Original article

Malnutrition and enteric parasitoses among under-five children in Aynalem Village, Tigray

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Abstract: A cross sectional study was conducted in Aynalem Village, Tigray, in April 1997 on a total of 330 under-five children. Results from nutritional status assessment and stool examination for seven common enteric parasites are presented. The prevalence of stunting, wasting, and under-weight were 45.7%, 7.1%, and 43.1% respectively. The prevalence of low weight-for-age and stature-for-age were significantly associated with the age-group of children, (χ^2 =41.9, p<0.01 and χ^2 =47.3, p<0.01), respectively. The overall prevalence of infection (with one or more parasites) was 48.1% and it was linearly associated with age-group of children (χ^2 =18.1, p<0.01). Overall parasite prevalence ranged from the highest (16.3%), among 36-48 months old children to the lowest (1.4%) among the 6-12 months old children. The highest proportion of those children positive for one or more parasites harbored *Entameba histolytica* (18.3%) followed by *Hymenolopis nana* (17.3%), *Giardia lamblia* (7.7%) and *Ascaris lumbricoides* (5.8%). Fewer proportion 1.9%, 1.0%, and 1.0%, harbored *Strongloides stercoralis, Schistosoma mansoni, and Entrobius vermicularis,* respectively. There was no statistically meaningful association between age group specific prevalence of malnutrition and the prevalence of enteric infections. The results from this study indicate that both malnutrition and enteric infections exist to a level of public health significance in the area probably interacting synergetically and with other socio-economic and dietary factors. Long and short term measures necessary to alleviate the problem are discussed. [*Ethiop. J. Health Dev.* 2000;14(1):67-75]

Introduction

Malnutrition is an important problem on its own, firstly because good nutrition is an essential determinant of well-being, secondly, because good nutrition is a fundamental right, and thirdly because of the consequences associated with malnutrition. The consequences of malnutrition as indicated by anthropometry include childhood morbidity and mortality, poor physical development and school performance, and reduced adult size and capacity for physical work, with an impact on economic productivity at national levels (1). Malnutrition results from the interaction between poor diet and disease and leads to most of the anthropometric deficits observed among children in the world's less developed countries(2). The "nutrition-infection nexus" is well known as a powerful determinant of the ultimate nutritional outcome and it remains to be the most prevalent public health problem in the world today. It often increases the frequency and severity of infectious diseases, especially in infants and children (3). Mechanisms whereby infections lead to growth failure and clinical malnutrition operate through anorexia, changes in metabolism, malabsorption as well as behavioral changes affecting feeding practices. This lead to malnutrition in the context of limited nutritional reserves.

The existence of synergistic interaction between malnutrition and enteric infection among children has been documented from studies conducted elsewhere (4,5). On the contrary, studies conducted in Ethiopia (6) and Bangladesh (7) have reported the lack of associations between malnutrition and enteric infection.

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infection.

Ethiopia is one of those developing countries with high prevalence of child malnutrition (8) and enteric infections (9,10,11). Under-five mortality is among the highest in the world (ranking 16th) with a magnitude of 177/1000 (12). Despite all the poor nutrition and health conditions in the country, research endeavors to avail information to sensitize the public and policy makers as well as to describe health and nutrition interactions are minimal.

The aim of this paper is to describe the extent of malnutrition and parasitic infections and their interactions among under-five children in one community of Tigray.

Methods

*Sampling:*The total population of the village in 1997 was about 2500 with about 495 under-five children. The households with underfive children were selected ranomly after determining the sample size as described below. The number of children (n) which must be studied, ie, within 10% of the true proportion (W) with 95% confidence, was estimated to be 297 using the formula shown below (13). Ten percent was added to compensate for likely defaulting, bringing the total sample size to about 330.

$$n=16p(100-p)/W^2$$

The expected proportion of malnutrition (p) (as expressed by low weight-for-age) was assumed to be about 60%, using information from previous surveys in the Region (8).

Nutritional anthropometry: All anthropometric measurements were taken by an experienced nutritionist. Body weight was measured to the nearest 100g with minimum clothing (only T-shirts and shorts) and using battery-operated digital scales (SECA, manufactured for UNICEF). The instrument has been calibrated repeatedly using six 10 kg known weights (approved by the Ethiopian Standards Authority) and was found to be consitently sensitive. It has been initially established that using this, the weight of a child weighing two kgs or more could accurately be measured with the mother. Children who could not stand by themselves were, therefore, weighed with their mothers. Stature was measured without shoes, to the nearest 0.1, cm using Harpenden stadiometer. Length of children below two years was measured using wooden length board according to the standard procedures (13).

Stool examination: Stool samples were collected in plastic screw-capped cups, transported to the laboratory in an ice box, and direct microscopic examination for ova and parasite were carried out by experienced laboratory technicians during the evenings (within 2-8 hrs.).

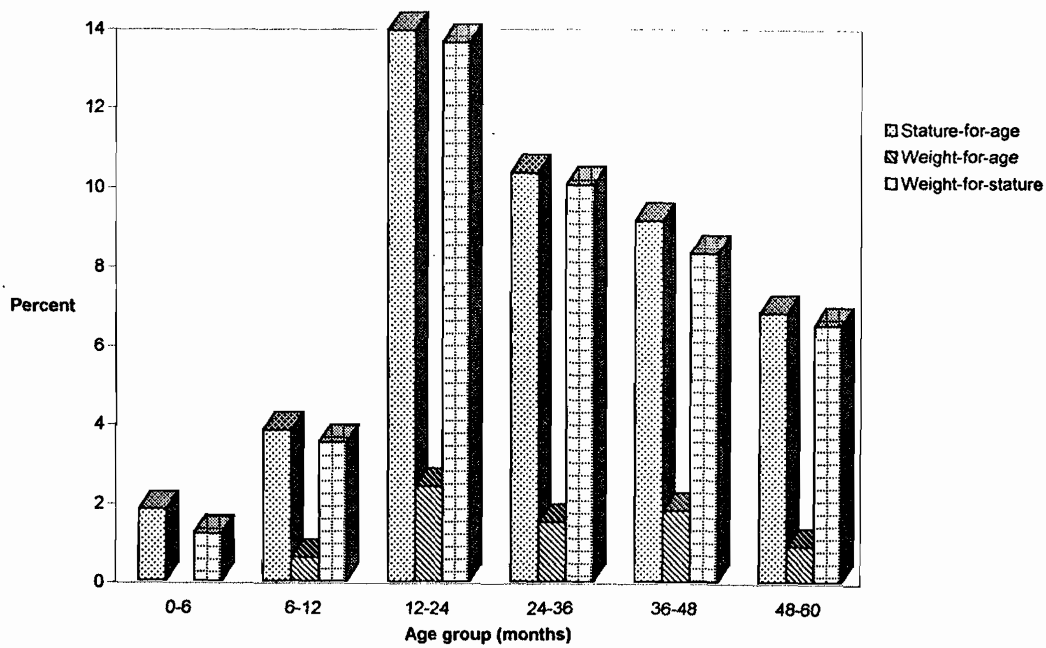
Statistical analyses: Data were entered and analyzed using SPSS/PC (14) and EPI INFO (15) computer packages. Chi-square test was used to examine associations and linear trends in group-specific proportions. One way ANOVA with *Scheffe* multiple comparison test was employed to test the difference between group means.

Results

Study site and population: The study site, Aynalem Village, is located five kms from Mekele Town. The mainstay of about 51% of the hoseholds was farming. About 55.7% of adult men and 58.8% of women were illiterate. Eventhough some households use composite flours, the staple food crop of the area is sorghum. A considerabe proportion of households indictaed that they consume vegetables, including cabbage, swiss chard, carrots, beet root and potato.

Child-feeding practices: Some 89% of the mothers reported that they initaited breast-feeding on the first day of delivery. About 70% of the mothers reported that children started complementary feeding before the age of six months. Sixty percent of the mothers reported that gruel or porridge made of teff is provided at least once a day for their weaning-age children. About 9% reported that cow milk was the main weaning food provided. Only very few (0.5%) of the mothers reported that animal products have been given to their children during weaning periods.

Protein-energy malnutrition: Figure 1 shows the prevalence of malnutrition (<-2SD) by age



Figur 1: **Prevelance of malnutrition (<2SD scores) among under-five children, by age group**

group. The overall prevalence of stunting, wasting, and underweight were 45.7%, 7.1%, and 43.1%, respectively. The prevalences of stunting and underweight were significantly associated with the age-group of children, $\chi^2 = 41.9$, $p<0.001$ and $\chi^2 = 47.3$, $p<0.001$, respectively. Both highest prevalences of low stature-for-age and weight-for-age were observed among the age group of 12-24 months whereas the lowest prevalences of stunting, wasting, and underweight were observed among the 0-6 months age group.

Table 1 below shows mean and SD of NCHS Z-scores by age. Oneway ANOVA with *Scheffe* multiple comparison test was employed to obtain significance of differences between age groups. The overall mean Z-score value for stature-for-age was -2.04±1.45. Mean weight-for-age and weight-for-stature Z-scores were -1.82±1.20 and -0.70±1.04, respectively. The mean Z-score values for age group 0-6 months were found to be significantly different from most other age groups.

Table 1: **Mean NCHS Z-scores, of children by age group**

			Stature-for-age		Weight-for-age		Weight-for-stature	
Row	Age	n	Mean	SD	Mean	SD	Mean	SD
1	0 - 6	27	$-0.94^{3,4,5}$	1.14	$-0.51^{2,3,4,5,6}$	1.05	$0.24^{3,4,5,6}$	0.99
2	7 - 12	33	-1.45^{3}	1.33	$-1.50^{1,3}$	0.98	-0.43	1.20
3	13 - 24	62	$-2.83^{1,2,6}$	1,51	$-2.40^{1,2}$	1.44	-0.86^{1}	1.27
4	25 - 36	38	-2.46^{1}	1.39	-2.21^{1}	1.10	-0.85^{1}	0.79
5	37 - 48	51	-2.30^{1}	1.41	-2.05^{1}	1.01	-0.90^{1}	0.82
6	49 - 60	97	-1.74^{3}	1.21	$-1.65^{1,3}$	0.89	-0.80	0.85
	0-6	308	-2.04	1.45	-1.82	1.20	-0.70	1.04

Superscripts on each value indicate the row number of other significantly different values within the same column (p<0.005)

Table 2: **Mean difference between weight and stature of NCHS reference median and weight and stature of the study children**

	n	Stature Mean Δ	SD	Range	Weight Mean Δ	SD	Range
Boys	165	-7.5	4.8	-20.4 to 4.0	-2.8	1.7	-7.9 to 2.0
Girls	166	-7.0	5.6	-21.7 to 7.9	-2.5	1.7	-7.0 to 2.8
All	331	-7.3	5.2	-21.7 to 7.9	-2.6	1.7	-7.9 to 2.8

Table 2 presents descriptive statistics of stature and weight differences. Compared to NCHS median, stature and weight were, on average, 7.2±5.2 cm and 2.6±1.7 kg lower than the reference median, respectively, with no statistically significant difference between boys and girls.

Prevalence of infection: Figure 2 shows the prevalence of parasite infection by age group of children. Children below six months were excluded from stool examination as it was diffcult to get specimens on the spot. Out of the total examined, 48.1% were found positive for one or more parasites. On the basis of parasite specific infection, about 18% of the under-five population harbored *E. histolytica* followed by *H. nana* (17.3%), *G. lamblia* (7.7%), *A. lumbricoides* (5.8%), and *S. stercoralis* (1.9%). The lowest rate of infection was by *E. vermicularis* and *S. mansoni* (1%).

Upon disaggregation by age group, significant association has been revealed between the age group of children and the overall prevalence of infection with one or more parasites ($\chi^2 < 18.1$, $p<0.01$). The trend was significantly linear ($\chi^2 = 16.2$, $p<0.001$) by Mantel-Haenszel test for linear association.

Children beteen 36-48 months old had the highest rate of overall infection (16.3%) whereas children 6-12 months old had the lowest. On parasite-specific basis, only the prevalence of infection by *Entameba histolitica* and *Strongloides stercoralis* were significantly associated with the age group of children ($\chi^2 = 9.14$, $p<0.05$, $\chi^2 = 11.1$, $p<0.05$). Neither

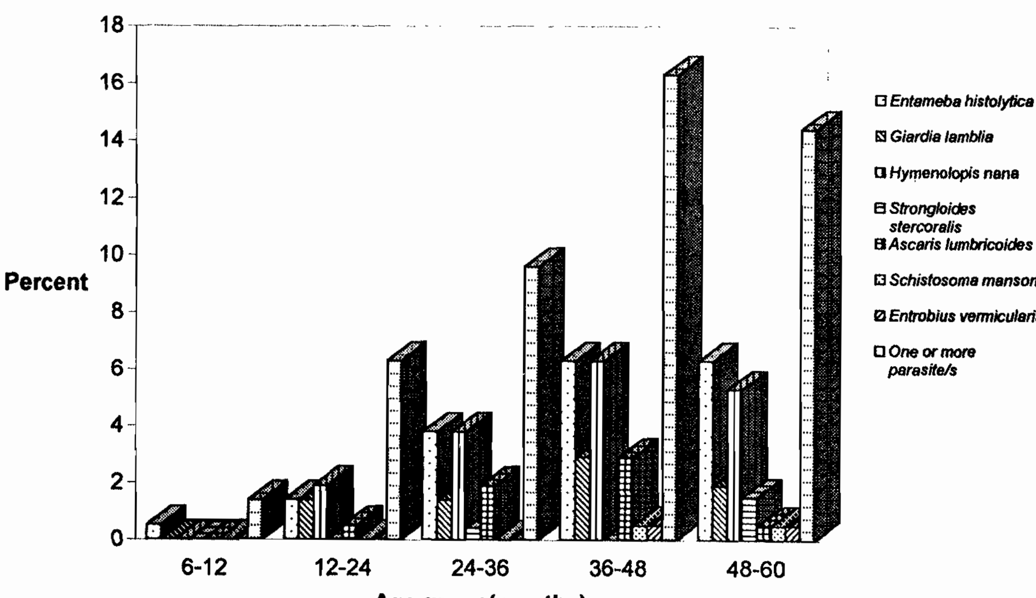


Figure 2: **Prevalence of parasite infection, by age group**

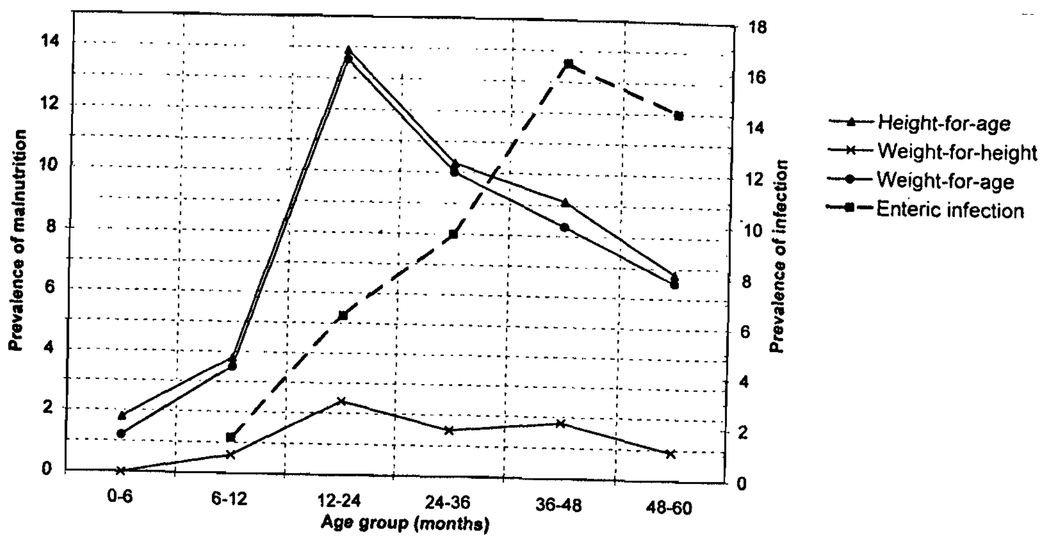


Figure 3: **Patterns of malnutrition (<-2SD Z-score) and entric infection, by age group**

overall nor parasite-specific prevalences were significantly related to the sex of the child.

A considerable magnitude of multiple infections has also been revealed. Among under-five children, multiple infection was observed in 8.6% of the total number of children examined and in 14.8% of those positive for one or more parasites.

Relationship between malnutrition and infection: Figure 3 presents mean age-group prevalence of malnutrition and infection. Generally the trends in the prevalence of malnutrition and infection have their minimum at early ages (before one year). Prevalence of malnutrition peaks among the 12-24 months old children whereas parasite infestation peaks among the 36-48 months old children. There was no statistically significant association between the prevalence of malnutrition (<-2SD score stature-for-age, weight-for-age and weight-for-stature) and overall infection when the Chi-square test was employed.

Discussion

The main observation from this study is the co-existence of high prevalences of child malnutrition with infection by various helminthic and protozoal parasites and the fact that both were related to the age group of children.

Child malnutrition prevalence figures obtained from this study were generally lower than what has been reported at national and regional levels (4). The most recent national survey conucted in 1996 (16) indicates that the rural parts of the Region are still affected by the highest level of chronic malnutrition as proxied by the prevalence of stunting. This observation is more or less consistent with what has been observed in Gurage Zone recently (17), except for the level of wasting which is much lower. Compared to more recent studies in the Gurage Zone, the observations and our figures for stunting are even lower than that reported for Mekele Town from the latest CSA survey. Unfortunately, our data set does not allow us to comment on this descrepancy. According to suggested severity criteria (18), however, both the prevalence of stunting and under-weight were categorized as very high while the prevalence of wasting was categorized as of medium severity. This indicates that child malnutrition is still of public health significance in the area.

It has been observed that the prevalence of stunting and underweight were associated with age group, inclining from the 0-6 months to the 12-24 months age-groups and with a declining trend thereafter until the 48-60 months age group (Figure 1). This observation is in agreement with that reported in Ethiopia (4) although the gradient in malnutrition rate between age-groups in the present study was much sharper. Such trends of stunting are common observations in many developing countries and the patterns of deterioration are amazingly consistent worldwide (1).

Many studies had already demonstrated high prevalence of enteric infection among Ethiopian children in various parts of the country (5, 6, 7, 19, 20, 21, 22, 23). The prevalence of infection with one or more parasites among under-five children found in this community was lower than that reported for Jigga Town, North west Ethiopia, and Central Ethiopia whereas the prevalences of *E. histolytica* and *G. lamblia* were quite comparable to what was reported in the study from Gigga Town (24). As parasite prevalence varies with agro-ecozones, altitudnal and other environmental factors, the parasite-specific prevalences may not be expected to coincide unless they are controlled by these factors and, hence, not too many comparisons were attempted. Our study also indicates that a significant proportion of the children were positive for multiple parasite infections. This is indicative of the overall sanitary situation as well as the lack of knowledge of the care takers to protect children by sanitary means from exposure to pathogens.

Prevalence of overall parasite infection among the under-five was linearly age dependent with the highest infection rates being observed among the 36-48 months old children. Parasite specific prevalences were also highest for *E. histolytica, G. lamblia, H. nana,* and *A. lumbricoides* among the 36-48 months age-group (Figure 2). This is probably due to the increased exposure of the child to pathogens with increased mobility and weaning practices. The low prevalnce of both malnutrition and enteric infection among the younger age-group (6-12 months) is generally indicative of the protective effects of breastfeeding indirectly through limiting exposure to pathogens via contaminated foods. However, during later ages, the introduction of the ususal less nutritious and less hygenic weaning foods expose children to increased risk of malnutrition and infection and, hence, both malnutrition and infection tend to be higher compared to the younger ages. The adverse consequences of these on growth and development of children should be of much concern for development initiatives.

This study did not provide any evidence of association between parasite infection and nutritional status of children. The lack of association between malnutrition and enteric infection, when stratified by age, is due to the fact that the trends, though related to the age-group, are different for malnutrition and infection. When ANOVA was employed without age-group stratification, i.e., when mean Z-scores of nutritional indicators were compared between those positive for one or more parasites, or for specific parasites and those negative for the former and the latter, no significant difference was revealed. Similar findings were reported in Ethiopia (11) and elsewhere (12, 25, 26). However, some studies, in contrast, have reported positive relationship, such as between *Giardiasis* and malnutriton (9). Among 2-5 year old children in Guatemala (5) it has been found that treatment with metronidazole was followed by improved growth as measured by anthropometric parameters. Another Guatemalan study (27) also reported that weight velocity of infected school children was lower compared to their *Giardia* negative counterparts. The lack of association between nutritional status and enteric parasitoses in this study may either be due to the small or dissimilar sample sizes and other limitations of the study or due to a real absence of measurable difference. However, further studies should be conducted before concluding from pocket studies like this one.

Studies (28, 29) indicate that severe stunting is related to poor intellectual performance.

High level of stunting among children suggests that there will also be long-term deficits in mental development that can leave children ill-prepared to take maximum advantage of learning opportunities in school (8). Stunting in childhood also leads to reduced adult size and reduced work capacity (30). Small women staure as a consequence of childhood stunting is also a risk factor for pregnancy complications and low birth-weight implying intergenerationl advers consequences. Malnutrition had also been found to potentiate the effects of infection (31) and the observed high prevalence of malnutrition and infection should be given due emphasis in development initaiatives.

The observed prevalences of both enteric parasitoses and malnutrition exceed the WHO minimum tolerable levels for mass chemotherapy (32) and, hence, it is recommended that high priority be given to de-worming programs in the area. Improvement in sanitation, such as by provision or promotion of latrines, is likely to result in a decline in the abundance of geohelminths in the host population (33). In general, health and nutrtion actions should preferably be integrated. In very poor regions with extremely limited infrastructure, nutritional activities, such as ensuring access to adequate food, should be integrated with health activities such as establishing accessible and relevant preventive and curative health care. Other activities that are regarded as nutritional include growth monitoring, promotion of breast-feeding, nutrition education, promotion of adequate complementary feeding, and micronutrient programs. Although supplementary feeding depends highly on resources, it is also one of the most important interventions required to bring about an improvement in nutritional status and consequently a more productive future generation.

This study, in addition to its cross-sectional nature, did not include socioeconomic, sanitary, and other important variables which could affect awareness, access to health facilities, income and others and, hence, these factors may need to be controlled to demonstrate a real and causal relationship. Due to analytical procedures and limitation of the sample size, dissimilar sample sizes were frequently encountered and this may also affect the strength of the statstical tests. Direct microscopy has also its own limitations and did not obviously allow comparison of the intensity of infection which has relevance to severity of consequences.

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