DEPARTMENT OF COMMUNITY HEALTH
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RELATIONSHIP BETWEEN NUTRITIONAL STATUS AND MENTAL DEVELOPMENT OF CHILDREN IN Elka Na Mataramofa, East Showa.

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List of abbreviation

ANC	Ante natal care
BMI	Body mass index
GNP	Gross national product
HAZ	Height for age Z score
H/A	Height for age
NCHS	National centre for health statistics
U.S.A	United States of America
UNICEF	United nation's children fund
WHO	World health organization
WHZ	Weight for age Z score
WAZ	Wight for height Z score

Abstract

Malnutrition is one of the major problem in the world particularly in developing countries and it is endemic in Ethiopia. Different studies have showed that severe malnutrition during infancy negatively affects mental development. Most malnutrition begins in the second year of life, and most of it is chronic and mild to moderate in severity. This is why the current study is looking at even mildly malnourished children 1 - 4 years of age.

To assess the mental development of children in relation to their nutritional status , 111 children 12 - 42 months of age from a single peasant association were taken in this study. From these children 49.5% were under weight , 52.2% were stunted and 9.9% were wasted. The mean Bayley score was 88 and SD 13. Most (71.2%) scored 76 - 101.

The mean Bayley score between those stunted and non-stunted showed a significant difference. Multiple linear regression also showed H/A significantly related to mental development. In addition to nutritional status, birth order and delivery events were shown to have strong relation to mental development. Therefore we recommend an extensive health education on nutrition, expansion of delivery services to the rural population and further research on mental development of children with emphasis on the effect of family interaction and child rearing practice on mental development.

INTRODUCTION

Malnutrition is one of the major health problems in the world. It accounts for as much as a quarter of deaths among children in association with infection and as a direct cause, it shares 3.4% of the global burden of disease and 6% of the total burden of illness in young children (1).

In the developing world, malnutrition is one of the leading causes of mortality and morbidity. It is widespread and endemic in all developing countries and may reach epidemic proportions as a consequence of natural and/or man-made disasters (2). It is estimated that 40 million preschool children in developing countries are living in a condition of acute malnutrition, and more than three times this number in a chronic state of inadequate nutrition and associated illness (3).

The problem is worse in most African countries where living conditions are worse than other countries with low economic development. This is further worsened by poor health care, scarcity of resources, political instability and rapid population growth that does not match the socioeconomic growth (4).

Ethiopia is one of the least developed low income countries with average annual population growth of 3.1%, GNP per capita of 120 US dollars (5), and with only 47% of the population having access to health facilities (6). Children under five years

constitute 18% of the total population (6), yet of all deaths in Ethiopia more than half are children under five years of age (6,7). The most common cause of child death is the interacting combination of malnutrition and infection (8).

Children are the most vulnerable group in any society. Their growth is mainly influenced by genetic programming and external influences. Nutrition is one of the external factors which influence growth and attainment of normal body dimension (9). It serves to meet the requirement for cell multiplication and for the process in which the growing tissues and organs take an increased complexity of function (10).

The level of nutrition is influenced directly by dietary intake and indirectly by the effect of infection, parasites, toxic and/or psychological stresses (11). The nutritional status of children in Ethiopia is mainly influenced by feeding practices and by the frequency of infection (12).

Malnutrition has an immediate effect such as death and morbidity from a severe case and, in childhood where there is rapid growth, it has a long term effect on the well-being of the individual. Unfavourable condition during rapid growth periods can be expected to retard development and result in reduced physical growth and impaired mental and psychosocial development which may affect working capacity in a later life. Thus sever malnutrition in infancy is said to affect mental development

(10,13).

In the fight against malnutrition, survival is the main concern. But there is the possibility of an increment in the number of survivors of malnutrition who may have impaired learning abilities affecting their future life.

Since children are the economic assets to the world and their future developmental outcome can be influenced by their nutritional status, the mechanism and the consequences of malnutrition need to be understood better. This being more true in a country like Ethiopia where malnutrition is almost universal, there is a need to identify the relation between nutritional status and mental development of children so that interventions can be planned to enable them to achieve optimum growth and development.

In Ethiopia, some studies have been made on the physical aspect of malnutrition, but only one community based study on its effect on mental development. Therefore, it is relevant and timely to carry out a community based study in rural Ethiopia where more than 80% of the population live and where the magnitude of malnutrition is higher.

Many studies have found that sever malnutrition in infancy negatively affect mental development. But as it is the case in Ethiopia, prevalence of malnutrition peaks in the second year of life and most of it is chronic, and mild to moderate in

severity. This is why the current research is looking even at mildly malnourished children 1 to 4 years.

The study is thus designed to determine the relationship between nutritional status and mental development in children, and the result obtained may be used by policy makers and programme managers in different parts of the country.

LITERATURE REVIEW

Nutritional assessment

Direct nutritional assessment of a community depends on biochemical tests, clinical examination and anthropometric measurements. Biochemical tests need laboratory facilities and are usually costly, time consuming and the results are difficult to interpret, so they need to be performed in well equipped health facility. To use clinical signs for nutritional assessment is inexpensive, fast and does not require highly qualified staff, but it is subjective and, clinical signs may not appear at an early stage of malnutrition (9,11).

Anthropometry is the most commonly used direct method for the assessment of nutritional status. The frequently employed anthropometric measurements are weight and height. Anthropometric measurements have the inherent potential for inaccuracy, require precise age, have limited nutritional diagnostic capabilities and there is some controversy in the selection of appropriate reference data. On the other hand, they are economical to carry out, objective, easily understandable, gives result which can be numerically graded and provides information on different degrees of malnutrition. Therefore, most studies on nutritional status are performed using anthropometric measurements(11). They have been used as indices of nutritional status of an individual and the community (14).

Child growth and the size of adults reflect the effect of diet, infection, psychosocial and genetic factors. Indirectly, it reflects agricultural and economic influences.

Anthropometric measurements are used to detect growth faltering and under-nutrition by comparing the measurements with reference data. International standards which are based on the growth of children in developed countries are used as reference to compare the child's growth. Some argue that local standards are preferable because they take into account genetic and ethnic differences. However, some studies have shown that environmental factors have more influence than genetic difference (11,15).

It has been shown that African infants usually thrive during the first six months of life and their growth curves resemble those of their European counterparts (16). However, various environmental factors including nutrition are responsible for the eventual deterioration in their growth during the second half of infancy, which coincides with the time when breast milk is unable to provide the nutritional requirement of the rapidly growing child (16).

Studies in Ethiopia showed that children follow the same weight increment pattern as children of the same age in developed countries up to the age of 6 months, after which it deteriorates. Same studies revealed that height also has a gradual downward deviation with increasing age(8).

Prevalence of Malnutrition

There is no reliable estimate on the extent of malnutrition in the world. However, it has been estimated that, in the world as a whole around 100 million infants and small children are moderately to severely underweight (below 75% of reference weight for age). Of these, 10% are below 60% of the reference weight, which implies an acutely life threatening situation for these infants and toddlers (17).

Each day, more than 40,000 young children in the world die from a combination of malnutrition and infection. For every child who dies, there are six children living in hunger and ill health,

which may have a long term damaging effect on their lives (18).

Malnutrition is important both as an underlying and contributory cause of child mortality in developing countries. WHO and UNICEF have estimated that malnutrition is a contributing cause in one third of all children deaths. In developing counties, 12% of children under 5 years of age suffer from acute malnutrition and almost 40% suffer from chronic malnutrition (18).

Findings from the 1992 national rural nutrition survey in Ethiopia shows the prevalence of chronic malnutrition to be more common than acute malnutrition and has increased significantly since 1983 in most regions. Stunting was found in 64.2% of all children, making it the third highest prevalence in the world; it is common among infants 6-12 months of age (56.5%), and reaches peak (72.7%) among 12-23 months old. Wasting affects 8% of all children in post harvest season, with a peak (11.7%) at 12-23 months of age. Underweight affects 47.7% of all children and the peak is among those aged 12-23 months. In all three anthropometric indicators, male children are more affected than female. It is found that breast feeding is universal and continues for a median of 25-30 months and the median age for complementary food introduction was 7.1 months. There was strong association between median age of introducing complementary food and prevalence of stunting among young children (19).

Cell mediated immunity , elimination of pathogens and tissue

repair are all likely to be affected by the nutritional state (20). Because of this, case fatality rate of diseases becomes high in malnourished children (1,21,22). Conversely, diseases can be contributory factors in the development of malnutrition.

The difference between a well nourished and malnourished children is not just in their anthropometry, but also in the relative proportions of various organs, tissues and in chemical composition like water, protein, fat and minerals. Malnutrition has an effect on structure and function of the different organs including cardiovascular, haemopoetic, hepatic, pancreas, gastrointestinal tract, kidney, skin and hair and the nervous system (23).

Malnutrition and mental development

Child development involves changes in a child's biological, social, cognitive and emotional dimensions. This is determined both by genetic and environmental factors (24).

There is a normal pattern of growth and development with a range at a particular age in which children reach a certain height, weight or ability to walk or talk. Growth is generally a smooth process in a healthy child (9).

The genetic endowment provides a range of possible levels one may ultimately reach, depending on the quality of the experience

in the environment (25). A variety of environmental factors including nutrition, disease, and psychological disturbances affect growth (26).

Malnutrition is a common health problem in the developing world, the tragedy of which may lie in the damage it inflicts on the growing brain. Under-nutrition is said to have a serious impact on child health and development affecting motor capabilities, perceptual function, school achievement socio-emotional maturity and may result in reduced working capacity in future life (27).

Neurons, the building blocks of brain, change in size, function and degree of interconnectedness with the child development (27). Along with an increase in brain size, functional organization of the nervous system takes place, which reflects its increasing responsiveness to stimuli from the environment (28).

As there are physical growth spurts, there is also a neural growth spurt period. This period varies in different animals, in different regions of the brain and different cell types (29,30). If conditions are not optimal at a given time, that opportunity is lost and compensation may be impossible (31). The first neural growth spurt when the number of neurons in the developing brain reaches the adult level is at about 30 weeks of gestation, the second growth spurt occurs in the first postnatal year and 70% of adult brain weight is achieved by the end of the first year (28). By about five years of age the child brain has

attained 90 % of it's adult size (9). Hence, the period of maximum vulnerability is seen in prenatal and first postnatal months. Nutritional deficiencies particularly those occurring very early in life and coinciding with a time of rapid growth may adversely affect brain development by reducing the rate of brain cell multiplication (13). Therefore, the dietary deficiency will impede brain growth quantitatively, the extent of which depends both on the age of onset, the duration and the extent of the insult (28,31,32).

Studies have shown that malnutrition reduces the number and size of cells in the brain together with the lipid, nucleic acid, enzyme and protein contents (27,28,33,34). An Ethiopian study also demonstrated abnormal transillumination and echoencephalographic changes of the brain in severely malnourished children which showed complete normalization after treatment (35).

Along with height and weight, head circumference, which is considered as gross brain size, was noted to be reduced in grossly undernourished children during infancy (33,35).

Infants who have suffered from clinically diagnosed marasmus during the first year of life and have been rehabilitated showed evidence of lasting mental deficit when examined at follow up on global measures of intelligence (28). Studies of children who have suffered kwashiorkor in infancy presented varied findings. Some showed that having history of kwashiorkor significantly

reduces scores on intelligence test (34). And other studies failed to have significant difference between groups with history of kwashiorkor and the controls (36). Overall, many studies conducted worldwide have shown that early sever malnutrition interferes with intellectual development (37,38,39,40).

Studies of marasmus and kwashiorkor rely on medically diagnosed early life condition, but studies of children with mild to moderately inadequate nutrition have to rely on direct anthropometric measurement(28).

More important, however, is the finding that even mild and moderate malnutrition in children beyond infancy can have a detrimental effect on mental development. Mild to moderate degree of malnutrition was found to influence the mental development and the relative risk of having low intelligence quotient, and this risk was shown to increase with the severity of malnutrition (41,42,43,44), and stunted children were found to have a lower score than wasted children (41,42).

Temporary food shortage was shown to have affected school children's attentiveness and activity and also reduced the amount of time a mother spends caring for her toddlers (45). In another study missing a single meal have been shown to affect cognitive function of school children who were stunted or wasted, and those who have survived severe malnutrition in early childhood (46).

The effect of malnutrition on boys and girls was found to be different in different studies. In a study done in Nigeria males were affected more by severe malnutrition than females (39), whereas females were more affected, though the correlation were not significantly different, in a Kenyan study (43).

One indirect way in which nutritional deprivation can influence brain development and function is through reduced stimulation, as prolonged apathy, inactivity and weakness due to nutritional inadequacies result in reduced exploratory and stimulating experiences, which are essential to normal development (13,46). Under nutrition is shown to lower exploratory activity, increase the need for physical closeness to the mother, increase time spent sucking the breast and decrease the time spent in playing (47). Thus malnutrition reduces the energy a child has to explore the environment, thus reducing the stimulation necessary for mental development.

Besides nutrition other environmental factors were also found to be associated with nutritional status and mental development of children (48). Environmental enrichment, in animal study, is shown to be equally important as nutritional status (48). One Jamaican study showed, stimulated malnourished children to be significantly ahead of the non-intervened malnourished children, and only slightly below the adequately nourished children (49). The precise role of the quality of environment in the link between malnutrition and mental development is not exactly

known.

Maternal involvement and stimulation was strongly associated with better behaviour and intelligence development and it is claimed to be the most significant environmental factor affecting children mental development (50,51). Maternal nutritional state is said to affect the amount of time they spent caring for their children (42).

Socioeconomic status and educational resource of the family were found to be associated with mental development (40,50,51,52). Child birth order were also said to have an important role (50). But these factors were found to have no influence on rural children in an Indian study (51). Morbidity is the other factor which is strongly incriminated to have an impact on mental development (42).

Because malnutrition is invariably associated with different sociocultural deprivations and these factors independently affect mental development, it is difficult to separate their effect.

Assessment of mental development.

Development tests assess whether a child possesses basic abilities at different stages of development and attempt to measure the current level of functioning (53). Infant development assessment tests such as the Grifith or Bayley

scales have been used with young children. One of the widely used test is Bayley scale of infant development that contains different subscales of motor and mental function. The mental and motor scales evolved from 3 California scales. Bayley scale of infant development was first published in 1969 in San Antonio U.S.A. (53). The 2nd edition of Bayley scales of infant development was published in 1993, and it is designed for children 1 - 42 months of age (53).

Bayley scale has been used as a complete developmental assessment battery, to chart child's progress after intervention, as a tool for teaching parents about their infant development and as a research tool.

It is an individually administered examination that assesses the current developmental functioning of infants and children. It consists of three scales; mental, motor and behavioral rating scales. The mental scale includes items that assess memory, habituation, problem solving, early number concept, generalization, classification, vocalization, language and social skills (53).

Items are put within items set by their increasing difficulty. It has basal and ceiling item for each age. Each item contains detailed instruction with all information necessary to administer the items and scoring the responses properly.

Assessment of mental development is very difficult unlike that

of assessment of physical development. One of the problems in assessing mental development is the absence of a test appropriate to use in different socio cultural settings. Most developmental tests are used in countries where they are developed. The application of mental development tests to countries with different culture and where there is no standard, require caution in administration of the test and interpretation of the results. Though, the application of these tests to countries with different cultures need caution, they provide valuable information. Consequently they are being used widely throughout the world.

Bayley scale of mental development was used extensively in different parts of the world including Africa (40,42,54). It was also used in a study done in Ethiopia in 1991, and found to be a valid measure of early development in Ethiopian rural children (44).

The present study is designed mainly to assess the mental development of children 12-42 months of age in relation to their nutritional status and identify other related factors.

General Objective

To assess mental development of children in relation to their nutritional status.

Specific Objectives

1. To describe nutritional status of children 12-42 months in Elka Na Mataramofa Peasant Association.

2. To determine the mental development of children 12-42 months using the Bayley scale.

3. To examine the relation between mental development of children and their nutritional status.

4. To identify other factors related to mental development in children 12-42 months of age.

METHODS

Study design

The study utilized a cross sectional design.

Study Area

The Borena Health and Nutrition Study (BHNS) project studies food system, nutrition and disease patterns in drought prone areas of southern Ethiopia. The two study sites for the project are Dubluk in Borena region and Elka Na Mataramofa (Elka) in East Showa.

To keep homogeneity of the study population and to minimize sociocultural differences within the study population one of the villages from the two BHNS sites, Elka, was taken as the study area. Elka was selected for logistic reason. Elka is found in the Rift valley, 15 km north of Zeway town and 145 km south of the capital city Addis Ababa, in Adamitulu woreda, East Showa zone of Oromia region.

Adamitulu Woreda lies within the great rift valley with an average altitude of 1,000 - 1,500 meters. The Woreda has small towns namely Bulbula, Adamitulu and the capital city of the Woreda, Zeway (55). In addition to these small towns, the Woreda has 63 peasant associations, one of which is Elka Na Mataramofa.

In the Woreda there are 1 health center, 3 health stations, 5 clinics and 12 pharmacies. The most important endemic disease in

the Woreda is malaria (55).

There are one high school, two junior secondary schools and ten elementary schools in the Woreda all administered by the Ministry of Education (55).

According to the 1996 census done by BHNS, Elka has 285 households and 1,311 population. Males constitute 50.5% and females 49.5% of the population and children under five year constitute 15% of the population.

It is mainly inhabited by Arsi Oromos which constitute 93.2% of the population, who used to be pastoralists before the resettlement. Agriculture has gradually been introduced and now their economy is mainly based on subsistence farming. Most (94.60%) of the population are Muslims (56).

Elka has a semi-arid savanna type ecology and is one of the drought-prone areas of the country. It has two rainy seasons, "Keremt" from June to September and "Belg" from March to April. The mean annual rainfall varies between 600-900 mm. The vegetation is that of a dry savanna (56).

Study population

All Children 12 - 42 months of age residing in Elka Na Mataramofa were the source population. Since all children 12 - 42 months of age were included in the study, study population is

the same as source population. Children aged 12-42 months constitute 8.4% of the total population.

Inclusion criteria

A single child per household who was in age group 12 - 42 month was included in the study. When more than one child per household was found one was selected by lottery method.

Exclusion criteria

Severely sick children who could not participate in the test were excluded.

Data Collection

All the interviews, measurements, observations and testing were conducted at their dwelling compounds of the subjects. Exact age, in month, of each child was taken from BHNS data.

Each child was subjected to medical examination which is carried out by the principal investigator at his/her residence. Children who were acutely sick were excluded from the study.

General information on the family characteristic of the child was collected through house to house visit using questionnaire developed in English and translated to Amharic and pretested (Appendix 3). Mothers knowledge on child development was assessed using four questions on age at which children develop specific skills,which was included in the questionnaire

(Appendix 3). Training on how to conduct the interview was given to the interviewers by the principal investigator for one day. Questionnaire was administered to care takers of the Children.

Anthropometric measurement was done for children enrolled to the study by the principal investigator, using standardized procedure to measure weight, height, arm circumference and head circumference
(Appendix 1).

Grades of nutrition were assessed using NCHS/WHO standards (57). Weight for age, weight for height and height for age were converted using the anthropometric software package CASP (58). The measurements were related to the reference population by standard deviation scores (Z scores) (57). Children below -2SD of the median were considered under weight, wasted or stunted respectively (57).

Mother's weight and height was measured using standard procedure. And body mass index (BMI) which is, weight for height square (W/H^2)was calculated.

Mental development assessment was done using the Second edition of Bayley scale of mental development. Six secondary high school graduates who could communicate well with the local language were recruited and Bayley score training was given by a psychologist who is knowledgable and experienced on the Bayley

scale.

The training took 8 days. Different methods of teaching including lecture, demonstration, practice in small groups, role play and field practice were used. After which three were assigned to be testers and the rest recorders.

In this study, 107 items from the mental scale for children 12 months to 42 months were used which were translated to Amharic, modified for the Ethiopian context by including materials and words familiar to these rural children and by omitting items requiring timing (Appendix 6).

All measurements were done at thier dwelling compounds of each child and in the presence of their care takers. Score was given on a separate score sheet by each recorder. The raw score was computed by principal investigator by adding the total number of items for which the child received credit and all items below the basal item. The raw score was then converted to mental development index score by the principal investigator using the second edition of Bayley scales of infant development manual (53). The index score, instead of raw scores, was used to control for age effect.

Data management and analysis

Data entry, cleaning and analysis were done using Statistical package for Social Science (SPSS) (59). Descriptive, bivariate

and multivariate techniques were used in the analysis. Correlation and regression analysis were used where appropriate to assess factors associated with child nutrition and mental development, then multiple linear regression analysis was used as main statistical tool. Probability level of less than 0.05 was considered significant.

Socioeconomic status measures included questions about land ownership, possession of cattle, sheep, goats, chicken and type of house they have. Factor analysis, which is statistical technique to identify relatively small number of factors that can be used to represent relationships among sets of interrelated variables, was performed and socioeconomic grades were given for each household depending on these variables.

Management

The study was conducted in November and December 1995. Suitable time for the test was arranged with each mother. Pretesting of the questionnaire was conducted in the nearby village to evaluate its understandability by the respondents.

There was continuous supervision and quality control checks of data by the principal investigator and by the psychologist. Missing information in a visit were completed with repeated visits.

Ethical consideration

Verbal consent was obtained from the community leaders and care takers. Children with medical problem were given treatment and referrals were made for those requiring further help.

RESULTS

A total of 285 households were found in Elka Na Mataramofa, out of which 114 (40 %) were found to have children 12-42 months of age. Of these 3 households were excluded because the children were sick. For households who had more than one child in this age group a single child was selected by lottery method. This left 111 children for the study.

1. Parental demographic and socioeconomic information

Of the total study population 107 (96.4%) households were headed by males. The majority 106 (95.5%) of head of the households were from Oromo ethnic group and 98.2% spoke Oromigna. One hundred and five of head of the households (94.6%) were Muslims (Table 1).

Most (67.6%) of the children were living in households with five or more family members, and 44 (40%) were living in households with two or more under five children. Care takers of all

children were their biological parents (Table 1).

Nearly 96% of the mothers were married and 99.1% were housewives. Most (91.0%) were illiterate and none of the mothers had formal education. The mean age of mothers was 29.6 and SD of 7.77 with minimum of 17 years and maximum of 45 years. Most (72.7%) were between 21-40 years of age. Body Mass Index of the mothers showed, 89.7% of them to be in the normal range. But, because of cultural reason a question on pregnancy was not answered by most mothers, and only 17 (15.3%) said they were pregnant. This may affect the body mass index (Table 2).

Seventy six (70.4%) of the fathers were between 21-40 years of age. The mean age was 37.8 and SD of 12.99 with minimum age of 20 and maximum age 76 years. And 96.4% (107) were engaged in farming. Fifty six (50.5%) of the fathers were illiterate, 42 (37.8%) can read and write. Of those who attended school, 1 completed elementary school, 10(9%) attended Junior and Secondary high school and only one person completed 12th grade.

Only 1.8% of the families live in corrugated iron roofed house. Thirty three (11.5%) of the houses have their own pit latrine and only 5 (1.7%) have proper garbage disposal places. Eighty five households (76.6%) had at least a cow or an ox, and 105 households (94.6%) had their own farm plot.

Table 1. Socio demographic characteristic of head of households. Elka. 1996.

Characteristic	(N=111)	%
Ethnicity		
Oromo	106	95.5
Kembata	3	2.7
Guragae	1	0.9
Mareko	1	0.9
Language		
Oromigna	109	98.2
Kembatigna	2	1.8
Religion		
Muslim	105	94.4
Christian	6	5.4
Housing		
Thatched	109	98.2
Corrugated	2	1.8
Family size		
2 - 5	63	56.8
6 - 10	46	41.4
$\geq$ 11	2	1.8
Farm plot		
Yes	105	94.6
No	6	5.4

Table 2. Maternal sociodemographic and birth related characteristics. Elka. 1996

Characteristic	(N=111)	%
Maternal age		
15 - 19	7	6.4
20 - 29	49	44.5
30 - 39	40	36.4
40+	15	12.7
Marital status		
Married	106	95.5
Divorced	1	.9
Widowed	4	3.6
Mothers educational status		
Illiterate	101	91.0
Write + read	10	9.0
Mothers occupation		
Housewife	110	99.1
Commercial	1	0.9
Parity		
1 - 2	22	19.8
3 - 4	34	30.6
$\geq$ 5	55	49.5
ANC		
Attended	52	46.8
Not attended	59	53.2
Delivery place		
Home	100	90.1
Health institution	11	9.9
BMI*		
$\geq$18.5	96	86.5
17 - 18.4	9	8.1
16 - 16.9	6	5.4

*17 mothers (15.3%) were pregnant.

2. Age, sex distribution of children and their nutritional status

In the study 53 (47.7%) were male and 58 (52.3%) were females with sex ratio of 90:100. The minimum age was 12 months and maximum age 42 months. Mean age was 25.95 months with SD of 8.45.

Most (47.7%) were between 12 - 23 months of age, 31.5% in 24 - 35 months age group, and 20.7% in 36 - 42 months age group. Fourteen children (12.6%) were 1st born and the rest were second and above (Table 3).

Of the total 111 children 108 (97.3%) were breastfed for at least four months. Additional food was introduced during the 4th to 6th months of age for 24.3% children but the rest (75.7%) were exclusively breast fed for more than six months of life (Table 3).

Fifty five (49.5%) children were underweight (<-2 SD WAZ). Distribution by sex showed that, 58.5% of males and 41.4% of females were affected. Children 24-35 months of age were affected most and those 36-42 months of age were affected least (Table 4).

Stunting (< -2SD HAZ) was found among 58 (52.3%) of children with sex distribution of 54.7% of males and 50% of females. Children aged 24-35 months were affected most and children 36-42 months old were affected least. Among the studied children 11 (9.9%) were small weight for height (< -2SD WHZ) from which 6 were males. Those 36-42 months of age were affected most. In all anthropometric measurements, males were more affected (Table 4).

Table 3. Demographic and nutritional status of the study children. Elka. 1996.

Characteristic	N=(111)	%
Age		
12 - 23	53	47.7
24 - 35	35	31.5
36 - 42	23	20.7
Sex		
Male	53	47.7
Female	58	52.3
Birth order		
1st	14	12.6
2nd	16	14.4
3rd	14	12.6
4th	17	15.3
≥ 5th	50	45.0
Breast fed		
< 4 months	3	2.7
≥4 months	108	97.3
Age when supplementary feeding started		
4 - 6 month	27	24.3
7 - 12 month	84	75.7
WAZ		
≥ -2SD	56	50.5
< -2SD	55	49.5
HAZ		
≥ -2SD	53	47.7
<-2SD	58	52.2
WHZ		
≥ -2SD	100	90.9
<-2SD	11	9.9

Table 4 Distribution of nutritional status by age group and sex. Elka. 1996.

		WAZ	HAZ	WHZ
VARIABLE	Total N=111	<-2SD n=55(49.5%)	<-2SD n=58(52.2%)	<-2SD n=11(9.9%)
AGE				
12-23	53	24(45.3%)	28(52.8%)	5(9.4%)
24-35	35	23(65.7%)	20(57.1%)	3(8.6%)
36-42	23	8(34.8%)	10(43.5%)	3(13.0%)
SEX				
MALE	53	31(58.5%)	29(54.7%)	6(11.3%)
FEMALE	58	24(41.4%)	29(50%)	5(8.6%)

Table 5 Nutritional status of children according to Waterlow classification. Elka. 1996.

VARIABLE	TOTAL N=111	NORMAL n=48	WASTED n=5	STUNTED n=52	WASTED & STUNTED n=6
AGE					
12-23	53	22(41.5%)	3(5.7%)	26(49%)	2(3.8%)
24-35	35	14(40.0%)	1(2.9%)	18(51.4%)	2(5.7%)
36-42	23	12(52.2%)	1(4.3%)	8(34.8%)	2(8.7%)
SEX					
MALE	53	22(41.5%)	2(3.8%)	25(47.1%)	4(7.5%)
FEMALE	58	26(44.8%)	3(5.2%)	27(46.6%)	2(3.4%)

3. Bayley mental score of children

The mean Bayley score was 88 and SD of 13. The minimum score was 50 and the maximum 114. Of the total 111 children 16 (14.4%) scored 102 (+1SD) and above, 79 (71.2%) scored 76 - 101 (± 1SD), 12 (10.8%) scored 63 - 75 (-1 to -2SD), and 4 children (3.6%) scored less than 62 (<-2SD).

Distribution by sex showed 84.9% of males and 86.2% of females scored 76 and above. T test of mean scores between the two sexes were non signifcant. No correlation was found between childs age and Bayley score (Table 6).

Mean Bayley mental score by nutritional status is showed in table 7. T-test of mean Bayley score showed significant difference between stunted and non stunted children. No significant difference was observed in other anthropometric indices or with morbidity (Table 7).

Table 6 Bayley mental score in relation to demographic and nutritional characteristic. Elka. 1996.

Variable		Bayley mental score	
	N=111	≤75 n=16(14.4%)	≥76 n=95(85.6%)
Child age			
12 - 23	53	6(11.3%)	47(88.7%)
24 - 35	35	8(22.9%)	27(77.1%)
36 - 42	23	2(8.7%)	21(91.3%)
Child sex			
Male	53	8(15.1%)	45(84.9%)
female	58	8(13.8%)	50(86.2%)
WAZ			
≥-2SD	56	3(5.4%)	53(94.6%)
<-2SD	55	13(23.6%)	42(76.4%)
HAZ			
≥-2SD	53	3(5.7%)	50(94.3%)
<-2SD	58	13(22.4%)	45(77.6%)
WHZ			
≥-2SD	100	15(15%)	85(85%)
< -2SD	11	1(9.1%)	10(90.9%)

Table 7. Mean and standard deviations of Bayley score in different nutritional status. Elka. 1996.

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VARIABLES	MEAN	SD	T	Sig.
Child sex				
Male	88.74	12.61.40	0.53	
Females	87.22	12.37		
WAZ				
≥ -2SD	89.21	10.911.17	0.28	
< -2SD	86.65	13.83		
WHZ				
≥ -2SD	93.82	11.002.76	0.10	
<- 2SD	87.30	12.48		
HAZ				
≥ -2SD	90.49	10.944.37	0.04	
<- 2SD	85.62	13.36		
Sick in ≤ 2 Weeks				
Yes	87.05	14.570.34	0.56	
No	88.49	11.05		
Supplimentary feeding				
<6 month	86.07	13.88.085	0.372	
≥ 7 month	88.55	11.98		

Mean Bayley mental score by sociodemographic characteristics of households showed signficant difference in birth order, mother's parity and place of delivery. But no significant difference was observed in different family size, mother's age, mother's educational status or father's educational status (Table 8).

Birth order, family size and mothers parity were found to correlate positively with Bayley score ($r=.29$ at $p<.005$, $r=.21$ at $p<0.05$, $r=.27$ at $p<.005$ respectively). There was no significant correlation with parental age and educational status, and no correlation was observed with socioeconomic status of the family. Birth order was found to correlate with maternal age ($r=.63$, $p<.001$) and with family size ($r=.66$, $p<.001$).

Table 8 Mean and standard deviation of Bayley score in different sociodemographic status of the households. Elka. 1996.

Variable	N=111	Mean	SD	F	Sig.F
Family size					
1-5	63	87.08	12.80	0.704	0.403
≥6	48	89.08			
Mother's parity					
1	10	79.30	13.25	3.003	0.054
2-4	46	87.85	11.76		
≥5	55	89.60	12.44		
Mother's age					
≤20	17	87.76	11.52	0.722	0.488
21-30	46	86.70	13.27		
≥31	47	89.74	11.60		
Mother's education					
Illiterate	101	88.08	12.50	0.127	0.723
Write & read	10	86.60	12.47		
Mother's ANC attendance					
Yes	52	86.31	13.01	1.704	0.194
No	59	89.39	11.86		
Delivery place					
Health institution	11	73.20	15.93	7.796	0.006
Home	100	88.64	11.91		
Birth order					
1st	14	82.79	12.50	2.79	0.09
2nd & above	97	88.69	12.33		

Father's education					
Illiterate	56	89.70	12.52	1.93	7.149
Write & read	42	87.76	10.82		
Formal education	12	82.08	15.50		

Correlation between anthropometric indices and Bayley mental score showed only HAZ to be significantly correlated with Bayley score (r =.25, P< .005) (Table 9).

Correlation between different anthropometric indices showed HAZ to be strongly correlated with WAZ (r =.63, p<0.001), with child arm circumference (r=.40, p<.001) and child head circumference (r=.37, P<.001) (Table 10).

To minimize effect of multicollinearity only HAZ, which showed to

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To determine which set of variables best predict Bayley score at 12-42 months of age, a stepwise multiple regression was calculated. Three variables contributed to 16% of the variance, in order of entry these three variables were: birth order, place of delivery and HAZ. Birth order shared 48.3% of the variance, place of delivery shared 29.7% of the variance and HAZ shared 22.1% of the variance (Table 11).

Table 9 Correlations of anthropometric measurements and Bayley mental score with their correlation coefficients and 2 tailed significance.

	HAZ	WAZ	WHZ	HC	AC
Bayley Mental score	.25 (p=.007)	.10 (p=.302)	-.06 (p=.540)	.04 (p=.687)	.02 (p=.804)

Table 10 Correlations of HAZ with other anthropometric indices and thier correlation coefficient and 2 tailed significance.

	WAZ	WHZ	HC	AC
HAZ	.63 (P=.000)	.06 (P=.545)	.38 (P=.000)	.40 (P=.000)

Table 11 Multiple regression predictors of Bayley mental score and their Beta weight. Elka. 1996.

Variables	Beta	T	Sig.T
Child age	-0.1306	-1.45	0.15
Child sex	-0.0921	-1.03	0.31
Age when Supplementary feeding started	0.1563	1.74	0.08
Birth order	0.2338	2.58	0.01
Delivery place /health institution	-0.2084	-2.29	0.02
HAZ	0.1908	2.13	0.03
Family size	0.0039	0.03	0.97
Number of children < 5 Yr	0.0989	1.09	0.28
Number of adult family members	0.0169	0.18	0.86
Parity	-0.2041	-0.52	0.61
Mother's education	0.0063	0.07	0.94

Father's education	-0.0802	-0.88	0.38
Mother age	-0.1384	-1.23	0.22
V.poor knowledg	-0.0812	-0.90	0.37
Poor knowledg	0.0075	0.08	0.93
Fair knowledg	0.0381	0.41	0.68

R^2=.16449 F= 6.03 Sign F= .0003

Relative importance of predictor variables.

Variable	R^2	R^2 change	% change
Birth order	0.0795	0.0795	48.3
Place of delivery	0.12849	0.04899	29.78
HAZ	0.16449	0.03641	22.14

Discussion

In this study under weight was found in 49.5% of children and stunting was found in 52.2% of the children. The prevalence of underweight and wasting were in agreement with the national studies (19). But the prevalence of stunting was lower than the national figure. In all three anthropometric indices, males were more affected than females which is similar to the national study. Unlike the national situation, the age group which were most affected by underweight and

stunting were 24 - 35 months, similar pattern was obsereved in other parts of the country (N.Omo, W.Shoa, N.Gondar, Illubabor, Sidamo) in 1992 survey. Breast feeding was found to be universal and supplementary feeding was started after 7 months of infancy in 74.8% of children. Delayed initiation of supplementary feeding was observed which is also the same in other parts of the country (19).

Most of the children tested scored between 76 - 101. Significant difference was observed in mean Bayley score of children who were below -2SD HAZ and those above -2SD. The multiple linear regression analysis results also supported this finding. Unlike the Kenyan study (40), this study supports findings that H/A and mental development are positively related as shown in other studies (41,42,51). But no significant relation was observed with other anthropometric measures unlike other studies (43,55).

Multiple regression analysis indicated that although Bayley mental score and nutritional status have significant relationship, it is not very strong, as stunting contributed to 4% of the total variance. This finding suggests that although the two variables are related with each other, it is very difficult to predict the mental development score of children even if their nutritional status is known, as the variance

explained in mental score is very small. This could be because of the home environment which may provide good social stimulation, which in other study showed to be the most important variable predicting intelligence as compared to nutritional status and family variable (49).

Males and females were not different in mean Bayley score as seen in a Kenyan study (40).

Other studies have shown that socioeconomic and Parental educational status are strongly associated with mental score (46). Our result showed that performance in Bayley score was independent of economic status, family size, mother's education, father's education and mother's knowledge on child development.

This might be because, the population did not vary with regard to various environmental factors studied, had narrow socioeconomic range and similar parental stimulation and home environment.

Birth order and place of delivery are the other important predictor variables ,other than HAZ. Unlike the study done in India which showed negative relation (50), birth order showed to have positive relation to mental score. This could be becouse of its correlation with family size, which may provide social stimulation

and mother child rearing practice.

Place of delivery shares 5% of the total variance. Delivery in health institution was found to have negative relation with Bayley score. It was also found that, all mothers who delivered in health institutions had prolonged labour for which they were taken to health institutions. This could be the reason for low score observed in those who were delivered in health institution as delivery events are some of the factors which deleteriously affect mental development (25).

Limitations of this study

Determinant factors were not exhaustive. Family style of care giving, home rearing practice which were found to be the most important variables in predicting mental score in other studies (49,50) were not included in our study because of time constraints which maybe very important for this study.

Reliability of the timing of introduction of supplementary feeding and parents age could be questioned, since there is problem of recall.

The major limitation, as most similar studies which utilized mental development tests developed in other countries, and the use of an index score which was

devloped in different sociocultural set up which may affect the Bayley score outcome, .

Validity

The result of this study are assumed to be internally valid. Selection bias is unlikely as all houses having children 12 - 24 months of age were included. To improve compliance appropriate arrangement was made with each mother so that they can attend the test session and this explains the high response rate (97.4%)

Reliability was maintained by prior training of interviewers and regular and continuous supervision by the principal investigator and the psychologist.

As most of the questions were closed ended, simple to comprehend and collected by trained interviewers who were continuously supervised and cross checked, possible introduction of inter-observer and intra-observer biases were minimized during interview. Most measurements in Bayley scale were scored in an objective and straight forward manner which maximized consistency of scoring between examiners.

All anthropometric measurements were taken by a single person to avoid inter-observer variation and

equipments were checked and adjusted regularly. Exact age of each child was obtained from BHNS data.

Generalizability

It will be very difficult to generalize the findings of this study to the country because of the culture and ethnic diversity.

Conclusion and recommendation

This study demonstrated high prevalence of malnutrition particularly the chronic malnutrition. And this was shown to relate to mental development. Malnutrition and environment were found to be synergistically contributing to poor development of children. Other than nutrition, birth order is the factor which was shown to have positive relation with mental development. The other factor which was shown

to relate to mental development score was the birth event.

Recommendation

- Extensive health education services to the rural population on nutrition, with emphasis on the time of introduction of supplimentary feeding.

- Expansion of delivery services to the rural community.

- Further research on mental development of children with emphasis on the effect of family interaction and child rearing practice on mental devlopment.

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APPENDIX 1

Methods of anthropometric measurements

A. Length/ Height (Cm) . Crown heel length was measured using calibrated standard wooden boards for children less than 2 years of age, and standing Height

without shoes was measured by calibrated anthropometric steel road with head piece for children more than tow years old and mothers. And the measurements were recorded to the nearest 0.1 Cm. Grades of nutrition will be assessed using NCHS/ WHO data.

B. Body weight(Kg) . Weight of a child was taken with minimal clothing using salter type spring hanging scale which is 25x100gm, calibrated and rounded off to the nearest 100 gm. Weight of the mothers were taken using salter scale recorded to the nearest 100 gm.

C. Mid upper arm circumference. This was taken at mid point between the acromion and olecranon process of left arm while hanging freely using metric tape without compressing the skin. And the circumference is recorded to the nearest 0.1 Cm.

D. Head circumference (Cm).This was measured with measuring tape encircling the occipital protuberance on the back of the head and glabella infront. And it was recorded to the nearest 0.1 Cm.

APPENDIX 2 AN ENGLISH VERSION OF THE QUESTIONNAIRE

Date.....

Place.....

PART 1. GENERAL INFORMATION

1. Peasant association..... House Number....
2. Family size.....
   Adult=.... children(<15)=.... Under=.....

3. Head of the household
   1. Father
   2. Mother
   3. Other, specify_____

PART 2

I. Basic information on family or care-taker

1. Is the child's mother alive? Yes____ No____
   If yes, what is her age? _____
   Where is she living?_____

2. Is the child's father alive? Yes____ NO____
   If yes, what is his age?_____
   Where is he living?_____

3. What is the number of children born alive?____

4. Marital status of parents of the child
   1. Single/ unmarried
   2. Married/ together
   3. Divorced
   4. Widowed

5. Religion of head of the household
   1. Christian
   2. Muslim
   3. Other/ specify_____

6. Language spoken in the family
   1. Oromigna
   2. Amharigna
   3. Guragigna
   4. Other/ specify_____

7. Ethnicity of parents/ care takers
   1. Oromo
   2. Amhara
   3. Guragae
   4. Other/ specify

8. Mothers educational status
   1. Illiterate/neither read nor write
   2. Read and write
   3. Elementary school complete
   4. Junior high school
   5. Senior high school
   6 12th grade complete

9. Occupation of the mother
   1. House wife
   2. Civil servant
   3. Commercial - small shop owner___
      - open market___
      - bar tender___

4. Other/ specify_____

10. Fathers educational status
    1. Illiterate/ neither read nor write
    2. Read and write
    3. Elementary school complete
    4. Junior high school
    5. Senior high school
    6. 12th grade complete

11. Occupation of the father
    1. Civil servant
    2. Farmer
    3. Trader
    4. fisher man
    5. pensioned
    6. Unemployed
    7. Other, specify____

12. Housing type
    1. Thatched
    2. Corrugated iron roofed

13. What is the approximate monthly income of the family?
    1. Less than 50 Birr
    2. 51 - 100 Birr
    3. 101 - 200 Birr
    4. 201 - 500 Birr
    5. > 500 Birr

14. Does the family own cattle? yes____ no_____
    If yes, how many? 1. 1-5
    2. 6-10
    3. 11-15
    4. >15

15. Does the family own sheep? yes___ no_____
    If yes, how many? 1. 1-5
    2. 6-10
    3. 11-15
    4. >15

16. Does the family own goats? yes___ no___
    If yes, how many? 1. 1-5
    2. 6-10
    3. 11-15
    5. >15

17. Does the family own chicken? yes____ no___
    If yes, how many? 1. 1-5
    2. 6-10
    3. 11-15
    4. >15

18. Does the family own farm plot? yes____ no____

19. Do all family members eat together? yes___ no___
If not, who is served first? 1. father
2. mother
3. children
From the children, who is served first?
1. male children
2. female children

Whom does the family food distribution favours?
Age 1. children_____ 2. Adult_____
3.No difference___
Sex 1. Male_____ 2. Female_____
3.No difference___

II. Information on index child

1. Age of the child _____ months

2. Sex of the child 1. Male 2. Female

3. Birth order of the child _____

4. Did the mother attend ante natal care while pregnant? Yes__ No___

5. Where is the child delivered?
1. Home 2. Health institution 3.Other,specify__

6. Was the delivery uneventful
1. Yes___ 2. No___
If no, what was the problem?_____

7. For how long has the child been breast fed
1. < 4 month 3. 1 - 2 years 5. Still feeding
2. < 1 year 4. > 2 years

8. At what age did you start him on supplimentary feeding? __M

9. Was the child vaccinated?
1. Yes 2. No
If yes, for how long?_____ (see the card)

10. Was this child ill in the past two weeks?
1. Yes 2. No 3. Do not remember

11. If the child was sick, do you know the type of illness?
1. Yes 2. No

12. If yes, what was the illness

	Yes	NO
1. Diarrhea	___	___
2. Vomiting	___	___

3. Fever ___ ___
4. Skin rash ___ ___
5. Eye infection ___ ___
6. running nose ___ ___
7. Difficult to swallow ___ ___
8. refuse to feed ___ ___
9. Hoarseness of voice ___ ___
10. cough ___ ___
11. Difficulty or fast breathing ___ ___
13. Ear discharge ___ ___
14. Ear pain ___ ___
15. Other symptoms_____

13.What was done to the child during the illness?
1. Taken to health institution
2. Assisted by traditional healer
3. Given home care only
4. nothing was done

III. Mothers knowledge about child development

1. At what age does a child identify who its mother is?_____

2. At what age does a child start to understand word spoken?_____

3. At what age does a child start to communicate using sound/ words?_____

4. At What age does a child start to remember?_____

PART 3 ANTHROPOMETRY

CHILD 1. Weight in KG (to the nearest 0.5 gm) _____
2. Height in Cm (to the nearest 1 Cm) _____
3. Head circumference in Cm (>> >>) _____
4. Arm circumference in cm (>> >>) _____
Mother 1. Weight
2. Height
3. BMI (W/H2)=_____Pregnant Y__N__

MEASURES TAKEN
Health advice_____
Referral given_____
Treatment given_____

APPENDIX 3.

AMHARIC VERSION OF THE QUESTIONNAIRE

APPENDIX 4 ANSWER SHEET DATE------

NAME---------- SEX----- DATE OF BIRTH----

AGE IN MONTH---------- TESTER---------- RECORDER---------

(√) for right (x) for wrong

8m→→ 59---
60---
61---
9m→→ 62---
63---
10→→ 64---
65---
11→→ 66---
67---
68---
69---
70---
12→→ 71---
72---
73---
74---
75---
76---
77---
13→→ 78---
79---
80---
81---
82---*8M
83---
84---
85---
86---*9M
14-16→87---*10M
88---
89---
90---
91---
92---*11M
93---
94---
95---
96---
17-19→97---
98---
99---
100--*12M

101---
102---
103---
104---
105-- *13M
106---
20-22→107---
108---
109---
110---
111---*14-16M
112---
23-25→113---
114---
115---
116---
117---
118---
119---
120---
121---
122---
26-28→123---
124---
125---
126---
127---*17-19M
128---
129---
130---
29-31→131---
132---
133---
134---
135---*20-22M
32-34→136---
137---
138---
139---
35-37→140---
141---
142---

143---
144---
145---
38-42→146---
147---
148---*23-25M
149---
150---
151---
152---
153---
154---*26-28M
155---
156---
157---
158---*29-31M
159---
160---
161---
162---
163---
164---
165---
166---*32-34M
167---
168---*35-37M
169---
170---
171---
172---
173---
174---
175---
176---
177---
178---*38-42M

TOTAL SCORE=---------

To be filled by the principal investigator.

INDEX SCORE-------

APPENDIX 5

BAYLEY MENTAL SCALE TEST MATERIALS, ADMINISTRATION AND SCORING DIRECTIONS IN AMHARIC.