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Full Length Research Paper

Effect of mild to moderate chronic malnutrition on cognitive development of toddlers in Jimma town, Ethiopia

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Abstract

In developing countries like Ethiopia, the effect of mild to moderate chronic malnutrition on the development of children is both understudied and under-attended. To assess the pattern of cognitive development of toddlers, to identify their nutritional status and to determine the effect of mild to moderate chronic malnutrition on cognitive development, fifty three children of age 29-42.5 months were studied from May-June, 2011 in Jimma town, Ethiopia. Cognitive development was measured in Bayley scales-III, and nutritional assessment was done using anthropometric measurements. Data were analyzed using SPSS version 16 and ANTHRO 2007. Descriptive statistics, Pearson correlations, t-test and ANOVA test were computed. Cognitive development of the children was 7 (13.5%) average, 40 (77%) low average, and 3 (5.8%) borderline. The developmental age of the children was 12.3 +/- 4 months behind their chronological age. The chronological age of the children had negative correlations with cognitive composite scores ($p<0.01$, $r = -0.46$). Mild to moderate stunting was associated with lower cognitive level ($p<0.05$, eta squared= 0.09). Mild and moderate malnutrition can have a significant negative effect on cognitive development. Researchers, schools and healthcare providers should give it adequate attention.

Keywords: Chronic malnutrition, development, Ethiopia.

INTRODUCTION

Malnutrition stands among the commonest causes of child mortality and morbidity worldwide (WHO, 1999; USAID, 2009; Caulfield et al., 2004) and in the developing world under nutrition is responsible for 53% of under five deaths (USAID/ PVO Child Survival and Health Grants Program, 2005). Children that survive under nutrition frequently suffer from cognitive delays that impair latter schooling, and productivity (USAID/ PVO Child Survival and Health Grants Program, 2005; Alaimo et al., 2001).

Although the world is working to achieve the millennium development goals and success has been shown, the success is not uniform (Deconinck et al., 2008). Child underweight is continuing to rise in Africa contrary to the projected decline from 1990 to 2015. For example, childhood underweight has been estimated to increase by 25% from 1990 to 2015 in East Africa where Ethiopia is included (De Onis et al., 1990, 2015). According to the 2011 Demographic and Health Survey of Ethiopia, 44% of children under five years were stunted with 21% severely stunted, 29% were underweight with 9% severely underweight, and 10% were wasted with 3% severely wasted (Central Statistical Agency (Ethiopia) and ICF International, 2012).

In Ethiopia, malnutrition is a long-term year-round problem found in the majority of households across all regions of the country. This chronic poverty is frequently accompanied by illiteracy with ignorance about the nutritional needs of children, the importance of play and psychosocial stimulation in child development, the decisive effect of hygiene in health, the necessary measures to take when children become ill, and the ill effects of different traditional practices (Federal Ministry of Health of Ethiopia, 2007). The chronic food shortage is a very strong factor influencing approaches to malnutrition by creating pressure to focus primarily on food security, nutritional surveillance and/ or to respond to pockets of emergencies (Jennings and Hirbaye, 2008) with the main focus on screening and managing Severe Acute Malnutrition (SAM) (Federal Ministry of Health of

Ethiopia, 2007). The effect of chronic malnutrition, specifically when it is mild and moderate, on the development of children is both under studied and under attended.

In the health care delivery system of Ethiopia, childcare practices do not include assessment of development. Even the Ethiopian National Strategy For Infant and Young Child Feeding document produced by the Federal Ministry of Health in 2004 (Federal Ministry of Health of Ethiopia, 2004) has totally excluded the necessary components of child care that enhance child development such as play and psychosocial stimulation.

The available literature has not included what happens to the development of children when there is persisting mild and moderate malnutrition and the health care delivery system is lacking essential elements that enhance development.

The objectives of this study were to assess the pattern of cognitive development of toddlers in Jimma town, to identify their nutritional status, and to determine the effect of mild to moderate chronic malnutrition on cognitive development.

METHODS

This was a quantitative survey conducted in seven kindergartens in Jimma town, southwest Ethiopia from May-June 2011. Although the plan was to include children of age above 24 months to 42.5 months, the participants found were in the age range of 29 months to 42.5 months. The age limits were set because of the nature of the Bayley III scale. The scale was developed for age groups 1 month to 42.5 months. However the application of the scale up to the age of 24 months needs the knowledge of the gestational age of the children for the purpose of adjusting for prematurity (Bayley, 2006), which is the type of data unavailable for most children in Ethiopia. The children included were apparently well, able to communicate verbally, have attended in their kindergarten at least for six months, and have their birth certificate attached to their document. Only 53 children were found to fulfill the criteria and all of them were included in the study.

The dependent variable of the study was level of cognitive development among the toddlers and it was measured using the cognitive component of Bayley Scale of Infant and Toddler Development, third edition (BSID-III). The developers of the test had standardized it for different parental levels of education, ethnicity, geographic location, age and sex (Bayley, 2006). The Bayley scale was administered by the principal investigator who has a basic training in standardized testing and certified to use the scale by the publisher. Bayley-III scaled scores and composite scores provide the most accurate description of test data (Bayley, 2006) and therefore composite scores were used in the inferential analysis. However, qualitative classification was also made using the cut off points of composite scores given in the technical manual of the scale (Bayley, 2006): very superior 130 and above), superior (120-129), high average (110-119), average (90-109), low average (80-89), borderline (70-79), and extremely low (69 and below).

The independent variables of the study were the indices of nutritional status (USAID/ PVO Child Survival and Health Grants Program, 2005): weight-for-age (level of underweightness), height-for-age (level of stunting), and weight-for-height (level of wasting). Weight was measured with the child in minimum clothing using UNISACLE to the nearest 0.1 kg and age was taken from the child's birth certificate. Height was measured using a portable instrument manufactured by the recommendation of UNICEF to the nearest 0.1 cm with the child barefoot, removing scarf, cape, and in minimum clothing. Two experienced and trained nurses were working together as assistant and reader. Every child was measured two times with the roles of the nurses reversed during the second measurement. When the difference between the two readings was greater than 0.1 cm, the procedure was repeated by both nurses. The standard procedure recommended by WHO was followed to measure the children's height and weight. Weight-for-age and height-for-age scores were converted to Z-scores as this is the simplest way of describing the reference population and making comparisons to it as recommended by WHO. Qualitative classification was made using the following same criteria for levels of underweight, stunting and wasting (USAID/ PVO Child Survival and Health Grants Program, 2005): normal (Z-score -1 or more), mild (Z-score -2 to <-1), moderate (Z-score-3 to <-2), and severe (Z-score < -3).

In each school, a quite room was arranged where weight, height and cognitive development of the children were measured in that order. While weight and height were taken together for each child, the Bayley scale was administered on the next 3 days. The teachers of the children were available during the procedures and colorful balloons were given to the children to make them cooperative.

The variables measured for the purpose of controlling were history of breastfeeding, immunization status, primary caretaker (mother or someone else), maternal education, and child stimulation at home. Data on control variables were collected from the primary caretakers of the children using a structured interview guide either at the child's home or at the school depending on feasibility.

This research was conducted after ethically reviewed and permitted by Jimma University Ethical Review Board, the university where the investigator was based. Formal letter was written to the schools from the university. Parents/guardians of children had given their written informed consent and every child was measured only with care and affection. Although the plan was to soothe and leave a child with the colorful balloon if it refuses, no child was found to refuse the tests.

Data was analyzed using SPSS version 16.0. Z-scores for indexes of malnutrition were computed using ANTHRO 2007 software. Descriptive statistics were computed to describe the study participants in terms of their background characteristics, qualitative classifications of level of cognitive development, and qualitative classification of level of chronic malnutrition. Pearson correlation was computed after checking scatter plots and normality of distribution of scores to see the magnitude and direction of associations between cognitive score and nutritional indices. After checking assumptions of equality of variance and normality of distribution of the composite scores, the independent-samples t-test was computed to assess the presence of differences in the level of cognitive development between chronically malnourished children and those who were not chronically malnourished. One-way between groups ANOVA was computed to compare the level of cognitive development among the different age categories. Post hoc Turkey HSD tests were computed when ANOVA tests became statistically significant to identify between which groups the difference occurs in terms of the dependent variable. Effect sizes of t-tests and ANOVA tests were measured in partial Eta- squared values and statistical tests were considered significant when p-value was less than 0.05.

RESULTS

There were 53 children included in the study whose age ranged from 29-42.5 months with a median of 39 months, and a mean of 38.2 ± 3.4 months. Thirty one (58%) of the children were males. All of them were breastfed for a median duration of 18 months, were born from educated mothers, and fully immunized for the childhood vaccine preventable illnesses. Forty six (96%) of the children were born in health institutes. A good proportion of them had the opportunity to be stimulated by playing with toys, storytelling, watching children's movies at home, and visiting recreational places (table 1).

Regarding the nutritional status of the children, none of them were severely underweight, or wasted. Only one child was found to be severely stunted. However, 9 (17.3%) were having mild underweight, 15 (28.9%) had mild to moderate stunting, and 4 (7.7%) had mild to moderate wasting. Qualitative classification of the level of cognitive development of the children on Bayley scale showed that 7 (13.5%) were average, 40 (77%) were low average, and 3 (5.8%) were borderline. Two children had cognitive composite scores extremely low. The developmental age of the children ranged from 18 to 30 months. Likewise, the difference between the developmental ages and the chronological ages of the children ranged from 0 to 22.2 months with a mean of 12.3 ± 4 months and a median of 12.7 months (table 2).

Pearson binary correlations were computed after checking for the necessary assumptions to see the association of level of cognitive development with height-for-age z-scores (level of stunting), weight-for-age-z-scores (level of underweight), and weight-for-height z-scores (level of wasting). Only height-for-age Z-scores were found to have a statistically and practically significant association with cognitive composite scores ($p<.01$, $r=0.4$). As expected, cognitive composite scores had a negative correlation with the difference between chronological age and developmental age measured in months. ($p<0.001$, $r=-0.8$). Spearman's rho was computed (because the chronological age of the children did not have a normal distribution) to see the correlation between age of the children and their cognitive composite scores. This analysis has shown a negative correlation between the two variables ($p<0.01$, $r= -0.46$) (table 3). Chronological age had no correlation with height-for-age Z-scores (table not shown).

Further analysis was done using independent samples t-test to determine the effect size stunting has on cognitive development by comparing the mean composite scores of those who were stunted with those who were not stunted. The result showed that the effect size was a partial eta squared value of 0.09 ($p<0.05$). Similarly ages of the children were classified at 33.33rd percentile and 66.67th percentiles and one-way between groups ANOVA with post hoc Turkey HSD test was computed to examine the effect size age has on cognitive composite scores. Here again the result showed that the significant difference was only between the lower third and the upper third groups and the effect size in partial eta squared value was 0.16 ($p<0.05$) (table 4 and figure 1).

DISCUSSION

This study was designed to examine the effect of mild to moderate chronic malnutrition in a developing country among children that were from relatively better home environments and having the main opportunities for normal growth and development: full immunization, breast feeding, stimulation at home, and access to schools that provide them with additional opportunities such as more stimulation at school and interaction with other children. In this regard this research is therefore, the first of its type in the world.

Despite the presence of all those opportunities at home, there were problems in the growth and development of the children. The proportion of children with stunting 16 (29.8%), wasting 4 (7.7%), and underweight 9 (17.3%) were in the range of high prevalence, medium prevalence, and medium prevalence respectively according to WHO cut off values (USAID/ PVO Child Survival and Health Grants Program, 2005), although much lower than the national occurrences in

Table 1. Socio-demographic characteristics of the toddlers, May 2011

Characteristics		Number %)
Sex (n=53):	Male	31 (58.5)
	Female	22 (41.5)
Immunization status (n=53):	Completed	53 (100)
	Not completed	0(0)
Age in months (52):	min.=29, max.=42.5, mean= 38.2, SD=3.4, median= 39	NA
Place of delivery(n=48):	Health institute	46 (95.8)
	Home	2 (4.2)
Source of information (48):	mother	42 (87.5)
	Other caretaker	6 (12.5)
Breast feeding (n=48):	Yes	48 (100)
	No	0 (0)
Duration of breast feeding in months (N=48):	Min.=1.5,max.=38, Mean=17.3, SD=9.7, median=18	NA
Habit of visiting recreational places (n=48):	yes	40 (83.3)
	No	8 (16.7)
Play with commercial play materials at home (n=47):	Yes	45 (95.7)
	No	2 (4.3)
Habit of watching children's movies at home (n=48):	Yes	33 (68.7)
	No	15 (31.3)
Parents/car taker read story books to child (48):	Yes	23 (47.9)
	No	25 (52.1)
Habit of listening to storytelling at home (n=48):	Yes	35 (72.9)
	No	13 (27.1)
Educational status of mother (n=48):	Grade 1-6	3 (6.3)
	Grade 7-12	23(47.9)
	College level	22 (45.8)

NA= not applicable

Table 2. Nutritional status and cognitive level of the toddlers, May 2011

Characteristics		Number (%)	Minimum/maximum	Mean (median)	SD
Level of underweight (n=52):	Normal	43 (82.7)	NA	NA	NA
	Mild underweight	9 (17.3)			
Level of stunting (n=52):	Normal	36 (69.2)	NA	NA	NA
	Mild stunting	11 (21.2)			
	Moderate stunting	4 (7.7)			
	Sever stunting	1 (1.9)			
Level of wasting (n=52):	Normal	48 (92.3)	NA	NA	NA
	Mild wasting	3 (5.8)			
	Moderate wasting	1 (1.9)			
Level of cognitive development (n=52):	Average	7 (13.5)	NA	NA	NA
	Low average	40 (76.9)			
	Borderline	3 (5.8)			
	Extremely low	2 (3.8)			
Developmental age of the children in months (n=52)		NA	18 /30	25.8/25.5	2.1
Difference between chronological age and developmental age (n=52):		NA	0/22.2	12.3/12.7	4.0

NA= not applicable

Table 3. Pearson correlations of cognitive composite score with nutritional status indices, May 2011

Measures (n=52)	1	2	3	4	5	6
(1)Cognitive composite score	1					
(2)Difference between chronological age and developmental age	-.80***	1				
(3)Height-for-age Z-score	.40**	.37**	1			
(4) Weight-for –age Z-score	.16	-.11	.77**	1		
(5)Weight-for-height Z-score	-.09	.17	.31*	.82**	1	
(6) Age in months when Bayley administered $^{\rho}$	-.46**	.82**	-.22	-.08	.01	1

***=Pearson correlation is significant at 0.001 level (1-tailed)
**=Pearson correlation is significant at .01 level (1-tailed)
*=Pearson correlation is significant at .05 level (1-tailed)
$^{\rho}$=Spearman's *rho* was computed

Table 4. Independent samples t-test and one-way between -groups ANOVA with post hoc tests on cognitive composite scores among toddlers in Jimma Town, May 2011

Characteristics		Number	Mean	T/F	Df	p-value	Partial Eta squared
Presence of stunting (n=51):	Normal	35	11.73	2.19	49	.034	.09
	Stunted	16	13.38				
Age in months (n=52):	29-37.3*	17	85.00	4.51	(2,49)	.016	.155
	37.33- 40.3	18	81.39				
	40.33- 42.5*	17	79.41				

**=significant difference at 0.05 level after the post hoc Tukey HSD test*

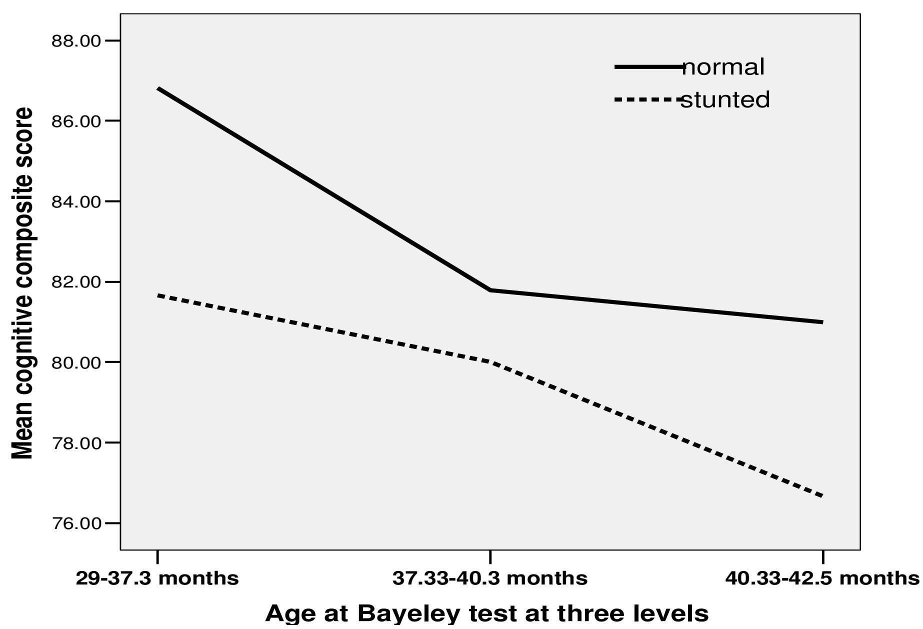

Figure 1. Effect of age and stunting on cognitive development of toddlers, May 2011

Ethiopia (Central Statistical Agency (Ethiopia) and ICF International, 2012). A tragedy of highest stunting in food surplus areas of Ethiopia was reported from a national survey in 1993 (Central Statistical Authority, 1993).

Whether the children were chronically malnourished or not, their developmental ages were on the average one year behind their chronological ages. In both groups, cognitive development declined as their age increased from 29 months to 42.5 months; however, the decline was more marked in the chronically malnourished children. This finding shows that factors other than chronic malnutrition are also playing a significant negative role in the cognitive development of the children. The finding that the decline increased with time also suggests that the factors become more intensified with age. This makes the question to be focused on the general environment, particularly the school as the children often pass most of their time in schools when they are not at home at those ages.

Comparing the findings in this research with previous works is very difficult for four major reasons: firstly: all other studies investigating the association between chronic malnutrition and cognitive development conducted their studies on children recovering from severe malnutrition with possible cascades of problems to grow and develop. Secondly, different researchers have used different instruments and hence direct comparison is difficult. Thirdly, in many of the studies effect sizes were not clearly reported. And fourthly, the age groups studied by different researchers were different. Despite all these differences in the existing literature, agreement exists that chronic malnutrition is associated with lower mental ability (USAID/ PVO Child Survival and Health Grants Program, 2005; Alaimo et al., 2001; Grantham-McGregor et al., 1991; Kar et al., 2008; Grantham-McGregor, 1995). Two points have been added in this study: first, cognitive development has declined with age regardless of nutritional status and a conducive home environment probably because of the adverse general environment. This strongly suggests that concerted efforts targeting the whole population are superior to any strategy that focuses on selected interventions on special groups. Second, mild to moderate stunting is enough to affect cognitive development significantly in such less supportive general environments. This finding suggests that the less humanitarian, less ethical, and less economical strategy of delaying interventions until children pass the screening criteria of severe malnutrition should be reconsidered in developing countries.

Generally, the cognitive development of the children was found to decline as their age increases regardless to their supportive home environments and nutritional status. In such setups mild to moderate chronic malnutrition is severe enough to lead to delayed cognitive development. Schools and health care provides need to revise the way they are supporting children.

The major weaknesses of this research are that it has considered only cognitive aspect of development because of absence of a reliable instrument and small sample size to analyze the effect of confounders.

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