-judgmental atmosphere, the women participating in the study were willing to give a more honest representation of their breastfeeding and infant feeding behaviour (Richter, 1989).

2.5.3 Use of traditional preparations in lactation and infant feeding

Women often cite breast milk insufficiency as a reason for discontinuing breastfeeding, even though it has been found that less than 1 % of women cannot truly produce sufficient amounts of milk to feed their infant (Van Steenbergen 1984). The use of galactagogues to promote increased breast milk production during lactation is a common practice globally (Newinger 1998, Baumslag 1987). Galactagogues may be taken for a variety of reasons including to improve lactating women's diet or fluid intake or as a means of relaxing the mother, decreasing anxiety and encouraging the let-down reflex. Most galactagogues are herbs (i.e. fenugreek) but some can be foods. In India ginger and a variety of herbs are used, while in many parts of Latin America people advocate herbal teas for increasing breast milk. Guatemalan women believe in the use of steam baths coupled with herbal tea while in Northern China women use a 'lactation soup' to increase milk volume (Baumslag, 1987).

It is difficult to comment on the clinical impact of galactagogues since well designed, controlled, blinded studies investigating the effects of these traditional preparations on milk volume are absent. Nonetheless, in South Africa use of traditional herbal preparations during pregnancy and lactation seems to be a common practice, even though some people are reluctant to discuss their use of traditional medicine (Varga & Veale,1997). The extent of galactagogue use and what foods or herbs are used to encourage adequate breast milk supply is unclear, as is the extent of traditional herbal preparation use in infant care.

2.6 TARGET POPULATION

As with many other parts of the world, South Africa is experiencing rapid urbanization. Projections for the year 2010 have estimated that 70 % of the population in South Africa will be urbanized, affecting mostly the African population (Bourne *et al.* 1994). Families migrating from rural areas into large cities in search of a better life are often met with extreme hardship and poverty. Consequently, these families are forced to live under poor housing conditions, usually dwellings that are little more than shacks, located on the outskirts of large metropolitan areas.

Segal & Hirschowitz (1994) found that the majority of children living in informal metropolitan areas were underweight. The parents or caretakers of these children were more likely to indicate that they were too poor to feed their children adequately compared to their urban counterparts living in formal housing.

An increasingly urban lifestyle can lead to alterations in traditional behaviour, often imposing a profound impact on the most vulnerable groups in the population. Within such an environment there is a tendency for women to shun breastfeeding in their aspiration to become 'modern', choosing instead to feed their infants breast milk substitutes. This shift in perspective leads to increased use of breast milk substitutes which is viewed as prestigious, a sign of affluence and a superior method of feeding a child (Williams *et al.* 1986). Obviously this is a dangerous trend, since appropriate feeding of substitutes requires financial stability. Consequently, breast milk substitutes are often over-diluted to help extend the amount of formula available to a child, a practice that often leads to growth failure and illness.

STUDY RATIONALE

Anemia and VAD are serious burdens of disease contributing significantly to infant morbidity and mortality. Breast milk is an essential source of both vitamin A and iron in an infant's diet and therefore an important determinant of nutritional status. Investigation of breastfeeding patterns in a population at increased risk for deficiencies can assist in identifying the determinants of micronutrient status of both mother and child. South Africa is in the process of developing a supplementation program targeting high risk pregnant and lactating women and their infants (Charlton). Data on the association between breastfeeding patterns, anemia and vitamin A status of high risk young infants and their mothers will assist and complement any strategies aimed at improving nutritional health of a community's vulnerable members. Moreover, documentation of the co-existence of anemia and VAD in this specific target group is important information that may influence planning of public health policy and highlight the need for multiple micronutrient intervention programs.

RESEARCH QUESTIONS

1 Does sub-clinical VAD and anemia exist in peri-urban South African breastfed infants under six months of age?

2 Are anemia and VAD present in the lactating mothers?

3 Which breastfeeding patterns are the most protective of the infant's vitamin A and hemoglobin status ?

PURPOSE AND STUDY OBJECTIVES

A. The study objectives covered in Manuscript 1, Thesis Chapter 3 are:

(1) To determine the prevalence of sub-clinical VAD and anemia in lactating women and infants 1-6 months of age residing in a peri-urban community of the Cape Métropole, South Africa.

(2) To determine the vitamin A status of breastfeeding women using both serum retinol and breast milk retinol concentration.

(3) To investigate the association between infant hemoglobin and serum retinol concentrations and breastfeeding patterns.

B. The study objectives covered in Manuscript 2, Thesis Chapter 4 are:

(1) To categorize the breastfeeding patterns practiced by the study population and to determine the markers utilized in selection of breastfeeding patterns.

(2) To document the breastfeeding cultural beliefs, practices and attitudes of the lactating mothers.

(3) To investigate the beliefs in and use of traditional preparations for both breast milk production (galactagogues) and for infant use.

Chapter 3, manuscript 1.

HEMOGLOBIN AND VITAMIN A CONCENTRATIONS OF LACTATING WOMEN AND INFANTS 1-6 MONTHS FROM A PERI-URBAN SETTLEMENT IN SOUTH AFRICA

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3.1 ABSTRACT

The aim of this study was to determine the retinol and hemoglobin (Hb) concentrations of high risk lactating women and their young breastfed infants from a peri urban community of Cape Town, South Africa. Results indicated that the mothers (n=113) with a mean age of 26 years and BMI of 28.6 ± 5.1 kg/m^2 had mean Hb of 12.4 ±1.3 g/dL with 32 % of subjects being anemic (Hb <12g/dL). Maternal retinol concentrations did not indicate evidence (only one mother) of sub-clinical vitamin A deficiency ((VAD) < 20 µg/dL) since maternal serum retinol was 49.8 ±13.2 µg/dL while median retinol concentration of breast milk (BM) was 66.0 µg/dL, with a significant association found between BM retinol concentration and milk fat (p=0.04). The majority (62 %) of infants (n=113) were under 3 months of age with no implication of acute or chronic malnutrition as indicated by their Z scores (-0.69 ± 0.81, 0.89 ± 1.01 and 1.78 ± 0.83 for HAZ, WAZ,WHZ respectively). The mean infant hemoglobin (Hb) concentration was 10.9 ±1.1 g/dL with prevalence of anemia being 50%, 33 % and 12 % using Hb cut-offs below 11 g/dL, 10.5 g/dL and 9.5 g/dL respectively. Mean infant serum retinol was 26.9 ±7.2 µg/dL, indicating a 10 % prevalence of sub-clinical VAD. Mother's Hb was found to be associated with maternal serum retinol (r = 0.43, p<0.001) however, there was no significant correlation between maternal and infant Hb or between mother and infant serum retinol concentrations. None of the infants were being exclusively breastfed (EBF); 78 % were complementary (mixed) breastfeeders and 22 % predominantly breastfed. Infant weaning foods were introduced at ≤ 1 month of age to 32 % of the infants. Our findings indicate that within this peri-urban setting, the lactating mothers' nutritional status did not seem overtly compromised as demonstrated by their mild level of anemia with no evidence of marginal VAD. However, their very young infants had a high prevalence of anemia with a moderate level of sub-clinical VAD. This discrepancy between maternal and infant status may be due to the lack of EBF coupled with a high prevalence of mixed breastfeeding at an early age, feeding practices that may contribute to the micronutrient deficiencies observed in these infants.

3.2 INTRODUCTION

Globally, greater than 2000 million people are deficient in one or more micronutrients (WHO, 1991) with both vitamin A deficiency (VAD) and iron deficiency anemia (IDA) prevalent in much of the developing world. Combined, these two micronutrient deficiencies contribute to serious burden of disease in many areas of the world and consequently are declared public health problems of great enormity (U.N., 1990).

Iron deficiency is recognized as the primary, although not the only cause of anemia (de Benoist, 2001). The numerous consequences of IDA include impaired cognitive development and psychomotor function in infants and children (Lozoff *et al.* 1991, Soewondo *et al.* 1989), a decrease in work productivity and maternal or child mortality in cases of severe anemia (Stoltzfus, 2001). Therefore it's multi-level effect on the health and economical viability of afflicted individuals make IDA investigation important, particularly in high risk population groups. South African data indicate that one in ten children are iron deficient and estimate that one in twenty children have IDA, the most vulnerable group being children in the 6 to 23 month age group (SAVAAG, 1994).

Sub-clinical VAD, the more common form, has been shown to increase the risk of infections, a major contributor to the morbidity and mortality of deficient children (Bhaskaram, 1995). In South Africa, a third of the nation's pre-school aged children have been identified as having sub-clinical VAD and by WHO (1994) criteria South Africa has a serious public health problem of VAD.

Iron deficiency anemia and VAD often co-exist within the same sub-populations (ACC/SCN, 2000). Inadequate intake of vitamin A has been shown to result in anemia, with vitamin A use leading to improved iron balance (Palafox *et al.* 1996).

Breastfeeding is considered protective of both vitamin A and iron status of infants under six months of age. The high bioavailability of iron in breast milk (Kawakami & Lönnerdal, 1991) combined with the infant's own stores, protects the newborn's iron status in those first initial months of life. Human milk provides the infant with a rich source of retinol both through colostrum and mature breast milk (Chappell *et al.* 1985, Valquist & Nilsson, 1979). However, as the infant matures iron is mobilized to support red blood cell synthesis and infant growth, consequently depleting iron stores and thereby placing the infant at risk for IDA (Dellman *et al.* 1980). Moreover, it has been shown that marginal VAD can exist in breastfed infants from vulnerable, disadvantaged backgrounds (Wahed *et al.* 1997).

In South Africa, although breastfeeding rates are highest in the African population (Rossouw & Jansen 1990), early introduction of complementary "weaning" foods is a common practice in breastfeeding women (Richter 1994; Styen *et al.*1993; Zollner & Carlier 1993; Ross *et al.* 1983). Decreased intake of breast milk combined with consumption of micronutrient-poor complementary foods may impose a negative influence on the vitamin A and iron status of the breastfed infant during a period of high nutrient needs for development.

South African data specifically focusing on iron and VAD status of breastfed infants under six months of age and their lactating mothers living under resource poor conditions are few. Given the cultural value of breastfeeding in the African population and the significance of these two micronutrients in preserving maternal and child health, this study was undertaken to investigate the prevalence of anemia and VAD in lactating women and their infants under six months of age from a peri-urban settlement of the Cape metropolis, and to elucidate which breastfeeding patterns are associated with positive vitamin A and hemoglobin profiles.

3.3 SUBJECTS and METHODS

Study area

The peri-urban setting selected, with high a level of poverty rendered some of the inhabitants at risk for nutritional deficiencies. The study took place in the community of Langa, one of many settlements situated on the periphery of Cape Town, South Africa. Dwellings in this community (settled in 1933), range from formal homes to informal squatter camps, Langa is one of the oldest 'Townships" and has a current population of 46,505.

Study design and subjects

This cross-sectional survey of women and their infants attending a community health clinic in Langa was undertaken between August and November 2000. Infants were eligible if they were between the ages of 1-6 months, had a birth weight ≥ 2500 g (both criteria confirmed by the infant's R*oad To Health Card* (documentation recorded by health personnel at time of infant birth), were still being breastfed and had no current illness or history of being sick in the past two weeks (mother questioned plus clinical examination performed by a pediatrician). Both mother and infant were excluded if they had received any vitamin/mineral supplements. Once the study was clearly explained to the mother in Xhosa (local language), informed signed consent was obtained for participation of both the mother and infant.

Of the 137 women initially recruited to participate in the study, nine declined participation (mothers feared distressing their infants) and 11 mother and infant pairs were discharged from the study due to our inability to draw blood from the infants. Additionally two infants were discharged because one was febrile and the other suspected of HIV infection with both infants referred for immediate follow up. Participating in the study were 115 mothers and 117 infants (two sets of twins, however data analysis was limited to singletons, n = 113).

Ethical approval for the study was obtained from both McGill University research ethics committee in Canada and from the ethics body of the University of Cape Town Medical School in South Africa.

Collection and analysis of blood samples

Non-fasting blood samples from both mothers (10 ml) and infants (5 ml) were drawn by venipunture into two vacutainer tubes per mother and infant; one tube with EDTA for the purpose of full blood count (FBC) determination and the other for determining the serum retinol. Infant blood draws were conducted by a pediatrician while the maternal blood collection was performed by a qualified nurse. On occasion, insufficient blood was obtained for all the biochemical tests. Sera for serum retinol measurement were covered and stored immediately on ice. All samples were transported within 5 hours of collection to the Medical Research Council (MRC) for determination of serum retinol using high performance liquid chromatography (HPLC) as per Catignani and Bieri (1983) method. The Haematology Department at Groote Schur Hospital undertook the FBC determination, with analysis conducted within the same day. Using H*1 and Advia 120 (Bayer) instrument, FBC analysis included: Hemoglobin (Hb), hematocrit (Ht), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC).

Collection and analysis of breast milk samples

All lactating mothers were asked to express breast milk (approximately 30 ml) into sterile plastic containers with lids. Given the choice between a breast pump and manual expression, all subjects chose manual expression. Once collected, breast milk samples were immediately placed on ice in a portable cooler with a cover and transported, within 5 hours of expression, to the MRC laboratory. Prior to freezing, the breast milk sample was re-homogenized and the fat content determined according to the creamatocrit method described by Lucas et al. (1978). The sample was then aliquoted then frozen at -20° C until analyzed. Vitamin A content was determined by an HPLC method, based on the method described by Strobel *et al.* (2000).

Anthropometric measurements

Body weights were measured using an A & D Precision Health Scale UC-300 (Tokyo, Japan) scale. Infants were weighed without clothing (dry diaper only) using an indirect method and the mothers were weighed directly without shoes or coat/sweater. All weights were measured to the nearest 0.1 kg. Supine infant lengths were measured using a measuring board with a fixed headboard and a moveable foot-board placed on a flat surface. Two people conducted the measurement, one positioning the head and the other the feet and read the measurement to the nearest 0.1 cm in triplicate. The mother's height was measured (without shoes) to the nearest 0.1 cm in triplicate using a measure (2 m Panamedic) attached to the wall with a sliding headpiece.

Anthropometric indices for assessing infant growth are Z scores (using reference population from the National Centre for Health Statistics) for: height-for-age (HAZ), weight-for-height (WHZ) and weight-for-age (WAZ). For the mothers, BMI (kg/m^2) was used.

Questionnaire

A trained field worker interviewed the mothers in Xhosa using a field-tested questionnaire. Mothers choosing to complete the survey in English were interviewed by the principal investigator (LS). The structured questionnaire was adapted from the data collection guidelines developed by WHO for breastfeeding research (WHO, 1981) and designed to elicit information on socio-demographic variables, infant feeding behaviour and breastfeeding beliefs, attitudes and practices. Mothers participating in our study were asked to describe their breastfeeding behaviours as well as their complementary breastfeeding practices. WHO (1997) breastfeeding categories were used to classify the infants according to pattern of breastfeeding followed.

Statistical analysis

Data were analyzed using the SAS system for Windows version 8.0 (SAS Institute Inc. Cary, NC). EPI-INFO (version 2000, Centers for Disease Control and Prevention, Atlanta) was used to calculate the Z scores of all the infant subjects. Hemoglobin, serum and breast milk retinol were all normally distributed. Pearson correlation was used to examine associations between variables. Relationships between categorical and continuous variables were analyzed using linear and multiple regression. Differences between means were analyzed using Student t test while Chi squared was employed to look at differences between proportions. Results were considered significant at $p < 0.05$.

3.4 Results

Participating mothers ranged in age from 15 to 43 years of age, with almost half primiparous (**Table 3.1**). The mean maternal BMI was high at 28.6 and significantly correlated ($p < 0.001$) with both maternal age and parity. The level of unemployment was very high (81%) in this population despite the fact that 64% of the mothers reported having attained an education level ≤ grade 11.

The majority (62%) of the infants were under 3 months of age when examined. Infant anthropometric data (**Table 3.2**) illustrates a negative mean HAZ score of - 0.69 with only two (1.8%) infants having scores < – 2. Both WAZ and WHZ had positive means indicating generally large but short babies, further evidenced by 12% and 35 % of the infants having WAZ and WHZ values > 2 respectively. There were no associations found between infant anthropometric values and infant and maternal micronutrient measurements.

Mean serum retinol for the lactating mothers was 49.8 ± 13.3 µg/dL, indicating no evidence of VAD, only one mother had a level below < 20µg/dL (**Table 3.3**). The median retinol concentration in breast milk was 66.0 µg/dL, which confirms the adequate vitamin A status of the mothers. The mean milk vitamin A concentration as a ratio of milk fat concentration in breast milk was 8.4% (mean breast milk vitamin A concentration divided by mean volume percent of milk fat as determined by creamatocrit). Breast milk retinol concentration was found to correlate significantly with milk fat concentration ($P = 0.04$).

In contrast, the infants had a mean serum retinol of 26.9 ± 7.1 µg/dL with a 10% prevalence (11 infants) of sub-clinical VAD. A majority of the deficient infants (9/11) were under 3 months of age. Furthermore, the mean serum retinol concentrations for infants below 3 months of age were found to be significantly different from the values of those above 3 months of age ($p<0.001$) (**Table 3.3**). There was no significant correlation found between breast milk vitamin A concentration and infant serum retinol.

Using the hemoglobin cut-off value of <12 g/dL for lactating women, we found a 32 % prevalence of anemia in the mothers and a mean maternal hemoglobin concentration of 12.4 ± 1.3 g/dL (**Table 3.3**). Thirteen- percent of the mothers had low MCV (<80 fL) values and 20 % had low hematocrit (<0.36 %) levels.

The mean infant hemoglobin concentration was 10.9 ± 1.1 with prevalence of anemia found to be 50%, 33% and 12% using hemoglobin levels cut-off values of 11 g/dL, 10.5 g/dL and 9.5 g/dL respectively. There was no statistically significant difference found between the mean hemoglobin concentration of infants younger and older than 3 months of age (**Table 3.3**). Low hematocrit (< 0.33 %) levels were found in 37% of the infants while 2.8 % (3 babies) had low MCV ($\leq$73 fL) values. The distribution of hemoglobin values for both mothers and infants are illustrated in **Figures 3.1a and 3.1b,** respectively.

Infant hemoglobin did not correlate with infant serum retinol. Mother's hemoglobin correlated with maternal serum retinol ($r = 0.43$, $p < 0.001$), however, maternal and infant hemoglobin levels as well as their serum retinols were not correlated. A positive correlation was found between maternal and infant MCV values ($p = 0.001$).

Examination of the independent variables associated with infant micronutrient concentrations indicated a positive relationship between infant serum retinol and infant age, weight and length ($p<0.001$) as determined by linear regression. Since weight and length are highly correlated, infant length was selected, along with age, to be used in the multiple regression analysis. Although both independent variables were related to infant vitamin A concentration ($R^2 = 0.21$, $p < 0.001$), the only significant association was with infant length ($p = 0.02$) and not age.

The responses from mothers describing their breastfeeding practices were categorized into predominant breastfeeding (mostly breast milk plus small amounts of non-nutrient liquids) and complementary breastfeeding (breast milk in addition to other foods or liquids). The complementary breastfed group was broken down further into three subgroups: i) breast milk plus solid food (BM +

S); ii) breast milk plus solid food and breast milk substitute (BM + S + Subs) and iii) breast milk plus breast milk substitute (BM + Subs). Seventy-eight percent of the infants in the study were complementary breastfed while 22% were predominant breastfeeders. There were no exclusively breastfed (breast milk only, nothing else including water) infants found in the entire sample of infants who were on average under 3 months of age.

Infant foods were introduced at $\leq$ 1 month of age to 32 % of the infants. Of the mothers feeding infants weaning foods (65%), 85% cited commercial infant cereal as the solid food of choice, with the remainder reporting that they gave a homemade, maize- based gruel. The breast milk substitutes offered to infants were iron fortified, with some mothers reporting use of UHT (ultra high temperature) milk when they ran out of breast milk substitutes. Furthermore, in some cases breast milk substitute was often used to mix with infant cereal rather than fed directly to the infant. Water and the liquid from a traditional maize dish (*samp* and beans) were the only other fluids reported as being offered to the infants. In the predominant breastfeeding group, all the mothers reported water as the fluid given to infants. The prevalence of infants with hemoglobin concentrations <11g/dL was 21 % in the predominant breastfeeding group and 29% in BM + S, 33% in BM + S + Subs. and 17% in the BM + Subs. categories. A comparison of the percentage of infants below and over 3 months of age in predominant versus complementary feeders indicated that a significant difference ($p<0.001$) exists between feeding type and infant age (**Table 3.4**). However, the proportions of anemic infants between the predominant and complementary breastfed groups was not significantly different, even when 10.5 g/dL and 9.5g/dL cut-off levels were used. This was also the case when mean hemoglobin values were compared between feeding groups. Infant age is not a confounder in the feeding type anemia relationship since infant hemoglobin concentration was not found to be related to infant age. In the 11 marginally VAD infants, 4 were predominant breastfeeders and 2, 4 and 1 received BM + S, BM + S + Subs. and BM + Subs., respectively.

3.5 Discussion

Little is known about the micronutrient status of infants under 6 months of age in the South African population (Bourne *et al.* 1994) or of the breastfeeding mother and their young infant, within a high risk setting. We attempted to fill this gap in knowledge by examining the nutritional status of lactating women and their breastfed infants under six months of age within a South African peri-urban setting. More specifically, we examined the hemoglobin and retinol profile of this specific population from formal and informal dwellings within a community on the periphery of Cape Town.

Infant anthropometric data did not indicate stunting, wasting or underweight in our group of subjects. On the contrary, a fair proportion (12% WAZ and 35% WHZ) of the infants had z scores above 2. Our mean HAZ (-0.69) was similar to values found in a South African rural population (-0.45) of 6-11 month old infants. Given that this population of children were breastfed, we suggest that breastfeeding contributed to the dietary adequacy that protected these infants from signs of acute or chronic malnutrition at this stage of their development. Similar to the study of micronutrient status of Indonesian mothers and their breastfed infants by Dijkhuizen *et al.*(2001), we did not find any association between hemoglobin, vitamin A and anthropometry scores.

Iron deficiency is considered the most common cause of anemia particularly in areas where anemia is prevalent (Stoltzfus & Dreyfuss, 1998), therefore hemoglobin concentration is considered an acceptable and valuable measure for assessing IDA, particularly in the field setting (UNICEF/WHO, 1999). It should however be noted that in developing areas of the world, many other factors which may co-exist or interact, can contribute to the development of anemia, including parasitic infections and other nutrient deficiencies such as folate, vitamin A and B_{12} (Gillespie & Johnston, 1998). Since hemoglobin distribution may vary greatly among different races and ethnic groups, it has been suggested that for diagnosis of IDA in individuals of African origin a hemoglobin cut-off value 1 g/dL lower than that for individuals of Caucasian background as a more appropriate level (Khusun *et al.* 1999).

Employing the universal cut-off standards of hemoglobin concentrations for lactating mothers (<12 g/dL) and young infants (<11 g/dL), we found mild anemia to be prevalent in our population of breastfeeding mothers (32%) and their infants (50%). Absence of low MCV values (2.8 %) in the infants is not surprising given that our data suggests a prevalence of mild anemia and low MCV values occur when iron deficiency is severe (Gibson, 1990). Although anemia does exist in the maternal population the hemoglobin values of many of the mothers fell between 11g/dL and 13.5 g/dL. In the babies 33% of the hemoglobin values fell between 10.5 g/dL and 12 g/dL. In comparison, Oelofse *et al.* (1999) found a lower prevalence (21.8%) of anemia (Hb < 12 g/dL) in mothers from a rural community of Kwazulu-Natal. The prevalence of decreased infant hematocrit levels in our sample (37%) was comparable with that of a Bloemfontein peri-urban settlements (36.4%), however the same study observed a lower rate of mild anemia (27.3% and 37.5%) in it's two groups of mostly breastfed infants under one year of age (Dannhauser *et al.* 2000). Nutritional assessment of rural 6 months to 6 year old (n = 105) found a 23.8% prevalence of anemia (Hb < 11 g/dL) in the preschoolers (Oelofse *et al.* 1999). It is difficult to compare our results with these rates since both studies had relatively small numbers of infant subjects compared to our study of 113 breastfed infants, all under 6 months of age.

Our data do not indicate a significant correlation between maternal and infant hemoglobin concentrations. Our findings confirm that of Okolo *et al (* 2000) which indicated there was no significant relationship between iron concentration in breast milk and infant serum in their group of Nigerian lactating mothers.

While a third of South African children (21% in the Western Cape) aged 6-71 months have been found to be marginally vitamin A deficient (SAVACG, 1995), we identified VAD in 10% (11/110) of our participating infants, indicating a moderate level of sub-clinical vitamin A deficiency (WHO/UNICEF, 1994).

Although it is uncommon to find VAD in breastfed infants under six months of age, infants in high risk settings may be at risk for deficiency (Wahed *et al.* 1997, Stoltzfus & Underwood 1995). Of interest in our findings is that the mothers did not exhibit any VAD as indicated by both serum and breast milk retinol levels. Adequate breast milk retinol levels imply concurrent protection of the mother's breastfed infant from VAD. However, that was not our observation, since a proportion of infants were marginally VAD. It is reasonable to assume that the tendency towards overweight found in the mothers implies absence of malnutrition. In Wahed and colleagues' (1997) study of Bangladeshi lactating women and their young infants (5.9 ± 2.3 months), 64% of the infants were vitamin A deficient with maternal malnutrition found to be common. This finding suggests that the women had low vitamin A concentration in their breast milk consequently their infant's vitamin A status was compromised.

Again few South African vitamin A status studies have included young infants as part of their cohort. Faber and Benade (1999) assessed the nutritional status of rural South African children aged 4 to 24 months and found that 37.3 % had low vitamin A status even though breastfeeding was initiated by 99% of the mothers 80% of the infants still being breastfed. In another site, sub-clinical VAD prevalence rates for infants under a year from the Joe Slovo and JB Mafora settlements were 19.2 % (4/21) and 27.3 % (3/11) respectively (Dannhauser *et al.* 2000). These data, including our results provides evidence of VAD in very young infants living under certain vulnerable conditions.

Both serum and breast milk retinol concentrations confirmed that lactating mothers had adequate vitamin A status. Given that the mean maternal BMI was 28.6 kg/m^2 it is not unreasonable that these mothers have adequate vitamin A status. Overweight among disadvantaged women is an increasing trend observed in transitional communities similar to the one under study (Bourne *et al.* 1994). A study of Indonesian mothers found that there was a positive association between BMI and maternal serum retinol and that heavier women had higher breast milk retinol concentration than their thinner counterparts (Stoltzfus, 1993).

Among the African population in South Africa, breastfeeding is a highly valued and culturally acceptable mode of infant feeding. However, not all breastfeeding is the same. There is variation in ways women chose to breastfeed. In our entire sample of 117 infants there were no exclusively breastfed (breast milk only, nothing else permitted) infants. All infants were either predominantly breastfed (22%) or the complementary breastfed (78%). Significantly more infants were predominantly breastfed under 3 months of age than over with the percentage of infants receiving complementary feeding being higher than predominant feeders, regardless of age category. Although breast milk contains a relatively low concentration of iron, the iron is highly bioavailable, thus meeting the infants needs up to six months of age (Saarinen *et al.* 1977), however, iron stores decline as iron is mobilized to support infant growth (Dellman *et al.* 1980). Consequently after six months an exogenous source of iron is recommended for breastfed infants. Our data clearly indicates that infant subjects were deficient prior to six months of age. There was no statistical difference found between feeding categories and levels of anemia. Other studies report similar findings. Dewey *et al* (1998) reported low hemoglobin values in infants receiving breast milk in addition to iron fortified foods. We speculate that the anemia may be a consequence of the early introduction of solid foods and other liquids to the breastfed infants intake, particularly since iron from breast milk is thought to be poorly absorbed once solids are added to the infants diet (Oski & Landaw 1980) Furthermore, our infant subjects were heavy as indicated by our z scores, and rapid growth has been reported to be associated with depletion of iron stores as in the case of a recent study of breastfed Ghanaian infants (Lartey *et al.* 2000). Other studies confirm this association between rapid growth and iron status (Michaelsen *et al.* 1995, Cohen *et al.* 1994, Willows *et al.* 2000).

In summary, lactating mothers from a peri-urban community in South Africa are at risk for developing anemia. More importantly, their breastfed infants under six months of age may be at an additional risk of multiple micronutrient deficiencies, specifically anemia and sub-clinical VAD. Early introduction of iron fortified solids and or breast milk substitutes did not protect this subgroup of infants from anemia. Less than optimal feeding practices that include a high prevalence of complementary breastfeeding combined with early introduction of food may be contributing to nutritional deficiencies in these infants, rather than these deficiencies being attributed to the inadequacy of breast milk. Breastfeeding is culturally valued in this population and the benefits, with regards to infant morbidity and mortality, far outweigh any perceived disadvantages. We advocate prospective studies with larger sample sizes and additional micronutrient indicators to investigate the iron and vitamin A status of infants under six months of age from a similar background, who are exclusively breastfed and compared to other feeding categories. The results of this type of study can be used in the planning of programs that promote optimal breastfeeding practices.

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Table 3. 1: Characteristics of lactating mothers and their infants 1-6 months, from a peri-urban community of Cape Town (Langa).

Mothers	
(n=115)	
Age[1] (years)	26 (15-43) ± 6.25[2]
BMI (kg/m^2)	28.6 (18.1-46.1) ± 5.09
Primiparous (%)	48
Unemployment (%)	81
Education (% ≤ grade 11[3])	64
Infants	
(n = 113)	
Gender (% male)	51
Age (months)	2.79 ± 1.32 1≤ 3 months (62 %) > 3- 6 months (38%)
Birth weight (g)	3216(2500-4400) ± 390.5
Weight (kg)	6.2 (3.9-10.4) ± 1.3
Length (cm)	57.7 (49.9-69.2) ± 4.1
Vaginal births (%)	76
MOU[4] / hospital births (%)	98

[1]n=113 for age and n=114 for BMI due to missing data.
[2]Means ± SD
[3]Grade 11 is equivalent to standard 9 in the previous South African education system.
[4]Maternal and obstetrics unit (MOU)
Numbers in brackets are minimum and maximum values

Table 3.2 : Z scores for breastfed peri-urban infants 1-6 months of age

Anthropometric Indices	Z score[a] (n =113)
HAZ[b]	-0.69 ± 0.81 (-2.37 - 1.93)[e]
WAZ[c]	0.89 ± 1.01 (-0.90 - 3.73)
WHZ[d]	1.78 ± 0.83 (0.14 - 4.24)

[a] Mean ± SD
[b] Height-for-age
[c] Weight-for-age
[d] Weight-for-height
[e] minimum and maximum values

Reference population data from the National Center for Health Statistics (NCHS)

< -2 SD is categorized as moderately depleted
-2 to <-1 SD is mildy depleted
± 1 SD is normal
>2 SD is excessive
(De Onis et al. 1993)

Table 3.3: Hematological and serum retinol profiles of lactating mothers and infant subjects

Biochemical indices	Maternal concentrations (n = 110)	Infant concentrations (n = 104)	
		≤ 3 mos	> 3 mos
Serum retinol (μg/dL)	49.8 ± 13.3†	24.8 ± 6.4‡	30.1 ± 7.1*
BM Vitamin A (μg/dL)	70.6 ± 24.6	-	
Hemoglobin (g/dL)	12.4 ± 1.3	10.8 ± 1.1	11.1 ± 1.1
MCV (fL)	86.6 ± 6.3	90.5 ± 6.6**	80.4 ± 5.28**
Hematocrit (%)	0.38 ± 0.04	0.34 ± 0.03	
MCH	27.9 ± 2.2	28.2 ± 2.7	
MCHC	32.2 ± 1.3	32.7 ± 1.3	

Values reported as means ± SD
†n = 112
‡n = 110
* significantly different, P < 0.001
** significantly different, P < 0.001
BM breast milk retinol (n = 99), cut-off is < 30 μg/dL (1.05 μmol/l) MCV mean cell volume
MCH mean cell hemoglobin
MCHC mean cell hemoglobin concentration
Sub-clinical VAD is classified as serum retinol <20 μg/dL (<0.70 μmol/l)
Anemia is defined as hemoglobin concentrations < 11.0 g/dL and <12.0g/dL in infants and lactating women respectively.
Hematocrit cut-off < 33% for infants, < 36 for 12-49 year old women.
MCV cut-off < 73 fL for infants, and < 80 for 18-49 year old women (Dallman 1977)

Table 3.4: Proportion of infants within each breastfeeding category by infant age.

Breastfeeding pattern	1-3 months (n= 72) %	3.1-6 months (n=45) %
Exclusive Bf	0	0
Predominant Bf	33	2*
Complementary Bf	67	98

Differences between predominant and complementary breastfeeding were significant by χ^2.
Bf = breastfeeding , predominant Bf = mostly breast milk plus non-nutritive fluids, complementary Bf = breast milk plus food and /or fluids including breast milk substitutes.

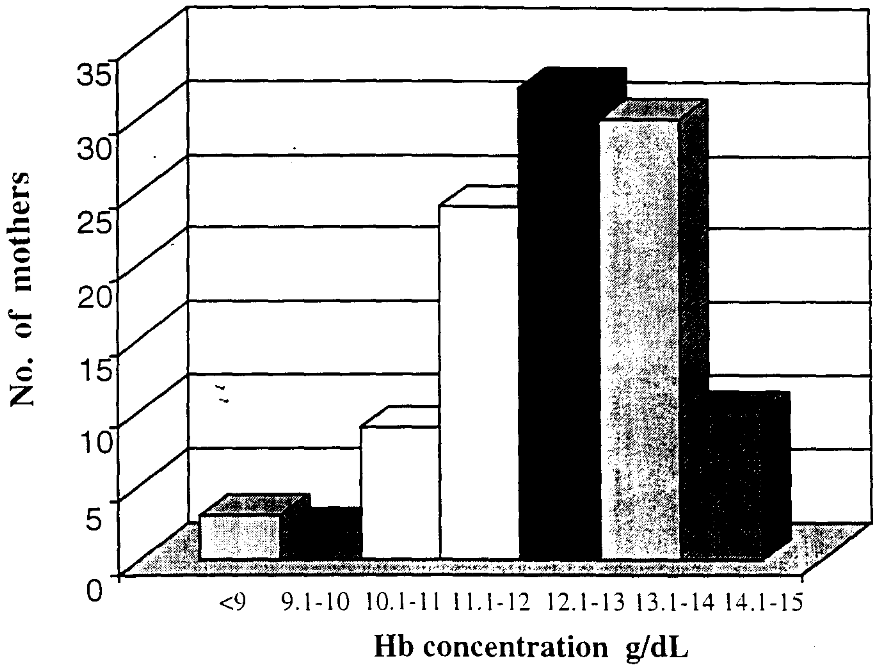

Figure 3.1 a: Distribution of hemoglobin (Hb) concentrations for lactating mothers (n=110), cut-off used for classifying anemia is Hb < 12 g/dL.

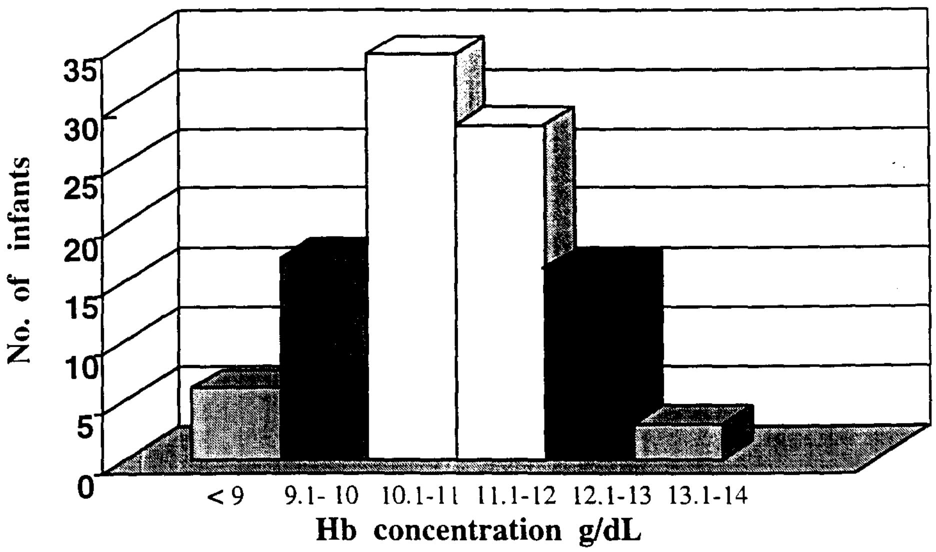

Figure 3.1 b: Distribution of hemoglobin (Hb) concentrations for infants 1-6 months of age (n=104), cut-off used for classifying anemia is Hb<11g/dL .

Bridge

There is a gap in knowledge regarding the hemoglobin and vitamin A status of breastfed infants under six months of age in South Africa, since most research focuses on the risk for older preschool aged children. Although anemia and vitamin A deficiency co-exist within the same population, few studies have documented the prevalence of these deficiencies in an at risk sub-population of the breastfeeding mother and infant pair.

Our study reports the hemoglobin and serum retinol concentrations for breastfed infants under six months of age and for their mothers residing in a peri-urban population of the Cape metropole in South Africa. Furthermore, both breast milk retinol and serum retinol are used as indicators of maternal vitamin A status. The focus of the first manuscript is to describe the extent of anemia and VAD within the specified population and to examine the breastfeeding patterns associated with the deficiencies. Results documented in the first manuscript indicate that anemia does indeed occur in lactating mothers and more importantly in their infants, a majority of whom were under three months of age. Furthermore, risk of VAD in breastfed infants under the age of six months is considered rare, however our findings indicate otherwise. The factors associated with these nutritional profiles are explored in the first manuscript.

It is understood that nutritional deficiencies are a consequence of a complex set of issues and therefore influenced by a number of determinants. Biochemical indicators can not be used in isolation in the investigation of nutritional deficiencies of a population. A holistic understanding of the health determinants involved requires investigation of the sociocultural and economic influences existent within the specified population. Breastfeeding cultural attitudes, belief and practices as well as economic power are major indicators of a population's risk for nutritional deficiencies. Hence, the focus of the second manuscript is a discussion of the infant feeding practices of the breastfeeding mothers as well as the determinants influencing some of their feeding choices, taking into consideration the context of the women's socio-economic environment.

Chapter 4, manuscript 2.

BREASTFEEDING PRACTICES, BELIEFS AND ATTITUDES OF XHOSA MOTHERS FROM A PERI-URBAN COMMUNITY IN CAPE TOWN.

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4.1 ABSTRACT

This study was undertaken to investigate the breastfeeding practices, beliefs and attitudes of peri-urban lactating mothers with infants under six months of age. In total 115 Xhosa speaking lactating mothers and their infants (n=117) participated in the study. Our findings indicate a mostly primparous (48%) population of mothers with mean age of 26 and 62% of infants under the age of 3. Seventeen percent of the mothers lived in shacks, 56% in hostels (56%) and 27% in formal homes. These were overcrowded dwellings, where 50% of the homes had a single room, housing 3 to 6 individuals per dwelling. Furthermore, a majority of households (58%) did not have piped water. Only 12.4 % of the mothers were employed even though most (87%) had received some level of formal education. Health benefits was the number one reason for mothers to breastfeed. Hospital practices promoted breastfeeding initiation soon after birth with non of the mothers reporting use of prelacteal fluids nor additional fluids while in hospital. Close to all (90%) of the mothers fed their infants colostrum. Demand feeding was practiced with more than a third of the mothers reporting breastfeeding their infants > 15 times per 24 hour period. Water was fed to infants daily by 90% of the mothers, while 42 % of the mothers discarded a little breast milk prior to some feeds. There were no exclusively breastfed infants in the entire sample instead, complementary (mixed feeding) was the most favoured (78%) feeding mode. Weaning foods were given to 32% of infants ≤ 1 month of age with 33% of infants receiving breast milk substitutes (Subs.) at the same age. Perceived inadequate production of breast milk was the most common (90%) reason cited for introduction of Subs. Galactagogue use was not common (3 /115) however, use of traditional infant herbal preparations (*muthi*) was highly valued with 52% of infants receiving muthi. Our data illustrates the strong influence of culture and social beliefs on breastfeeding practices.

4.2 INTRODUCTION

Breast milk is perfectly suited for a newborn, hence exclusive breastfeeding (EBF) for the first six months of a child's life is considered to be the gold standard for nourishment and protection from infections (UNICEF 1998). Not only is breastfeeding beneficial for a child's health status, but the benefits extend to the lactating mother, providing advantages such as child spacing, minimization of postpartum bleeding, emotional and psychological advantages (Cunningham *et al.* 1981).

Diarrhea, acute respiratory infections and malnutrition are major contributors to morbidity and mortality of infants in South Africa (Fincham *et al.* 1993). Exclusive breastfeeding, defined as a feeding pattern whereby the infant is receiving all fluids, energy and nutrients via breast milk is strongly associated with positive infant morbidity and mortality outcomes (WHO/UNICEF 1998). Current South African infant feeding recommendations advocate EBF for the first six months of an infant's life, however it is believed that the actual practice of EBF is uncommon (Westphal *et al.* 1981, Ross et al. 1983). Nationally, the incidence of breastfeeding is highest in the African population, with a greater prevalence in the rural community (91%) than in urban areas (83%) (Rossouw & Jansen 1990). However, most infant feeding studies indicate that approximately 35-50% of lactating women discontinue breastfeeding before 3 months postpartum and that introduction of complementary foods is a common practice, sometimes occurring as early as 6 weeks of age (Styen *et al.*1993, Ross *et al.* 1983, Richter 1989). Poor sanitation and nutritional quality of weaning foods plus a host of other complex factors are associated with life-threatening infant health problems that can be attributed to the early introduction of solid foods and to inappropriate breast milk substitute feeding (Cunningham 1979).

Studies describing the breastfeeding patterns and behaviours of South African lactating women from a peri-urban, potentially vulnerable ecological setting are scarce. The current study was undertaken to address this gap in knowledge. Keeping in mind that feeding practices are strongly influenced by cultural and social beliefs (Dudley *et al.* 1997, Dettwyler & Fishman 1992), our study was designed to investigate the overall breastfeeding beliefs, attitudes and practices of peri-urban mothers with infants under six months of age. Examination of these traditional and cultural values furthers our understanding of how such determinants impact on infant feeding practices.

4.3 SUBJECTS and METHODS

Study area

Langa, the selected study site is one of the oldest and more established townships, a legacy of the South African apartheid system, settled over 60 years ago. Located on the outskirts of the Cape Town metropolis, this peri-urban community has a population of 46,505[1] mostly Xhosa-speaking Africans. Elementary occupations, service and trade are the main areas of employment for the majority of the work force with much of the employed population earning less than R1000 (approximately $120.00 US) per month. Langa is composed of both formal and informal housing with a substantial segment of the population (approximately 5500) living in informal homes (shacks). Paraffin is a major source of fuel and lighting, however a large component of the population depends on candles for lighting and outdoor fires for cooking. Most people have access to a flush or chemical toilet or a pit latrine with water access varying between piped water in homes, piped water on site or communal taps. Although a majority of the refuse is removed by local authority, there is still a large proportion of dwellings without disposal systems.

Study design

All eligible women attending the community clinic were approached to participate in the study. The study took place between August and November 2000 and consisted of personal interviews of lactating mothers plus biochemical and anthropometric measurements of the mother infant pair. The scope of this paper will be limited to a discussion of the questionnaire data.

Study population

Breastfeeding mothers were eligible if their infants were full term healthy babies ($\geq$ 2500 g), currently breastfeeding and between the ages of 1 to 6 months with no recent history of illness. Additionally, the mother infant pair were eligible for the study if there was no prior history of vitamin/mineral supplements use, important since micronutrient measurements were also conducted for other components of the study.

The study was fully explained in Xhosa (native language of the mothers) and signed consent was obtained from all the women participating in the study. A total of 115 mothers and 117 infants (two sets of twins) participated in the study. Ethical approval for the study was obtained from both McGill University Research Ethics committee in Canada and from University of Cape Town, Medical School, South Africa.

Questionnaire development

Using the data collection guidelines from WHO (1981) for breastfeeding research as a foundation, a structured questionnaire consisting of 23 (plus sub-sections) open and closed ended questions was developed. This survey tool was designed to gather information on the lactating mother's beliefs, attitudes and practices regarding breastfeeding in addition to overall infant feeding behaviour. Socio-demographic information was also collected; The questionnaire took 20-25 minutes to administer.

Prior to study implementation a focus group composed of a representative sample of mothers was conducted to field test the questionnaire and solicit input on the development of the survey instrument. A trained Xhosa speaking field worker conducted the interviews of the mothers.

Data analysis

All descriptive and correlation (Pearson) analyses of data were conducted using SAS system for windows version 8.0 (SAS Institute Inc. Cary, NC). WHO (1997) recommended breastfeeding categories were used to classify infant feeding.

[1] 1996 Census data from Urban Policy Unit: Statistics South Africa.

4.4 Results

Socio-demographic characteristics of subjects

More than half of the 115 subjects participating in the study lived in dwellings classified as hostels, while 18% lived in shacks (**Table 4.1**). Half of the mothers reported living with ≤ 6 individuals in their homes with many (50%) having only one room in their dwelling. Slightly more than a quarter of the mothers were newcomers to Cape Town with 33% having been in the area longer than 3 years. Analysis of available amenities indicated that while 69 % of the subjects had access to electricity, 58% did not have piped water in their homes. Of those without a home based source of water, 55% used communal taps for their water source. Furthermore, a large proportion of our subjects (61%) did not have toilet facilities inside their homes.

The mean age of the mostly primiparous (48%) lactating mothers was 26, the youngest mother being almost 15 years of age. Only 12.4 % of the mothers were employed with 5 % still attending high school. Although a small percentage (3%) of the mothers had not pursued any schooling, most mothers had however received some level of education.

Infant subjects had healthy birth weights ranging from 2500 to 4400g with a mean current weight of 6.19 kg. The average infant age was 2.8 months, with 62 % between the ages of 1 and 3 months. Almost all infants were born in a maternal obstetric unit (MOU) or hospital (98%), with only 2 home deliveries reported. Three quarters of the deliveries were vaginal.

Breastfeeding and postpartum practices

Of the mothers delivering in MOUs or hospitals, 88% initiated breastfeeding soon after delivery (within 1-2 hours) (**Table 4.2**). None of these women used prelacteal fluids, however the two women who delivered at home reported giving 'traditional' ritual fluids to their newborns prior to initiating breastfeeding. Additional fluids (i.e. glucose, water) were not given to the breastfed infants while in the MOU/hospital setting. Two mothers reported being discharged from hospital with samples of breast milk substitute.

Breastfeeding patterns

There were no infants who were currently exclusively breastfed (EBF) in the entire sample (n=117). The breastfeeding patterns that were reported by the mothers encompassed two of the WHO (1997) breastfeeding practices categories, namely predominant (22%) and complementary breastfeeding (78%). The complementary breastfeeding category was further sub-divided for clarification of feeding styles into breast milk plus solid food (BM + S), breast milk plus solid food plus breast milk substitute (BM + S+ Subs) and finally breast milk plus breast milk substitute (BM + Subs). Analyses of feeding pattern for the predominantly breastfed group indicated that in all cases infants received breast milk with water being the only other fluid provided. The proportions of infants within each complementary feeding subgroup were 15 % BM + Subs, 27 % BM + S and 37% BM + S + Subs.

As an indication of the frequency of breast feeds, mothers were asked to report the number of times they breastfed their infant within specified time increments, over a 24 hour period. The highest breastfeeding frequency (>15 times) within 24 hours was reported by 37% of the mothers while 29 % of the mothers breastfed their infants 10 or less times per day. Giving infants additional water was another common feeding practice with 90% of infants receiving water on a daily basis. Infants receiving water once a day made up the largest proportion (43%) while 37% drank water twice per day and 20% greater than two times a day.

Asked when they intended to discontinue breastfeeding, 21% of the mothers did not specify an infant age but stated that they plan to stop breastfeeding when they perceive that their infants are either ready or no longer interested in breastfeeding. Sixteen percent plan to discontinue by the time their infants are a year old and 32% wish to breastfeed their infants up to the age range of 18-24 months. Furthermore, 22% of the mothers plan to breastfeed their infants past the two year mark with one mother reporting an intention to breastfeed her baby to the age of 5.

Forty three percent of the mothers stated that they would ensure that their babies were healthy and "old enough" prior to breastfeeding cessation. Lack of infant interest in breast milk would be a determining factor for breastfeeding discontinuation for 29% of the mothers. Mothers returning to school or work and a child being old enough for table foods were other reasons cited. None of the mothers identified an external source of pressure (i.e. spouse, extended family members) to discontinue breastfeeding their infant.

Complementary foods use

Early introduction of complementary foods was common with a large proportion (32%) of infants being initially given weaning foods at about 1 month of age; similarly intake of breast milk substitute was initiated for 33% of the babies within the same age range. The earliest introduction of weaning foods was reported in an infant 2 days of age. A positive significant correlation existed between the age breast milk substitute was introduced and the amount of substitute fed ($r = 0.64$, $p < 0.001$).

Commercial infant cereal, the most common weaning food offered to infants, was most frequently fed 2-3 times per day. A small percentage of the infants received homemade traditional (*pap*) cereal based gruel (**Table 4.3**). Most women (81%) mixed infant breast milk substitute with infant cereal, thus indicating that the substitutes were not primarily used to feed an infant but instead to mix with cereal and secondarily as a supplement to breastfeeding. In some cases water was used to mix the infant cereal, with only one mother reporting use of expressed breast milk to mix infant cereal.

Perceived inadequate production of breast milk and consequently a desire to supplement breast milk was the most prevalent (90%) reason given by the mothers for using breast milk substitutes. Starting a job or going back to school as well as a perception that the baby was unsatisfied were the other reasons reported for using breast milk substitutes. When families using breast milk substitute were unable to purchase the product, a variety of alternative fluids were given to the infant instead. These include ultra high temperature pasteurized milk (UHT), water and sugar mixture, juice from a traditional meal called *Samp* (*nembe*) or plain unmodified pasteurized cow's milk. However, close to half (43%) of these mothers said they would simply breastfeed more when they ran out of money to purchase breast milk substitute. Other foods given to infants included bananas, butternut squash mixed with potatoes (or either item on it's own), homogenized or 2% milk, yoghurt and fruit drink.

Reasons for breastfeeding

The most popular reason mothers reported for selecting breastfeeding as the preferred choice of infant feeding were the health benefits. The other frequently cited reasons are listed in **Table 4.4.** When asked who influenced their decision, 70% of the mothers identified nurses. Quoted, less frequently were family members such as aunts and mothers-in-laws. The table also indicates responses for what the mothers enjoyed about breastdfeeding, again infant health and growth benefits were the most popular reasons. Mothers also stated that another advantage of breastfeeding is how quickly an infant recovers form illness when they receive breast milk and that it was easier to comfort a crying child by breastfeeding them.

In an attempt to identify barriers to breastfeeding, mothers were asked to indicate what they found difficult about breastfeeding, 87.5 % did not identify any dislikes or disadvantages of breastfeeding. The remainder stated challenges including situations like not being able to leave their babies at home for someone else to feed, complaints of not having achieved or realized any weight loss associated with breastfeeding and experiencing sore nipples. Most (93%) of the women did not feel they ever needed any assistance with breastfeeding. Those experiencing breastfeeding problems listed low milk production as the most common concern, followed by establishing a proper latch when initiating lactation. When asked who they used or would use for advice and assistance with lactation problems, 91% identified staff (nurses, physicians and health educators) at the local clinic or hospital. Traditional healers, their mothers and grandmothers were the other people mentioned.

Beliefs and practices

Colostrum was fed to all the MOU/hospital born babies with a high percentage (90%) of the mothers breastfeeding their infants on demand as opposed to scheduled breast feeds. Discarding of a small amount of breast milk prior to each breast feed was practiced by 42% of the mothers. Reasons for this behaviour were many including mothers being told, usually by a family member, that culturally they must discard a little milk if they have been outside their homes as a means of ridding their milk of "anything" they may have come in contact with (55%). Milk 'sitting' in a breast for some time was believed to be stale and to posses germs by some (14%) while others felt that expressing a little milk allows the mother to see that she indeed has milk and what the appearance of the milk is (10%). A smaller percentage (8%) of mothers specifically stated that discarding milk after having been outside will rid the breast milk of any evil spirits the mother may have come in contact with. Women who did not discard breast milk (n=38) reported that they wipe their nipple/areola area with a wet cloth prior to each feed as a general hygienic practice.

To further understand infant feeding beliefs, a hypothetical scenario was posed to each mother, asking in their opinion whether an infant 0-4 months is able to grow and be healthy with (i) breast milk alone, (ii) breast milk plus substitute and (iii) substitue alone. Responses indicated that all mothers (100%) believed that an infant can thrive on breast milk alone, 94 % believed that babies can also thrive on a combination of breast milk plus substitute while 97% of the mothers felt that an infant cannot thrive on substitute alone.

Use of traditional medicines

Investigation of herbal product use indicated that galactagogues were not commonly used by the lactating women. The 3 mothers using products to increase breast milk production all used different substances (**Table 4.5**). However, practices differed in the case of herbal product use for infants with 52 % of the infants receiving some form of herbal mixture for getting rid of 'wind'. Of these infants, 79% received a traditional herbal mixture (***muthi Wenyoni***), generally from a traditional healer (*Inyanga or Sangoma*) and a few from a 'community chemist', who in this case was a woman with a nursing background. Mothers also purchased ready made herbal mixtures from pharmacies.

Of the infants receiving traditional herbal mixtures, 56% received the preparation by one month of age, with two mothers reporting that they gave their infants *muthi* at 1 and 3 days of age respectively. The length of time the mixture was given to an infant ranged from 2 weeks of age to an intended 4 years, a few infants (18) receiving the mixture 'until the bottle is empty'. No significant relationships were found between intake of infant traditional preparations and any of the maternal or infant parameters or socio-demographic characteristics.

4.5 Discussion

As with many other parts of the world, South Africa is experiencing rapid urbanization. Projections for the year 2010 have estimated that 70% of the population in South Africa will be urbanized, affecting mostly the African population (Bourne *et al.* 1994). Families migrating from rural areas into large cities in search of a better life are often met with extreme hardship and poverty. Consequently, these families are often forced to live under poor housing conditions in peri-urban areas located usually on the outskirts of large metropolitan areas. Segel *et al.*(1994) found that parents or caretakers of children living under these conditions were more likely to indicate that they were too poor to feed their children adequately compared to their urban counterparts living in formal housing.

In order to develop an understanding for the underlying determinants of breastfeeding selection and behaviour in peri-urban African women, we carried out a study examining the cultural beliefs, attitudes and practices of lactating Xhosa women residing in Langa, a settlement of Cape Town. A similar study for lactating mothers with infants all under six months of age, a particularly vulnerable age for morbidity and mortality, has not been published.

It is important to examine the ecological factors that may contribute to a populations' risk for a compromised health status. We found that more than half of our subjects were not Cape Town residents, many coming from rural communities and ending up in Langa. Peri-urban settlements are often considered transitional communities for newcomers, consequently the mothers in our study came from diverse housing backgrounds with the majority residing in hostels or shacks. Although hostels can be an improvement from a shack home, this is not always the case as evidenced by our findings which indicated that access to basic amenities is often equally poor in both types of dwellings.

Strong evidence indicates the protective effect of EBF in an infant's life, especially in developing countries where childhood infections can lead to increased mortality rates. Breastfeeding has been shown to be associated with lower morbidity and mortality rates as well as milder forms of illnesses, for shorter periods of time (Cunningham *et al.* 1991). Breastfeeding literature indicates that for infants under six months of age, the median relative risk of death was 25 when comparing EBF babies to their non-breastfed counterparts. Comparisons with partial breastfeeding showed a relative risk of 8.6 (Feachem & Koblinsky 1984). Overall, the benefits of breastfeeding have been found to have their greatest impact during the first six months of an infant's life with some evidence that the advantages can last into the second year (WHO/UNICEF 1998).

Current South African infant feeding recommendations suggest EBF (breast milk only) for the first six months of an infant's life followed by the addition of appropriate nutritious complementary foods and continued breastfeeding up to the child's second year of life (Department of Health, 2000). Although breastfeeding initiation rates in South Africa are high (estimated well above 80%), exclusive breastfeeding is an uncommon practice amongst mothers. Our data confirmed that EBF is indeed a rare practice, with none of the infant subjects being exclusievly breastfed. In general mothers seemed to find it an alien behaviour to give only breast milk to their infants, although theoretically they approved of EBF.

The Baby-Friendly Hospital Initiative (BFHI), an international program of WHO/ UNICEF (1992) advocates that hospitals practice the use of *Ten Steps to Successful Breastfeeding* , guidelines that help to create an environment conducive to the promotion, protection and support of breastfeeding. From the mother's report of their postpartum experiences in the MOUs and hospitals, it seems that certain procedures suggested by the above document are in place in some hospitals. Mothers were encouraged to breastfeed in the immediate postpartum period with prelacteal and additional fluids being discouraged, all procedures that assist the breastfeeding initiation process. In contrast, the mothers with home deliveries (2/115) did provide their infants with prelacteal fluids prior to initiation of breastfeeding. This observation suggests that although prelacteal feeds may be a cultural practice, mothers delivering in the hospital seem comfortable omitting this tradition. Two mothers did report that they were discharged from the hospital with samples of breast milk substitute, both for reasons they were unaware of.

Demand feeding is also encouraged by BFHI guidelines; we found that most mothers fed their infants on demand, a practice that promotes increased breast milk production since milk volume is determined to a large extent by infant demand (Dewey *et al.* 1991). Demand feeding as opposed to scheduled feeding also minimizes risk for breast engorgement or nipple soreness (Auerbach & Riordan 1993).

Our examination of breastfeeding patterns indicated that mothers were well aware of the benefits of breastfeeding with healthy and fast growth being the most valued perceived attribute of breastfeeding. The most prevalent intended duration for breatfeeding was 18-24 months, a range close to the nationally recommended duration of 2 years of age. Child-lead weaning, an often recommended method of infant weaning, was also quoted as determining lactation duration for 21% of our mothers.

Although breastfeeding prevalence is highest in the African segment of the South African population, an increasingly urban lifestyle can lead to alterations in traditional behaviour. Indeed, there is an emerging trend towards lower breastfeeding duration rates coupled with early introduction of complementary foods (Steyn 2000). This shift in infant feeding practices also leads to increased use of breast milk substitutes which some women view as prestigious, a sign of affluence and a superior method of feeding a child (Williams *et al.* 1986). Obviously this is a dangerous trend, since appropriate feeding of substitutes requires financial stability. Consequently, breast milk substitutes are often over-diluted to help extend the amount of substitute available to a child, a practice that often leads to growth failure and illness. On the positive side, our study indicates that the younger the infant is when introduced to breast milk substitutes the smaller the quantity of substitute. Also, it should be pointed out that our findings indicate that many (43%) of the mothers practicing complementary breastfeeding reported that they breastfeed their infants when they run out of financial resources. Some mothers reported using a myriad of liquids when they found themselves in a similar situation.

The optimal time for introduction of complementary foods into a breastfed infants diet is currently a hotly debated issue. However, it is believed that infants attain physiological maturation at around 4 to 6 months of age, a period that is considered appropriate to add foods other than breast milk (WHO/NUT 1998).

Our data indicates that three quarters of our sample of Xhosa mothers chose to combine breastfeeding with addition of complementary foods and fluids (mostly breast milk substitute). Early introduction of complementary foods was disturbingly common since close to a third of the complementary breastfed infants received weaning food at one month. Even with such a feeding pattern, many mothers still reported a high frequency of breastfeeds, which may very well be the case since documentation of infant care practices of mothers indicate that a child will often be placed on the breast not only for feeding purposes but also as an integral part of infant care (when crying, fussy) behaviour (Richter 1994).

Besides infant cereal, fruit and milk and dairy products were offered to the babies. The milk is of particular concern given that introduction of foods took place at a young age for many infants. Infants in this age range are too young to receive unmodified cow's milk, which can contribute to anemia since iron in this type of milk is not bioavailable (Mills 1990). Furthermore, intake of other foods has been shown to displace the amount of breast milk received by an infant even when feeding frequency is controlled for as was the case for young breastfed Thai infants who were also receiving complementary foods (Drewett *et al.* 1993). Moreover, in developing countries, early introduction of complementary foods poses a significant health risk for children. It has been found that infants who are fed these foods, including breast milk substitutes, are at increased risk of exposure to high pathogenic loads, due to sanitation factors. The infections arising from contamination of weaning foods have been identified as a major influence of under-nutrition in children living under low socio-economic conditions (Savage King & Burgess 1993).

A majority of the mothers using weaning foods did so as a means of supplementing breast milk, most holding the belief that breast milk was not enough to satisfy their infant. This belief was also evident when mothers were asked to select the optimal feeding practice within a scenario setting, with both EBF and breast milk plus breast milk substitute chosen by most of the mothers. Interestingly the mothers unanimously agreed that an infant can thrive with EBF, a contradiction to their reported practice since EBF was not practiced by any of the mothers. Concern over inadequate milk production and the belief that breast milk alone is an insufficient source of energy for a growing child is a common belief of lactating women throughout the world (Dettwyler & Fishman 1992, Van Steenbergen *et al.* 1984). However, in an extensive review of current breastfeeding literature, there was no growth advantage found to complementary feeding of breastfed infants prior to six months of age, even though weaning foods may increase total energy intake to some extent (WHO/NUT 1998).

The mothers strongly believed in giving their breastfed infants water frequently, a practice that may contribute to breast milk displacement and subsequently interfere with milk production. Water, depending on the sanitation conditions may also be a source of contaminants for the infant. Additional intake of fluids is not necessary in breastfed infants, studies having indicated that EBF infants can meet their fluid requirements even in hot climates (Brown *et al.* 1986).

This study also provided data on how traditional and cultural beliefs of lactating Xhosa women impact on practices surrounding the process of breastfeeding. South

African beliefs regarding use of colostrum are not clearly understood, since they change from cultural group to group. We found that feeding colostrum (*mtubi*) was a respected tradition of the Xhosa women from this area of the country and therefore most of the breastfed infants were recipients of the numerous nutritional and immunological benefits of colostrum. Cultural beliefs also influenced the practice of discarding milk prior to feeding, which was performed by a significant proportion of the mothers. This practice does not seem contraindicated during lactation since only small amounts are discarded. Unfortunately, wiping the nipple prior to feeding an infant removes some of the natural oils on the areola and may contribute to nipple trauma.

The use of galactagogues to promote increased breast milk production during lactation is a common practice globally (Baumslag 1987). Even though there seemed to be a great deal of concern over milk production, galactagogues were not used in our population of lactating mothers. Our data does however, indicate that traditional healers are highly valued providers who were often consulted for the procurement of traditional preparations (*muthi*) for infant use. All mothers using infant muthi used it to resolve infant colic like symptoms, referred to as 'wind' problems. Duration of infant herbal mixture use varied with some mothers indicating that they plan to use the herbal product for a period well beyond the time a child would typically suffer from abdominal cramps. Therefore one suspects that the mixtures may be taken for other beliefs not identified by our mothers. In South Africa use of traditional herbal preparations and consulting traditional healers is common during pregnancy and lactation, even though some people are reluctant to discuss their use of traditional medicine for fear of being judged or discouraged by conventional health professionals (Varga & Veale,1997).

It was surprising to find that a large number of mothers stated that their decision to breastfeed was influenced by nurses at the clinic during the prenatal period and that most mothers would look to health staff at the clinic for help to resolve any lactation problems experienced. We expected a greater proportion to identify family members as sources of lactation advice and assistance. Such a finding should be capitalized on for program delivery purposes.

In summary, our study investigated the traditional and cultural beliefs, attitudes and practices of lactating Xhosa mothers from a peri-urban community of Cape Town. Exclusive breastfeeding is not practiced within this community. Rather there is a strong preference for breastfeeding with early addition of complementary foods, this is of concern given that infants under six months of age are particularly vulnerable to increased morbidity and mortality risk. Nonetheless, it is noteworthy that these Xhosa mothers also had breastfeeding practices that contribute to their infant's health such as the feeding of colostrum, breastfeeding frequently and on demand. Most mothers seem to have a desire to breastfeed for a long duration.

Our data provides insight into how cultural beliefs and attitudes influence breastfeeding practices and that breastfeeding and overall infant feeding is a multidimensional process with many determinants impacting on the behaviour. Furthermore, information from these findings can be utilized to guide the planning of culturally acceptable breastfeeding promotion and infant feeding messages that are targeted at women of child bearing age.

Table 4.1: Housing characteristics of study subjects from a peri-urban community of Cape Town. (n = 115)

	Numbers
Number of years in Cape Town[1]	
Born in Cape Town	14 (22)[2]
≤ 1 yrs	17 (27)
1 ≤ 3 yrs	11 (18)
> 3 yrs	21 (33)
Accommodation type:	
Hostel	64 (56)
Shack	20 (17)
Formal	31 (27)
Number of people per dwelling:	
≤ 3	37 (32)
>3 ≤ 6	57 (50)
>6	21(18)
Number of rooms per dwelling[3]	
1	31 (50)
2	9 (15)
3	12 (19)
> 3	10 (16)

[1] n= 63, information was not obtained for all subjects
[2] figures in parenthesis represent percentages
[3] n=62, information was not obtained for all subjects

Table 4.2: Postpartum procedures for 111 lactating mothers delivering in MOUs[1]

Postpartum procedure	Percentage
Bf immediately after birth	88
Prelacteal fluids	-[2]
Additional fluids Discharged with Subs.	- 2

[1] MOU Maternal Obstetric Unit

[2] None of the mothers

Bf = breastfeeding

Subs = breast milk substitute

Table 4.3: Complementary foods and breast milk substitute feeding practices for breastfed infants 1-6[a] months of age. (n = 115)

	Percent
Introduction of complementary foods (mos)	
≤ 1	32
>1≤ 3	24
>3 ≤ 6	9
not giving weaning foods	35
Complementary foods used	
Commercial infant cereal	96
Homemade gruel	4
Frequency infant fed complementary food	
1x/ day	16
2x/day	39
3x/day	41
> 3x/da	4
When infant first receives Subs. (mos)	
≤ 1	33
>1≤ 3	17
>3 ≤ 6	1
not given Subs	49
Amount Subs. given	
≤ 125 ml	20[b]
>125 ml ≤ 250 ml	19
>250 ml ≤ 375 ml	5
>375 ml	7

[a] n=117

[b] Does not add up to 100% since 49% of infants were not receiving breast milk substitute.

Subs = breast milk substitute. Mean maternal weight = 70.7 ± 12.8 kg, mean maternal height =1.54 ± 0.21m.

Table 4.4: Reasons for breastfeeding, key persons in decision to breastfeed and identification of reasons breastfeeding is enjoyable for lactating Xhosa women

Reasons	**Frequency** (n = 115)
Why choose to Bf infant	
Nutritious and healthy	32
Just chose to (no specific reason)	25
Suggested by nurses	25
Cheaper	10
Enjoy breastfeeding	11
Prevents diseases	9
Who helped with decision to Bf	
Nurse	81
Own decision	30
Mother	4
What mother likes about Bf	
Good and healthy for baby	60
Helps baby grow quickly	19
Prevents disease	13
Closeness and bonding with baby	12
Baby likes it	12
Convenient and always ready	8
Cheap	7

Bf = breastfeeding

Table 4.5: Numbers of lactating peri-urban Xhosa mothers and types of galactagogues and infant traditional medicines used

	Frequency
Galactagogue use by mothers	3
Types:	
Ginger beer	
RooibOos tea	
Pharmaceutical agent	
Infants given traditional medicine	61
Types:	
Entrence[a] plus *Behoedmiddel,*	
Rooilavental + *Groenamaar mixture*	
From pharmacy.	
Mix "*muthi Wenyoni*"[b]	
From traditional healers	
Gripe water	
Age infant received traditional medicine (mos)	
≤ 1	34
> 1 ≤ 3	21
cannot recall	6
did not use	56

[a] Commercial product
[b] Mixture with unspecified content.

Table 2.1: Recommended [1] cut-off values for hemoglobin concentration by age category.

Age category	g/L
6-59 months	110
5-11 years	115
12-14 years	120
Non-pregnant	120
Pregnant woman	110
Adults males	130

[1]UNICEF, UNU and WHO recommend the use of the above cut-off points to define anemia within each age group.
Source: ACC/SCN 2000

Table 2.2: Some common iron status indices and their interpretation

Indices	Indicates
Hematocrit	Volume portion of packed RBC[a], decreases once hemoglobin production is deficient.
Mean Cell volume (MCV)	Measure of the average size of the RBC, only decreases when iron deficiency is severe.
Mean cell hemoglobin (MCH)	Indicates hemoglobin concentration of individual RBC, relatively greater decrease of MCH than MCV in severe IDA[b] situation.
Mean cell hemoglobin concentration (MCHC)	Refers to concentration of hemo-globin in RBC, last to decrease during iron deficiency.
Serum Transferrin	Iron transport protein, ID[c] results in increased transferrin synthesis hence elevated serum transferrin levels.

Source: Gibson 1990

[a] RBC Red blood cell

[b] IDA Iron deficiency anemia

[c] ID Iron deficiency

Table 2.3: Effect of lactating mother's intake and status on vitamin A and iron concentrations in breast milk

Nutrients affected by mother's status	**Nutrients not affected by mother's status**
Vitamin A	**Iron**
➢ Low maternal intake or stores decreases amount secreted in breast milk ➢ Breast milk concentration of nutrient can be improved by increased maternal intake ➢ Infant's stores of nutrient are low and easily depleted [1]	➢ Maternal intake and poor stores has little effect on amount secreted in breast milk ➢ Iron supplementation of the mother will benefit her and not the infant ➢ Mother's iron status will have no effect on amounts of iron required by infant from complementary foods

Source: Allen 1994

[1] Means that infant is dependent on receiving adequate amount of vitamin A from breast milk or from complementary foods

Table 2.4: Biochemical indicators and prevalence criteria[1] for Subclinical VAD

Cut-off	Mild	Moderate	Severe
Serum retinol ($\leq$ 0.70 μ mol/L)	$\geq$2% to <10%	$\geq$10% to <20%	$\geq$20%
Breast milk retinol ($\leq$1.05 μ mol/L)	<10%	$\geq$10% to <25%	$\geq$25%
RDR ($\geq$20%)	<20%	$\geq$20% to <30%	$\geq$30%
MRDR (ratio $\geq$0.06)	<20%	$\geq$20% to <30%	$\geq$30%

Adapted from World Health Organization 1994

[1] Prevalence below cut-offs define a public health problem and the level of importance.

RDR relative dose response.

MRDR Modified relative dose response

Table 2.5: Animal and plant food sources of vitamin A

ANIMAL SOURCES	*PLANT SOURCES*
Fish oils	***Tubers***
Halibut	Orange sweet potato
Shark	Yellowish Cassava
Cod	Yellow sweet potato and white cassava
Herring	
Mackerel	***Other vegetables***
	Carrots
Organ Meats	Butternut squash
Liver of sheep, ox	Dark green leaf vegetables
Kidney	Tomato
Beef, mutton, Pork	
	Fruits
Milk products	Mango
Margarine (fortified)	Paw paw
Butter	Apricot
Yellow Cheese	Orange
Eggs	
Milk	
	*Red Palm oil

Source: McLaren & Frigg 1997 and Ong & Tee 1992

Foods within each category are listed in descending order of retinol (animal sources) and ß-carotene (plant sources) content.

*Red Palm oil is an excellent source of ß carotene.

Table 2.6 : Vitamin A, hemoglobin and ferritin concentrations for children 6-71 months of age

Micronutrient	National (%)	Urban (%)	Rural (%)
Vitamin A[1] < 20 μg/dL	33.3	25.1	37.9
Hemoglobin [2] < 11 g/dL	21.4	20.7	21.1
Hemoglobin and Ferritin [3] Hb < 11 g/dL and Ferritin < 12 μg/l	5.0	5.4	4.6

Data from the South African Vitamin A Consultative Group (SAVACG)Study 1994.
[1] Vitamin A values refer to serum retinol concentrations
[2] Hb hemoglobin concentration , indicating level of anemia
[3] Ferritin and hemoglobin indicate level of iron deficiency anemia

Table 2.7: Anthropometic data for South African children aged 6-71 months

Indicator	National	Urban	Rural
Weight for height (%) (< -2 SD)	2.6	2.1	2.8
Height for age (%) (< -2 SD)	22.9	16.1	27.0
Weight for age (%) (< -2 SD)	9.3	6.9	10.7

Data from the South African Vitamin A Consultative Group(SAVACG) Study 1994.
Z scores indicating values less than 2 standard deviations (SD) from the norm using reference population data.

$$\text{Z scores} = \frac{\text{(observed value) - (median reference value)}}{\text{standard deviation of the reference population*}}$$

* Reference standards values from: National Center for Health Statistics (NCHS)

<-2 SD is categorized as moderately depleted
-2 to <-1 SD is mildly depleted
± 1 SD is normal
>2 SD is excessive
(De Onis et al. 1993)

Table 2.8: Infant feeding categories as recommended by the WHO

Feeding Pattern	**Infant receives**	**Infants *can* receive**	**Excluded**
Exclusive breastfeeding	Breast milk only includes expressed or wet nurse feeding.	Vitamin/mineral supplements, medicines.	Anything else
Predominant breastfeeding	Breast milk is major source of nourishment.	Fluids, ritual fluids and items as above.	Anything else non-human milk, food-based fluids.
Complementray breastfeeding	Breast milk and semi-solid or solid foods.	All foods or liquids.	
Breastfeeding	Breast milk.	All foods and liquids.	
Bottlefeeding	All liquids or semi-solid foods fed via bottle with nipple or teat.	All food or liquids, also allows breast milk by bottle.	

Adapted form Dettwyler and Fishman 1992

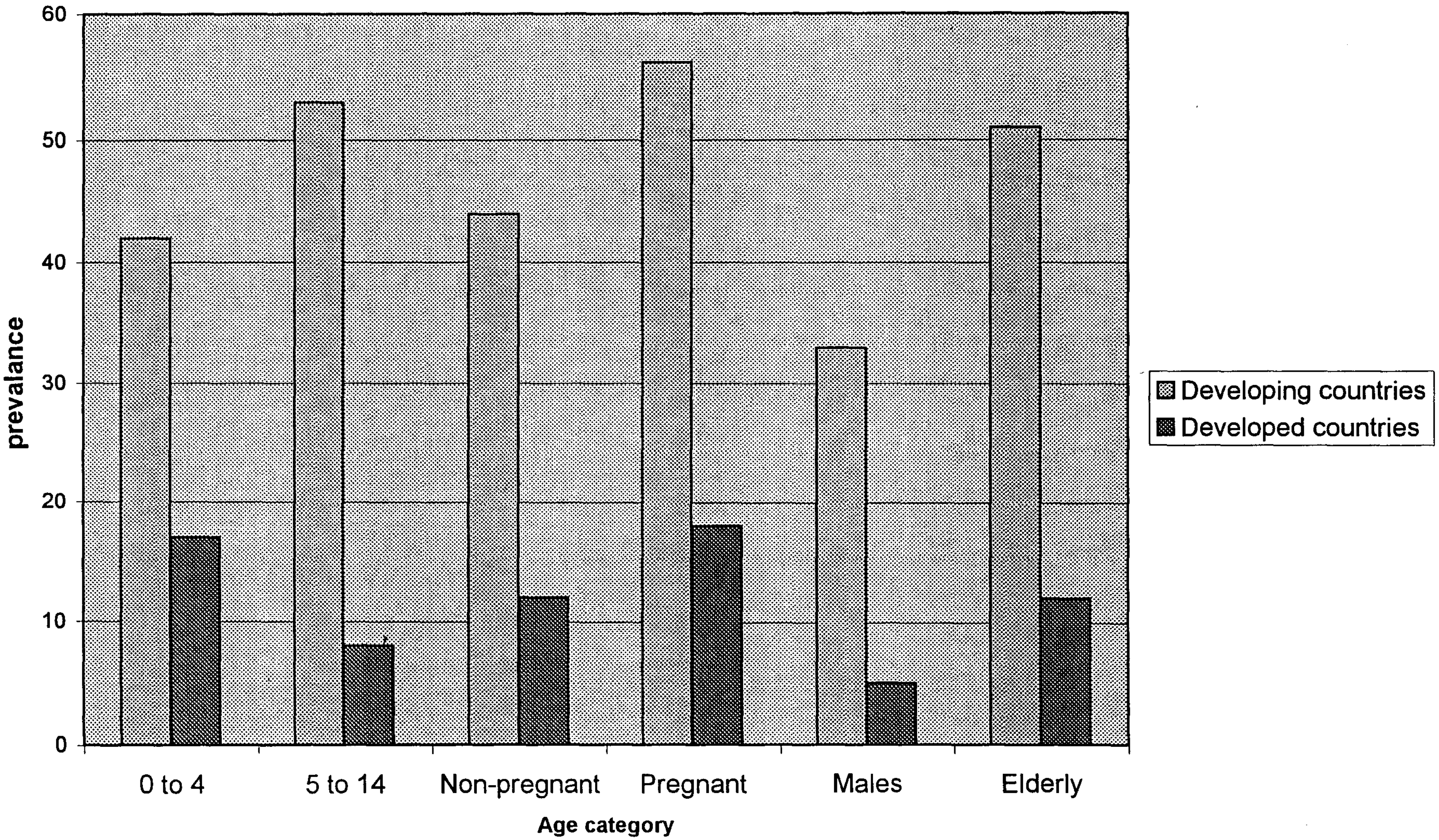

Figure 2.1: Comparing the prevalence of anemia in developed versus developing countries by age categogy, WHO 1998.

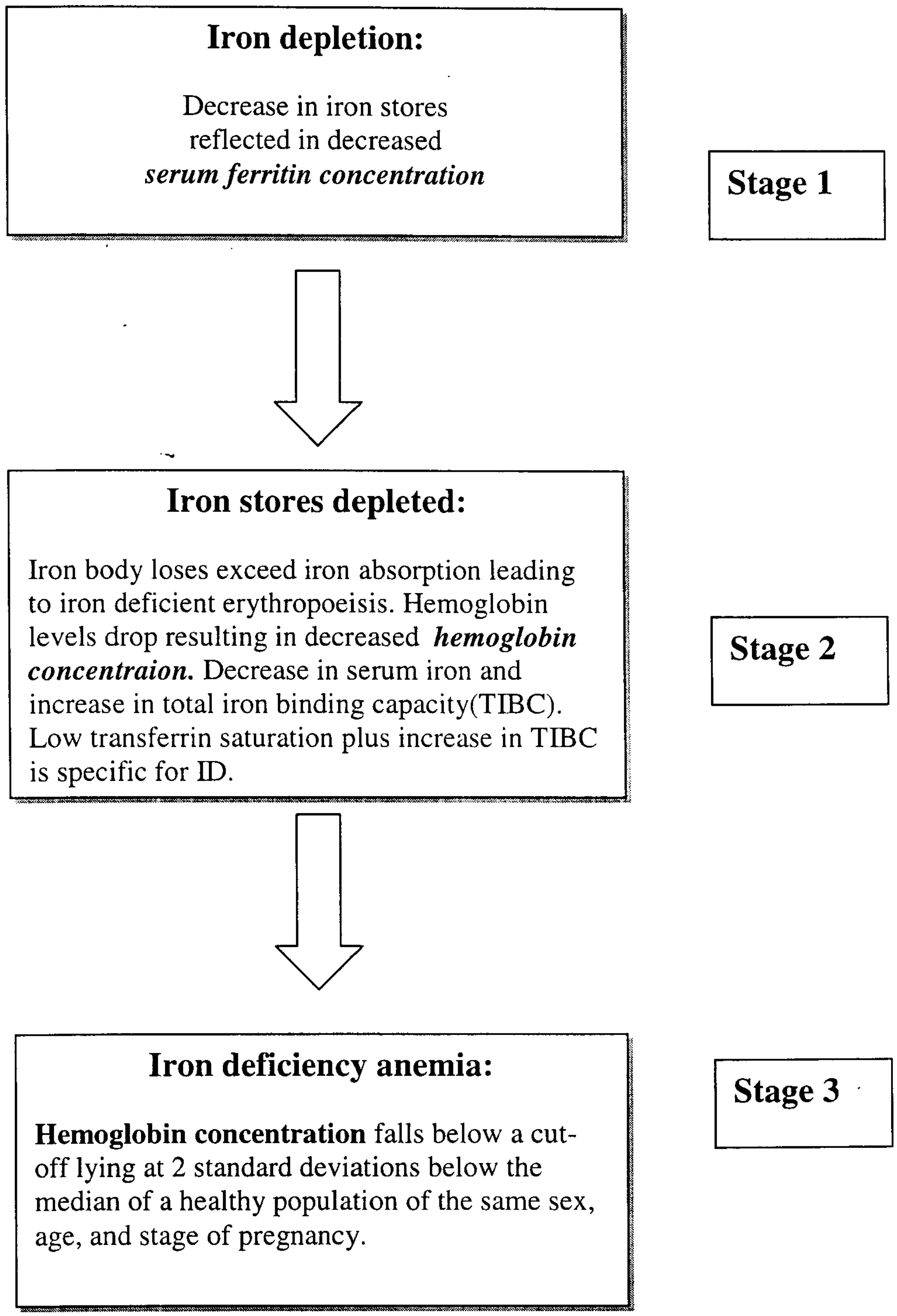

Fig 2.2: Describes the three stages involved in the development of iron deficiency anemia

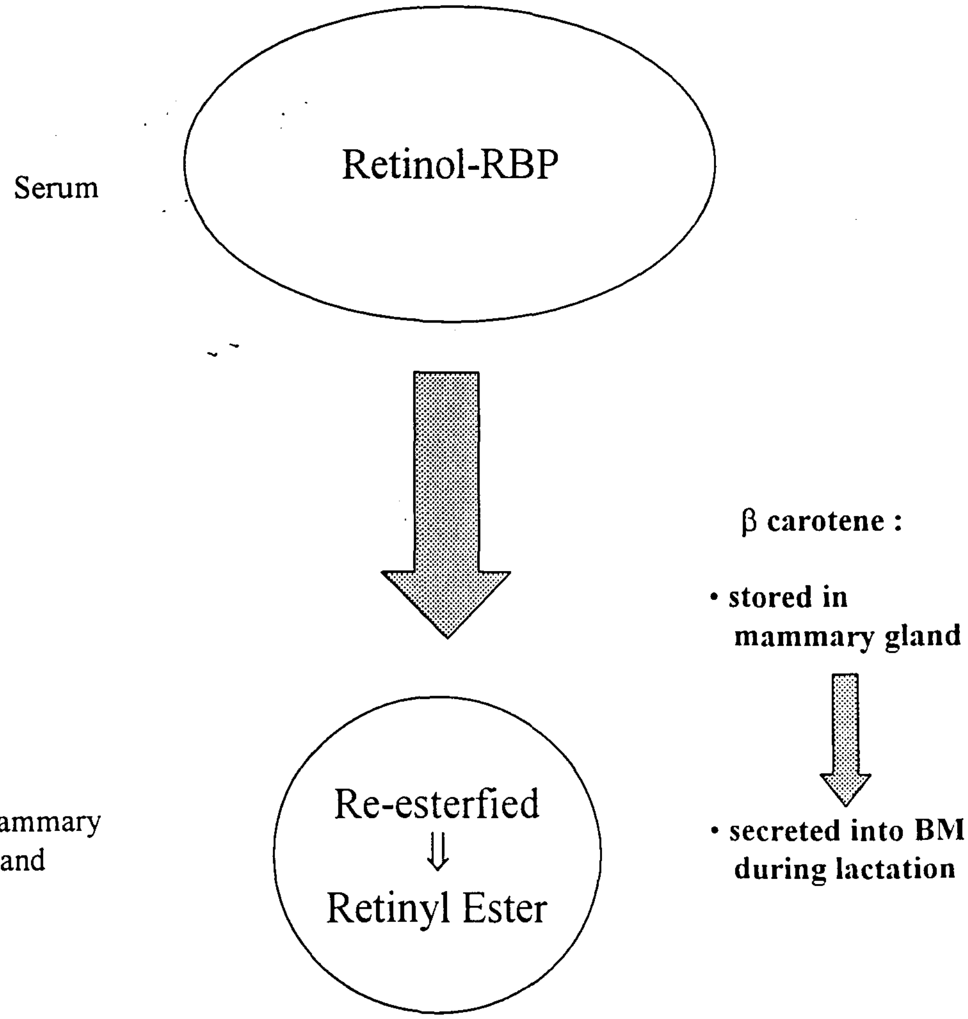

Figure 2.3 Schematic diagram illustrating the transfer of retinol from serum to mammary gland in the lactating mother. β **carotene** can be utilized directly from the mammary glands.

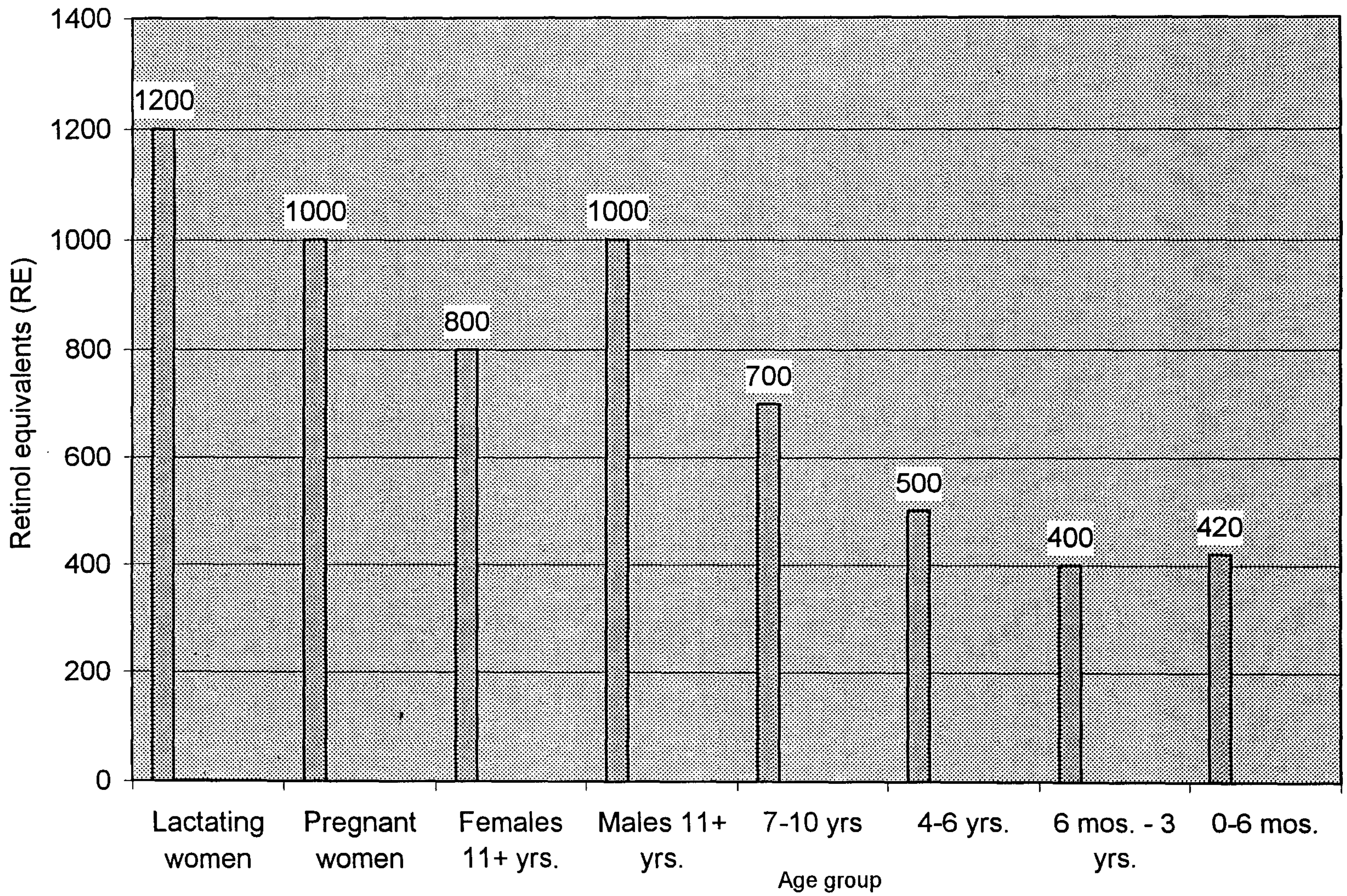

Figure 2.4 South African recommendations of daily requirements of vitamin A throughout the lifecycle. Department of Health, 1998.

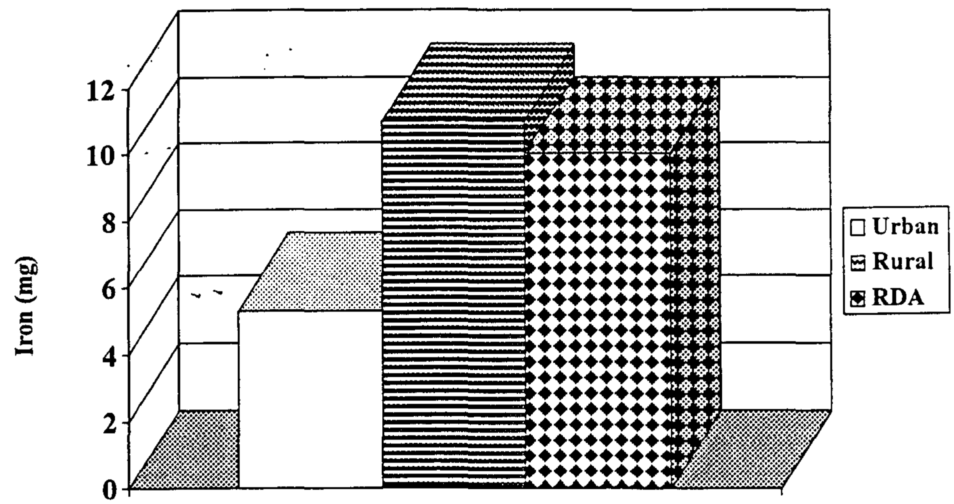

Figure 2.5: Daily iron intake in urban and rural children ages 2-6 years.

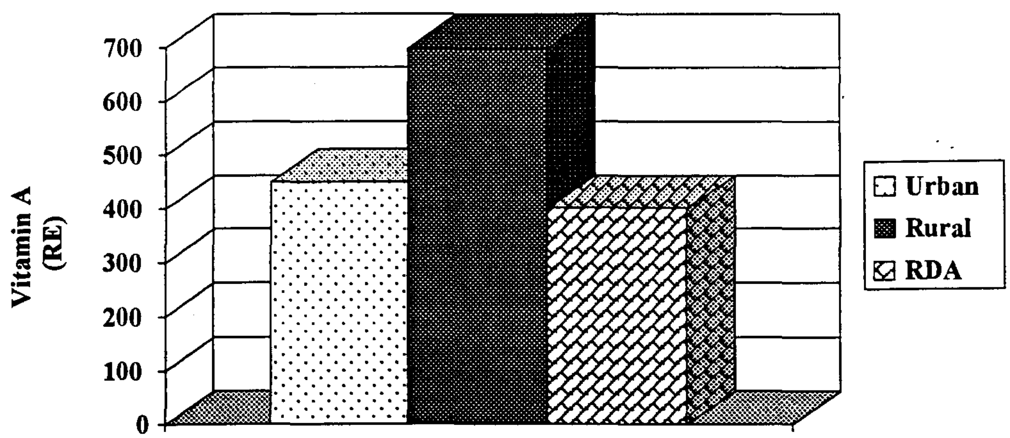

Figure 2.6 : Daily vitamin A intake of rural and urban children 2-6 years

GENERAL CONCLUSION

This study documents the nutritional status and feeding practices of the breastfeeding mother and young infant pair within the context of a resource poor and potentially vulnerable environment. To our knowledge ours is the first study focusing on hemoglobin and vitamin A status of lactating mothers and their infants, all between the ages of 1 and 6 months.

The first manuscript provides evidence of a high prevalence of anemia in breastfed infants under six months of age, majority of which were under three months of age. The early occurrence of anemia in these infants was a surprising finding as was the moderate level of VAD. Our findings also indicated that anemia is a health concern in the mothers, however, their vitamin A status seems to be protected. This micronutrient data from a peri-urban setting provides important insight into the nutritional status of infants at an age of increased risk for morbidity and mortality.

Data presented in the second manuscript on the beliefs, attitudes and practices of lactating women documents important behavioural aspects of breastfeeding, as well as contributes to the infant feeding literature of women in developing countries with similar backgrounds. Although the South African infant feeding guidelines recommend exclusive breastfeeding (EBF), mothers participating in our study did not exclusively breastfeed their babies, instead most chose to complementary breastfeed (mixed feed) their infants. The women had several positive (in terms of infant health) breastfeeding however, practices, early introduction of solid foods and 'other' fluids was common, as was the use of infant herbal mixtures from traditional healers. These practices may account for the early initiation of micronutrient deficiencies observed in these very young infants.

Prospective studies with larger sample sizes plus additional indicators of micronutrient status, within a similar target population, are needed to explore the relationships between infant feeding practices and nutritional status outcomes. A critical aspect of future research in this area is the inclusion of infants who are exclusively breastfed (albeit difficult to find). Outcomes of such studies would have important public health implications since they would help elucidate the impact of exclusive breastfeeding on micronutrient status.

Finally, our data suggests that the opportunity to promote optimal breastfeeding practices in this population of mothers exists, given that breastfeeding is highly valued and EBF is conceptually approved of. The benefits of EBF are well documented, particularly for developing countries hence it is vital to understand the barriers for EBF in settings similar to the one studied. Our data provides baseline information for further infant feeding studies, particularly ones that investigate and promote EBF.

BIBLIOGRAPHY

ACC/SCN Fourth Report on the World Nutrition Situation. Geneva: ACC/SCN in collaboration with IFPRI. (2000).

Allen LH. Nutritional influences on linear growth: a general review. European Journal of Clinical Nutrition. 1994; 48 (1): S75-S89.

Angeles I, Schultink W, Sastroamidjojo S, et al. Interactions of micronutrients to build pre-pregnancy iron reserve in adolescent girls: the role of vitamin A. In: Report of the XVII IVACG Meeting Guatemala, 1996. Washington, DC: IVACG, 1996; 78. Suharno D, M. Vitamin A and nutritional anaemia. Food Nutr Bull. 1996; 17:7-10.

Anonymous. Anthropometric, vitamin A, Iron and immunisation coverage status in children aged 6-71 months is South Africa. 1994. South African Vitamin A Consultative Group (SAVACG). S Afr Med J. 1996; 86 (4):354-7.

Arthur P, Kirkwood B, Ross D, Morris S, Gyapong J, Tomkins A and Addy H. impact of vitamin A supplementation on childhood morbidity in Northern Ghana. Lancet. 1992; 339:361-62.

Auerbach K, Riordan J. Breastfeeding and Human Lactation. Jones & Bartlett,

Boston.1993.

Barreto ML, Santos lMP, Assis AMO et al. Effect of vitamin A supplementation on diarrhoea and acute lower respiratory tract infections in young children in Brazil. Lancet. 1994. 344; 228-31.

Baumslag N. breast feeding: cultural practices and variations. In Advances in International Maternal and Child Health (vol 70). Oxford. Clarendon press (Jelliffe DB, Jelliffe EFP editors). 38-39.

Bhandri N, Bhan MK, Sazawal S. Impact of massive dose of vitamin A given to preschool children with acute diarrhoea on subsequent respiratory and diarrhoeal morbidity. BMJ. 1994; 309, 1404-07.

Bhargava M . Relationship of maternal serum ferritin with foetal serum ferritin, birth weight and gestation. J of Trop Med. 1991; 37: 149-52.

Bhargava A, Bouis HE and Scrimshaw NS. Dietary intakes and socioeconomic factors are associated with the hemoglobin concentration of Bangladeshi women. J Nutr. 2001; 131:758-64.

Bhaskaram P. Micronutrient deficiencies in children-the problem and extent. Indian J Pediatr. 1995; 62: 145-56

Bloem M, Wedel M, Van Agtmaal E, Speek A, Saowakontha S, Screurs W. Vitamin A intervention: short-term effects of a single, oral, massive dose on iron metabolism. Am J Clin Nutr. 1990; 51: 76-9.

Bloem MW, Wedel M, Egger RJ, Speek AJ. Chusilp K. Saowakontha S. Schreurs WH. Iron metabolism and vitamin A deficiency in children in northeast Thailand. Am J Clin Nutr. 1989; 50:332-38.

Bothwell TH, Charlton RW, Cook JD, Finch CA. Iron Metabolism in Man. Oxford: Blackwell Scientific Publications. 1979.

Bourne LT, Langenhoven ML. Steyn K et al. Nutritional status of 3-6 year old African children in the Cape Peninsula. E. Afr Med J. 1994; 71: 695-702.

Brown KH, Stallings RY, Creed de Kanashiro H, et al. Effects of common illnesses on infants energy intakes from breast milk and other foods during longitudinal community based studies in Huascar (Lima), Peru. Am J Clin Nutr. 1990;52

Brown KH, Creed de Kanashiro H. del Aguila R. Lopez de Romana G. Black RE. Milk consumption and hydration status of exclusively breast-fed infants in a warm climate. J Ped. 1986; 108:677-80.

Calvo EB, Galindo AC, Aspres NB. Iron status in exclusively breast-fed infants. Pediatrics. 1992; 90: 375-79.

Campos F, Flores H, Underwood BA. Effect of an infection on vitamin A status of children as measured by the relative dose response (RDR). Am J Clin Nutr. 1987; 46: 91-94.

Castenmiller J, West C. Bioavailability and bioconversion of carotenoids. Annu. Rev. Nutr. 1998; 18: 19-38.

Catignani GL, Bieri JG. Simultaneous determination of retinol and α-tocopherol in serum or plasma by liquid chromatography. Clin Chem. 1983; 29: 708-12.

Chappell JE et al. Vitamin A and E content of human milk at early stages of lactation. Early Human Development. 1985; 11: 157-67.

Choi JW, Kim CS, Lee J, Pai Sh. Erythropoietic activity and soluble transferrin receptor level in neonates and maternal blood. Acta Paediatr . 2000; 89: 675-9.

Cunningham AS. Morbidity in breast feeding and artificially fed infants. II J Pediatr. 1979;95:685-9

Cunningham AS, Jelliffe DB, Jelliffe PEF. Breast feeding and health in the 1980s: a global epidemiologic review. J Peditr. 1991; 118:659-666

Dallman PR, Siimes MA, Stekel A. Iron deficiency in infancy and childhood. Am J Clin Nutr. 1980; 33: 86-118.

Davies-Adetugbo AA. Sociocultural factors and the promotion of exclusive breastfeeding in rural Yoruba communities of Osun state Nigeria. Soc Sci Med. 1997; 45(1); 113-25.

de Benoist B. Iron-deficiency Anemia: Reexamining the nature and magnitude of the public health problem. J. Nutr. 2001; 131: 565S-567S

De Onis M, Monteiro C, Akré J, Clugston G. The worldwide magnitude of protein-energy malnutrition: an overview from the WHO Global Database on Child Growth. Bull. World Health organ. 1993; 6: 703-12.

De Pee S, West CE. Dietary carotenoids and their role incombating vitamin A deficiency: a review of the literature. Eur J Clin Nutr. 1996; 50:3 S38-S53

DeMayer EM. The WHO programme of prevention and control of vitamin A deficiency, xerophthalmia and nutritional blindness. Nutr. Health 1986; 4(2), 105-12.

Department of Health. Breastfeeding guidelines. Department of Health South Africa. 2000.

Dettwyler KA, Fishman C. Infant feeding practices and growth. Annu Rev Anthropol.1992; 21:171-204.

Dewey KG, Heinig MJ, Nommsen LA, Lonnerdal B. Maternal versus infant factors related to breast milk intake and residual milk volume: the DARLING study. Pediatrics. 1991; 87: 829-37.

Diaz S, Herreros C, Aravena R et al. Breastfeeding duration and growth of fully breastfed infants in a poor Chilean population. Am J Clin Nutr. 1995; 62:371-6.

Dijkhuizen MA, Wieringa FT, West CE, Muherdiyantiningsih, Mulilal. Concurrent micronutrient deficiencies in lactating mothers and their infants in Indonesia. Am J Clin

Nutr. 2001; 73: 786-91.

Drewett R, Amatayakul K, Wongsawasdii L, Mangklabruks A, Ruckpaopunt S, Ruangyuttikarn C, Baum D, Imong S, Jackson D, Woolridge M. Nursing frequency and the energy intake from breast milk and supplementary food in Thai population: a longitudinal study. E J C N. 1993; 47: 880-91.

Dudley L, Hussey G, Huskissen J et al. Vitamin A status, other risk factors and acute respiratory infection morbidity in children. S Afr. Med J. 1997; 87 (1):65-70.

Faber M. Benade AJ. Nutritional status and dietary practices of 4-24 months old children from a rural South African community. P Health Nut. 1999; 2(2) 179-85.

FAO/WHO Expert Consultation. Requirements of vitamin A, iron, folate and vitamin B12.; Food and Nutrition Series no. 23, FAO, Rome. 1988.

FAO/WHO. Preventing micronutrient deficiencies. ICN: Fact Sheet Number One. Supporting paper of the International Conference on Nutrition, Rome, Italy. 1992.

Feachem RG, Koblinsky M. Interventions for the control of diarrhoeal diseases among young children: promotion of breastfeeding. Bull WHO. 1984; 62:271-91.

Fincham R., Harrison D, Khosa M, Le Roux I. Nutrition and Health in South Africa. The State of Nutrition and Development of Nutrition Guidelines. World Bank: Statistics and Living Standards and Development.

Gebre-Medhin M, Vahlquist A, Hovander Y, Uppsall L &Vahlquist B. Breast milk composition in Ethiopian and Swedish mothers. 1976. Am J Clin Nutr. 29; 441-51.

Ghana VAST Study Team. Vitamin a supplementation in northern Ghana: effects on clinic attendances, hospital admissions and child mortality. Lancet. 1993; 342, 7-12.

Gibson R. Assessment of iron status In: Principles of Nutritional Assessment; pp349-76. Oxford University Press, New York. 1990.

Gillespie S, Mason J. Controlling vitamin A deficiency. State-of -the-art Series Nutrition Policy Discussion Paper No. 14. ACC/SCN. Geneva. 1994.

Gillespie S, Johnston JL. Expert consultation on anemia determinants and interventions, pp. 1-37. Micronutrient initiative, Ottawa, Canada. 1998.

Grajeda R, Pérez-Escamilla, Dewey KG. Delayed clamping of the umbilical cord improves hematologic status of Guatemalan infants at 2 mo of age. Am J Clin Nutr. 1997; 65:425-431.

Hall DMB, Beal-Preston R, Geefhuysen J et al. Artificial feeding of black infants. S Afr Med Jl. 1976; 50:761-63.

Heinig JM, Dewey KG. Health advantages of breast feeding for infants: a critical review. Nutr Res Rev. 1996;9:89 -110.

Hodges RE, Sauberlich HE, Canham JE, et al. Hematopoietic studies in vitamin A deficiency. Am J Clin Nutr. 1978; 31: 876-85.

Hossain MM, Reves RR, Radwan MM et al. The timing of breastfeeding initiation and its correlates in a cohort of rural Egyptian infants. J Trop Pediatr. 1995; 41: 354-8.

Hoffman M, Duncan N, Disler P. Breastfeeding in a socioeconomically disadvantaged area of Cape Town. Part Analysis of breastfeeding patterns among clinic attenders. S. Afr Med J. 1984; 66:64-65.

Howie PW, Forsyth JS, Ogston SA, et al. Protective effect of breast feeding against infection. Br Med J. 1990; 300:11-16.

Institute of Medicine. Nutrition during lactation. 1991; Washington DC, National Academy Press.

IVACG statement document: Vitamin A and Iron. 1998.OMNI, Washington, DC.

Johnson-Spear MA, Yip R. Hemoglobin difference between black and white women with comparable iron status: justification for race-specific anemia criteria. Am J Clin Nutr. 1994; 60: 117-21.

Kasinski SD, Russel RM, Otradovec CL, Sadowski JA, Hartz SC, Jacob RA, McGandy RB. Relationship of vitamin A and vitamin E intake to fasting plasma retinol, retinol binding protein, retinyl esters, carotene, tocopherol and cholesterol among elderly people and young adults: increased plasma retinyl esters among vitamin A supplement users. Am J Clin Nutr. 1989; 49: 112-20.

Katz J, Kharty SK, West KP et al. Night blindness is prevalent during pregnancy and lactatation in rural Nepal. J, Nutr. 1995. 125; 2122-27.

Kawakami H, Lönnerdal B. Isolation and function of a receptor for human lactoferrin in human fetal intestinal brush-border membranes. Am J Physiol. 1991; 261: G841-6.

Khusun H, Yip R, Shultink W , Dillon DHS. World Health Organization hemoglobin cut-off points for the detection of anemia are valid for an Indonesian population. J Nutr. 1999; 12: 1669-74.

Labadarios D. Micronutrient deficiencies among South Africans. S A J Clin Nutr. 1998; 89 (2): 4-6.

Landman WA, Henley LD. Tensions in settling health care priorities for South Africa's children. Journal of Medical Ethics. 1998; 24:268-73.

Lartey A, Manu A, Brown KH and Dewey KG. Predictors of micronutrient status among six- to twelve-month-old breast-fed Ghanaian infants. J Nutr. 2000; 130:199-207.

Lepage P, Munyazaki C, Hennart P. Breast feeding and hospital mortality in children in Rwanda. Lancet. 1981;2:409-11.

Lie C, Ying C, En-Lin et al. Impact of large dose vitamin A supplementation on childhood diarrhea, respiratory disease and growth. Eur J Clin Nutr. 1993; 47, 88-96.

Lönnerdal B, Hernell O. Iron, zinc, copper and selenium status of breast-fed infants and infants fed trace element fortified milk-based infant formula. Acta Paediatrica. 83; 367-373.

Lozoff B, Jimenez E, Wolfe A. Long-term developmental outcome of infants with iron deficiency. N Engl J Med. 1991; 325: 687-94.

Lucas A. Gibbs JA. Lyster RL. Baum JD. Creamatocrit: simple clinical technique for estimating fat concentration and energy value of human milk. *BMJ. 1978: 1(6119):1018-20,*

Lutter CK, Perez-Escamilla R, Segall AM. The effectiveness of hospital based breast feeding promotion programme to promote exclusive breast feeding among low income in Brazil. Am J public Health. 1997;87(4) 659-663.

Mahalanabis D. Breastfeeding and vitamin A deficiency among children attending a diarrhoea treatment center in Bangladesh: a case-control study. Br Med J. 1991; 303: 493-96.

Martines JC, Ashworth A, Kirkwood B. Breastfeeding among the urban poor in southern Brazil: reasons for termination in the first 6 months of life. Bull WHO. 1989; 67:151-61.

McLaren DS, Frigg M. Sight and life manual on vitamin A deficiency disorders (VADD); 1-5. Task Force Sight and Life, Basel, Switzerland. 1997.

Mejia LA, Hodges RE, Arroyave G, et al. Vitamin A deficiency and anemia in Central American children. Am J Clin Nutr 1977; 30:1175-84.

Mejia LA, Arroyave G. The effect of vitamin A fortification of sugar on iron metabolism in preschool children in Guatemela. Am J Clin Nutr. 1982; 36: 87-93.

Mills AF. Surveillance foe anemia: risk factors in patterns of milk intake. Arch Dis Child. 1990; 65: 428-31

Mohanram M, Kulkarni KA, Reddy V. Hematological studies in vitamin A deficient children. Int J Vitam Res 1977; 47: 389-93.

Morck TA, Cook JD. Factors affecting the bioavailability of dietary iron. Cereal Foods World. 1981; 26: 667-72.

Muhilal, Parmaesih D, Idjradinata et al. Vitamin A fortified monosodium glutamate and health, growth and survival of children: a controlled field trial. Am J Clin Nutr. 1988; 48:1271-76.

Narasinga Rao BS. Physiology of iron absorption and supplementation. British Medical Bulletin.1981; 37:25-30.

Ncube TN, Greiner T, Malaba LC, Gebre-Medhin M. Supplementing lactating women with pureed papaya and grated carrots improved vitamin A status in a placebo-controlled trial. J Nutr. 2001; 131: 1497-1502.

Neuwinger HD. African ethnobotany- poisons and drugs. London, chapman & Hall.

Newman V. Vitamin A and breast-feeding: A comparison of data from developed and developing countries. Food and Nutrition Bull. 1994; 15(2), 161-76.

Oelofse A, Faber M, Benadé JG, Benadé AJS, Kenoyer DG. The nutritional status of a rural community in KwaZulu-Natal, South Africa: the Ndunakazi project. Central African Journal of Medicine. 1999; 45(1): 14-19.

Okolo SN, Onwuanaku C, Okonji M, vanderjagt DJ, Milson M, Churchwell C, Glew RH. Concentration of eight trace minerals in milk and sera of mother-infant pairs in Northern Nigeria. Journal of tropical pediatrics. 2000; 46:160-2.

Olsen JA. Vitamin A, retinoids and carotenoids. In: Modern Nutrition in Health and Disease, 8th edition. Eds: Shils ME, Olson JA and Shike M. pp 287-307. Lea & Febiger, Philadelphia. 1994.

Olson J. Absorption, transport and metabolism of carotenoids in humans. Pure Appl. Chem.1994; 66:1011-16.

Ong ASH, Tee ES. Natural sources of cartenoids from plants and oils. Methods in Enzymology. 1992; 213:142-67.

Oski FA, Landaw SA. Inhibition of iron absorption from human milk by baby food. Am J disease of children. 1980; 134: 459-60.

Palafox NA, Gamble M, Kjolhede C. A comparison or serum retinol levels with hemoglobin concentration before and after vitamin A capsule distribution to children in the Republic of Marshall Islands. In: Report of the XVII IVACG Meeting, Guatemala, 1996. Washington, DC: IVACG, 1996;78.

Pilch SM. Analysis of vitamin A data from the Health and Nutrition Examination Surveys. J Nutr. 1987; 117: 636-40.

Pizarro F, Yip R, Dallman PR et al. Iron status with different infant feeding regimens: relevance to screening and prevention of iron deficiency. J. Pediatr. 1991; 118: 687-92.

Popkin BM, Adar L, Akin JS. Breast feeding and diarrheal morbidity. Pediatrics. 1990 86;874-882.

Power DJ, Willoughby W, De Waal RH. Breastfeeding in Cape Town. S Afr Med J. 1979; 56: 718-21.

Rice AL, Stoltzfus RJ, Kjolhede CL et al. "Casual" vs. "full" breastmilk expression: effects on measurements of vitamin A . In: Virtual elimination of vitamin A deficiency: obstacles and solutions for the year 2000. Washington, DC: International Vitamin A Consultative Group, 1996; 87 (abstr).

Rice A, Stoltzfus R, de Francisco A, Chakraborty J, Kjolhede C, Wahed M. Maternal vitamin A or beta-carotene supplementation in lactating Bangladeshi women benefits mothers and infants but does not prevent subclinical deficiency. J Nutr. 1999; 129: 356-65.

Rice A, Stoltzfus RJ, de Francisco A, Kjolhede CL. Evaluation of serum retinol, the modified-relative-dose-response ratio, and breast-milk vitamin A as indicators of response to postpartum maternal vitamin A supplementation. Am J Clin Nutr. 2000: 71:799-806.

Richter LM. The early introduction of solids: an analysis of belief and practices among African women in Soweto (report). 1987.University of the Witwatersrand, South Africa.

Roodenburg AJC. West CE. Yu S. Beynen AC . Comparison between time dependent changes in iron metabolism of rats as induced by marginal deficiency of vitamin A or iron. Br J Nutr. 1996; 71: 687-99.

Ross SM, Van Middelkoop A, Khoza NC. Breastfeeding practices in a black community. South Africa Med Journal. 1983; 63:23-25.

Ross SM, Loening WEK, Van Middelkoop A. Breast feeding- evaluation of a health education programme. S. Afr Med J. 1983;64:361-63.

Rossouw JPH, Jansen M. Memorandum to the Director General of the Department of National Health and Population Development. Breastfeeding in South Africa: 1987-1989.1990; Pretoria: Human Sciences Research Council.

Sachdev HP, Krishna J, Puri RK, Satyanarayana L, Kumar S. Water supplementation in exclusively breastfed infants during summer in the tropics. Lancet. 1991; 337: 929-33.

Savage King F, Burgess A. Breast feeding. In Nutrition for Developing countries.1993. Oxford. Oxford University Press. pp 90-91. 2nd ed.

Segal K, Hirschowitz R Research findings, children aged 5 years and younger In: A National Household Survey of Health Inequalities in South Africa. Community Agency for Social Enquiry (CASE) for Henry J Kaiser Family Foundation. pp 1-14. 1991.

Semba RD, Muhilal, Ward BJ Griffin DE. Scott AL. Natadisastra G. West KP Jr. Sommer A. Abnormal T-cell subset proportions in vitamin A deficient children. Lancet. 1993. 341:5-8.

Sijtsma KW, Van den Berg GJ, Lemmens AG et al. Iron status in rats fed diets containing marginal amounts of vitamin A. Br J Nutr. 1993; 70: 777-85.

Soewondo S, Husaini M, Politt E. Effects of iron deficiency on attention and learning processes in preschool children: Bandung, Indonesia. Am J Clin Nutr. 1989; 50: 667-74.

Solomons NW, Russel RM. The interaction of vitamin A and zinc: implications for human nutrition. Am J Clin Nutr. 1978; 31:876-85.

Sommer A, West KP. Vitamin A deficiency: Health, survival and vision. 1996. Oxford University press, inc., New York, NY.

Srikantia SG, Prasad JS, Bhaskaram C , Krishnamachari KAVR. Anemia and immune response. Lancet. 1976;1:1307-09.

Stephensen CB, Alvarez JO, Kohatsu J, Hardmeire R, Kennedy JI, Gammon RBJ. Vitamin A is secreted in the urine during acute infection. Am J Clin Nutr. 1994; 60: 388-92.

Steyn NP, Badenhorst CJ, Nel JH. et al. Breast feeding and weaning practices of Pedi mothers and the dietary intakes of their preschool children. S Afr J Food Sci Nutr. 1993; 5(1):10-13.

Steyn NP. A South African perspective on preschool nutrition. S Afr J Clin Nutr. 2000; 13: 9-13.

Stoltzfus R. Effect of maternal vitamin A or β-carotene supplementation on iron deficiency anemia in Nepalese pregnant women, postpartum mothers and infants. In: Report of the XVIII IVACG Meeting, Cairo, 1997. Washington, DC: IVACG, 1998:86.

Stoltzfus R. Defining iron-deficiency anemia in public health terms: a time for reflection. J Nutr. 2001; 131: 565S-567S.

Stoltzfus RJ, Hakimi M, Miller KW, Rasmussen KM. Dawiesah S. Habicht JP. Dibley MJ. et al. High dose vitamin A supplementation of breast-feeding Indonesian mothers: effects on the vitamin A status of mother and infant. J Nutr. 1993; 123, 666-75.

Stoltzfus RJ, Underwood BA. Breast-milk vitamin A as an indicator of the vitamin A status of women and infants. Bull WHO. 1995; 73(5), 703-11.

Stoltzfus RJ, Dreyfuss ML.Guidelines for the use of iron supplements to prevent and treat iron deficiency anemia, pp. 1-39. ILSI Press, Washington DC. 1998.

Stoltzfus RJ, Chwaya HU, Montresor A, Albonico M, Savioli L, Tielsch JM. Malaria, hookworm and recent fever are related to anemia and iron status indicators in 0-to-5 y old Zanzibari children and these relationships change with age. J Nutr. 2000; 130: 1724-33.

Strobel M, Heinrich F, Biesalski HK. Improved method for rapid determination of vitamin A in small samples of breast milk by H.P.L.C. J Chromatogr. 2000; 898: 179-183.

Tanumihardjo SA, Cheng JC, Permaesih Dl. Refinement of the modified-relative-dose-response test as a method for assessing vitamin A status in a field setting: experience with Indonesian children. 1996; 64: 996-71.

Tatala S, Svanberg U, Mduma B. Low dietary iron availability is a major cause of anemia: a nutrition survey in the Lindi district of Tanzania. Am J Clin Nutr. 1998; 68:171-78.

Tseng M, Chakraborty H, Robinson DT, Mendez M, Kohlmeier L. Adjustment of iron intake for dietary enhancers and inhibitors in population studies: bioavailable iron in rural and urban residing Russian women and children. J Nutr. 1997; 127:1456-68.

Underwood BA. Dietary approaches to the control of vitamin A deficiency: an introduction and overview. Food Nutr Bull. 2000; 2: 117-23.

Underwood BA. Maternal vitamin A status and it's importance in infancy and early childhood. Am J Clin Nutr. 1994; 59(suppl):S17S-24S.

Underwood BA, Arthur P. The contribution of vitamin A to public health. FASEB J. 1996; 10, 1040-48.

Underwood BA. Vitamin A deficiency. Bull WHO. 1998; 76 Suppl 2:124-5.

UNICEF.State of the Worlds Children. Oxford University Press.
Westphal R, Phillips G, Irwig LM. Infant care and feeding in an urban black population. S Afr Med J. 1981; 60:778-81. 1998

UNICEF/WHO. Prevention and control of iron deficiency anemia in women and children. 1999; World Health Organization, Geneva, Switzerland

United Nations. World Declaration on the survival, protection and development of children and plan of action for implementing the World Declaration on the Survival, Protection and Development of Children in the 1990s. New York, 1990.

Valquist A, Nilsson S. Mechanisms for vitamin A transfer from blood to milk in Rhesus monkeys. J Nutr. 1979; 109, 1456-63.

Van Steenbergen WM, Kusin JA, van Rens M.. Lactation performance. In Maternal and Child Health in Kenya - an epidemiological study. London & Sydney. Croom Heldon Ltd.. pp 153-165 (van Ginnekan JK, Muller AS, editors). 1984.

Varga CA, Veale DJH. Isihlambezo: utilization patterns and potential health effects of pregnancy related traditional herbal medicine. Soc Sci Med. 1997;44:911-24

Victora CG, Smith PG, Barros FC. Evidence of protection by breast feeding against infant deaths from infectious diseases in Brazil. Lancet. 1987;2:319-22

Voster HH, Jerling JC, Oosthuizen W, Becker P, Wolmarans P. Nutrient intakes of South African, An Analysis of the Literature (SANNSS Group Report). Isando:Roche, 1995.

Wahed MA, Alverez JO, Rahman MM et al. Subclinical vitamin A deficiency in young infants from Bangladesh. Nutr Res. 1997; 17, 591-98.

West KP. Efficacy of vitamin A in reducing preschool child mortality in Nepal. Lancet. 1991; 338, 67-71.

West KP, Katz J, Shrestha SR, LeClerq SC, Khatry SK, Pradhan EK, Adhikari R, Wu LS-F, Pokhrel RP, Sommer A. Morality of infants < 6 mo of age supplemented with vitamin A : a randomized, double masked trial in Nepal. Am J Clin Nutr. 1995; 62 : 143-48.

Westphal R, Phillips G, Irwig LM. Infant care and feeding in an urban black population. S Afr Med J. 1981; 60:778-81.

Williams DM. Racial differences of hemoglobin concentration: measurements of iron, copper, and zinc. Am J Clin Nutr. 1981; 34: 1694-1700.

Williams CD, Baumsland N, Jeliffe DD, Common problems in children. In Mother and Child Health- delivering the services. 1986. Oxford. Oxford University Press. pp 79-89.

Willows ND. Morel J. Gray-Donald K. Prevalence of anemia among James Bay Cree infants of northern Quebec. *CMAJ. 162(3):323-6, 2000*

Wright AL, Holberg CJ, Martinez FD. Breast feeding and lower respiratory tract illness in the first year of life. Br Med J. 1989;299:946-9

World Health Organization: Contemporary patterns of breast feeding: Report on the WHO collaborative Study on breastfeeding; pp: 165-211. Geneva Switzerland. 1981.

WHO Draft World declaration on nutrition. International Conference on Nutrition : Preventing specific nutrient deficiencies. Theme paper No. 6 in: Major Issues Nutrition Strategies. Food and Agricultural Organization, United Nations; 2-40. 1991.

WHO. Indicators and Strategies for Iron deficiency and Anemia programmes. Report of the WHO/UNICEF/UNU Consultation. Geneva, Switzerland, 6-10 December, 1993.

World health Organization. Indicators for Assessing Vitamin A Deficiency and Their Application in Monitoring and Evaluating Intervention Programmes. 1996.
WHO Geneva, Switzerland.

WHO. The global criteria for the WHO/UNICEF Baby Friendly Hospital Initiative, in baby friendly hospital Initiative Part II: Hospital Level Implementation. 1992. Geneva:

WHO/UNICEF.

WHO. Indicators for assessing breastfeeding practices, UPDATE, No10, WHO, Geneva, 1997.

WHO. Global Database on Anemia; WHO, Geneva.1998.

WHO/UNICEF. Indicators for Assessing Vitamin A Deficiency and Their Application in Monitoring and Evaluating Intervention Programmes. WHO/NUT/94.WHO Geneva, Switzerland. 1994.

WHO/UNICEF. Complementary feeding of young children in developing countries: a review of current scientific knowledge. WHO/NUT/98..WHO Geneva, Switzerland. 1994.

Yip, R. Iron deficiency: contemporary scientific issues and international programmatic approaches. J Nutr.1994; 124: 1479S-1490S.

Yip R. A recommended plan of action for the control of iron deficiency for Vietnam. Final Report of the 1995 Vietnam National Nutrition Anemia and Intestinal Helminth Survey, October 1, 1996.

Zeitlin MF, Megawangi R, Kramer EM et al. Mothers' and children's intakes of vitamin A in rural Bangladesh. Am J Clin Nutr. 1992. 56; 136-47.

Zollner E, Carlier ND. Breast feeding and weaning practices in Venda. S Afr Med J.1993; 83:580-583.

Appendix

Breastfeeding and infant feeding questionnaire:

Beliefs, attitudes and practices

August, 2000

Date of interview:_____/______/2000
Identification number (mother):_________________
Identification number (infant): __________________

1a) Name of mother:____________________________

b) Name of infant: _____________________________

c)

Male	1
Female	2

d) Address:____

Phone #:___________________________

e) How many years have you lived in Cape Town: __________________

f) Where did you live before:____________________________________

2a) Date of birth of mother (dd/mm/yy)?:___________________
do not know

b) Mother's Ht:________(m) Wt:_________(kg)

3a) Date of birth of Infant (dd/mm/yy) ?:_______________

b) Birth weight of infant?:_______ (g/kg) Weight not known

c) Current weight of infant ?: _________(g/kg)

d) Current length:________(cm)

4a) Where was your baby delivered ?:
hospital name ____
Other____________________________

b) Type of birth ?:

Vaginal	1
C-section	2

5) How many children (including this baby) have you given birth to?:____________

6a) Are you working at the moment?:

Full time	1
Part-time	2
Casual (sometimes)	3
Not at all	4

b) What do you do ?:

____

____

____

7a) Did you go to school ?:

Yes	1
No	2

b) What was the highest standard/grade you completed at school ?:

____

c) Have you had any other kind of education ?:

____

8 a) How many people, including yourself, live with you at home?:

____

b) How many rooms in your home (excluding kitchen and bathroom): ____________________

9. In your home do you have?:

	Yes	No
Electricity	1	2
Indoor tap	1	2
Outside tap	1	2
Public/ communal tap	1	2
Indoor toilet	1	2

10a) At the hospital, were you advised to breastfeed your baby right away after delivery ?:

Yes	1
No	2
Do not Re-member	3

b) Before starting to breastfeed for the first time, did you give the baby anything else to eat or drink, if yes what did you give and why?:

____

____

____

c) Did you let your baby have the colostrum (mtubi) from your breast?:

Yes why?:

___

No why ?:

___

d) If your baby was not given colostrum, what did you feed the baby while you were waiting for your 'milk to come in'?:

___

___

e) At the hospital, did your baby drink anything else (other than breast milk)? If yes, what and why?:

___

___

___

11. After having your baby and before you left the hospital did you get free formula and/or a baby bottle from the hospital?:

Yes	1
No	2
Do not Re-member	3

12 a) Why did you choose to breastfeed your baby ?:

___

___

___

___

b) Who helped you decide to breastfeed your baby ?:

____

13a) What do you like about breastfeeding ?:

____

____

____

____

____

b) What do you find difficult about breastfeeding ?:

____

____

____

____

____

14a) Have you felt like you needed help with your breastfeeding? if yes, help with what?:

____

____

____

____

____

b) Who would you go to or have gone to, to get help with breastfeeding ?:

____

____

____

15 a) How long are you planning to breastfeed your baby ?:

____

b) Why will you stop breastfeeding at that point?:

____

____

c) Does anyone think you should stop breastfeeding and why do they think so ?:

____

____

16. Do you think a child from birth to 4 months can grow and be healthy on?:

____

	Yes	No
Breast milk alone	1	2
Breast milk and formula together	1	2
Formula alone	1	2

17a) When do you breastfeed your baby?:

whenever the baby wants it (on demand)

at fixed times (schedule)   other:____________________

b) How many times in 24 hours (day & night) do you breastfeed your baby ?: __________ **times in 24 hours**

6 am to 12 noon __________   12 pm to 5 pm __________

5 pm to 10 pm__________   10pm to 12 am __________

12 am to 6 am __________

c) Are you throwing out breast milk for any reason, If yes why?:

____

____

____

____

____

18 a) Why did you start giving your baby food or drink (other than breast milk) ?:

____

____

____

b) How old was your baby when you started to give him/her food and/or drink (other than breast milk or formula)?:

__________ months old

c) What food or drink did your baby get the first time they ate something other than breast milk or formula ?:

____

____

19a) How old was the baby when you started to give him/her formula?: ____________ months old

b) If you are already breastfeeding, why do you also give the baby formula?:

____

____

____

c) How many bottles of formula do you give your baby a day?:

____

d) How big is the bottle ?: ________oz/ml

e)What do you do when you cannot afford the formula?:

____

____

____

20 a). How many times a day do you give water/juice/milk?:

Drink	Amount per day
Water	
Fruit drink	
Juice	
Milk	
Maasi	

20 b) How many times a day do you give your baby (solid or semi-solid)food ?:

____

c) Which foods did you give to your baby last week ?:

(i) Grain:

	Yes	No
Pap (mealie meal)	1	2
Baby cereal	1	2
Bread	1	2
Rice	1	2

Other grain?:

____

(ii) Meats:

	Yes	No
Meat	1	2
Chicken	1	2
Tinned Fish	1	2
Liver	1	2
Sausage	1	2
Eggs	1	2

Other meats?:

____

(iii) Fruits :

Yes	1
No	2

which fruit ?:

(iv) Vegetables:

Yes	1
No	2

which vegetables ?:

(v) Beans:

	Yes	No
Dried beans	1	2
Samp & beans	1	2

(vi) Milk:

	Yes	No
Cow's milk	1	2
Goat's milk	1	2
Maasi	1	2
Yoghurt	1	2

What kind of milk do you use (2 % or full cream)?:

____

(vii) Traditional drinks:

Yes	1
No	2

please name it:

____

____

(viii) other foods:

	Yes	No
Peanut butter	1	2
Chips	1	2
Jam	1	2
Cold drink	1	2
Ovaltine / Milo	1	2
Tea	1	2

Anything else you feed your baby ?:

____

____

____

21a) Some breastfeeding mothers take traditional herbs/drinks to help them make more milk. Do you or did you take anything (herbs, food, drink) to help you make more breast milk ?:

Yes	1
No	2

b) If yes what is it called or how did you ask for it?:

___

___

___

c) When did you start to take it and how long do you take it for ?:

___

___

d) Where do you buy it ?:

___

___

e) Did you feel you made more breast milk after taking it ?:

___

___

___

f) Do you want to tell me anything else about what you are or did take ?:

____

____

____

____

22 a) Some mothers tell us that they give their babies traditional drinks (like muthi for getting rid of a child's wind), what have you given your baby and at what age?:

____

____

____

b) What is it supposed to do for the baby and where do you buy it?:

____

____

____

c) Do you think it worked ?:

____

____

____

d) How long does the baby take this traditional medicine for?:

____

____

23. Anything else you want to tell us about breastfeeding or feeding your baby ?:

____

____

____

____

____

____

Thank you for helping us understand how mothers are feeding their babies.