Research Article

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DOI: 10.21767/2172-0479.100111

Translational Biomedicine
ISSN 2172-0479

2017
Vol. 8 No. 2: 111

Association between Nutritional Status and Soil-Transmitted Helminthes Re-Infection among School-Age Children in Chencha District, Southern Ethiopia: A Cross-Sectional Study

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Citation: Zerdo Z, Yohanes T, Tariku B, et al. Association between Nutritional Status and Soil-Transmitted Helminthes Re-Infection among School-Age Children in Chencha District, Southern Ethiopia: A Cross-Sectional Study. Transl Biomed. 2017, 8:2.

Abstract

Background: Soil-transmitted helminthes infection and malnutrition are the major health threat of school-age children (SAC) in developing countries. School-based mass-drug administration (MDA) is cost efficient and effective strategy in reducing the worm load of the parasites but re-infection is the main problem of this strategy. There is scarce data on the association of nutritional status of SAC and STH re-infection. Therefore, the present study was aimed at assessing the association of nutritional status and STH re-infection among SAC in Chencha district from April 20 to May 5, 2015.

Methods: A cross-sectional study design was used to recruit 406 SAC from 10 randomly selected kebeles from the district. Structured questionnaire was used to collect background characteristics of SAC while Kato-Katz thick smear technique was used to quantify number of STH eggs per gram of stool specimen. Pearson chi square and logistic regressions were used to assess association between STH re-infection and nutritional status of SAC.

Results and findings: The overall prevalence of malnutrition, stunting and underweight among SAC were 12.3% (95%CI=9.7% to 16.5%), 8.9% (95%CI 6.3% to 12.1%) and 4.2% (95%CI 2.5% to 6.6%) respectively. STH re-infection among stunted children was 25% (n=9) while it was 37.7% (n=139) among non-stunted children. However, this difference was not statistically significant with p-value equal to 0.132. In similar, the prevalence of STH re-infection among underweighted SAC was 52.9% (n=9) but it was by 7.1% lower among non-wasted children though it was not statistically not significant (P=0.151).

Conclusions: we found low prevalence of malnutrition among SAC in Chencha district. In addition, malnutrition was not associated with STH re-infection among such population. Further prospective studies with long duration of follow-up shall be conducted in other parts in order to give more strong information about the association.

Keywords: Children; Helminthiasis; Nutrition; Drug

Received: February 23, 2017; **Accepted:** May 19, 2017; **Published:** May 24, 2017

Introduction

Soil-transmitted Helminthiasis (STH) and malnourishment are the common health problems in the world. Globally, about 2 billion people are infected by soil-transmitted helminthes (STHs) and one in three people are affected by malnutrition. Of 2 billion people infected by STHs, about 8% were in the three most populous countries in Africa: Nigeria, Ethiopia and Democratic Republic of Congo [1-3]. STH is the major cause of neglected tropical diseases and commonly affects children in developing countries where

accesses to food, sanitation and hygiene practice are poor. It is caused by parasitic worms of four species of nematodes: *Ascaris lumbricoides*, *Trichuris trichiura*, *Ancyclostoma duodenale* and *Necater americanus* [4,5]. Ethiopia accounts for about one-third of soil-transmitted helminth infection in sub-Saharan Africa. The prevalence of *A. lumbricoides*, Hookworm and *T. trichiura* in Ethiopia was 26, 11 and 21 million people, respectively that made Ethiopia the 2nd, 3rd and 4th high burden country for *A. lumbricoides*, hookworm infection and *T. trichuira* [6].

Malnutrition and STH infections are in a vicious circle in which one predisposes to the other. Poor nutrient intake increases susceptibility to parasitic diseases and together they negatively affect the childhood growth and development [7]. Malnutrition often results in delayed mental development, poor school performance, reduced intellectual capacity, susceptibility to infectious diseases and an increased risk for death [8,9]. In Malaysia, moderate to heavy infection by STHs among children was associated with increased risk of being stunted [10].

STH causes malnutrition through feeding on host tissue which leads to iron and protein deficiency, increase malabsorption, cause loss of appetite and still some can cause diarrhea and dysentery [11]. Similar to the finding in Malaysia [10], moderate to heavily infected children in Honduras were wasted than children in which the infection was either light or not infected at all [12].

Periodic administration of anthelminthic drugs, improved sanitation and health education are the STH control strategies recommended by world health organization. School-age children are one of the riskiest groups of individuals in the world with the highest burden in Asia and African countries [13]. School-based mass drug administration (MDA) is cost efficient and effective in reducing the worm load from these children. In Honduras, children attending their education in school with poor hygiene and schools did not receive deworming treatment were at increased risk of STH infection [14].

Ethiopia has been implementing mass drug administration at school compound since December 2014 as a pilot in selected districts. However, rapid re-infection after effective treatment is the challenge of this strategy. As published elsewhere, the prevalence of STH re-infection within three months' post mass drug administration has reached about 93% of the baseline prevalence in Chencha district, present study area [15]. Similar to initial infection the rate of re-infection is also higher among children age less than 15 years as compared to adults [16]. As indicated by a study carried out in Malaysia, malnourished children were more likely to be infected than well-nourished children [17]. However, an old study conducted among school children in Kenya and Zambia, Iron or Iron and micronutrient supplementation has no effect on the prevalence of STH re-infection [18,19].

There is scarce data indicating whether nutritional supplements should be given along with MDA to reduce the re-infection or not among school children. In Malaysia, the rate of re-infection by STH within six months of treatment was significantly higher among stunted children than none stunted ones [10]. A systematic review and meta-analysis carried out by Gier, indicated that micronutrient supplementation has modest effect on the re-infection of STHs [20]. Saldiva and co-investigators followed children for one year after stratification into nourished and undernourished and found that the prevalence of STH re-infection among well-nourished children was lower than the well-nourished counterparts [21]. The reviewed studies indicate that findings STH re-infection and nutritional status differ according to different study settings. Therefore, the present study was aimed at assessing the association of nutritional status of SAC and STHs re-infection in Chencha district from April 20 to May 5, 2015. The nutritional status and Soil-transmitted helminthes re-infection were determined and their association was also tested.

Methods

Study area and description of study participants

The present study was conducted among primary SAC in Chencha district. Chencha is one of the rural districts in Gamo Goffa Zone, located about 40 km in the northwestern part of Arba Minch town which is in turn 505 km far from Addis Ababa, Capita of Ethiopia. There are 45 rural, three urban and two semi urban kebeles (the least administrative unit) in the district. A total of 17, 180 (8892 male and 8298 female) SAC were there in the 61 rural and 7 urban and semi urban primary schools (containing 1661 male and 1395 female). One primary school from urban, one from semi-urban and 8 from rural kebeles in the district were randomly selected. Proportional numbers of students from urban, semi urban and rural kebeles were enrolled into our study and the respective number of students enrolled to the study was 29, 21 and 358. This sample size was determined by using single population proportion formula to estimate the rate of STHs re-infection within three months' post mass drug administration which is published previously [15].

Study design and methods of data collection

A cross-sectional study design was employed to recruit the above number of students from April 20 to May 5, 2015. Socio demographic information from the students and their parents or guardians is collected by face to face interview using structured questionnaire. Children were weighed by using Seca digital scales. The scales were placed on a hard-flat surface. Children wearing only lightweight clothing (excludes shoes, belts, socks, watches and jackets) were weighted. Each child weight was measured to the nearest 0.1 Kg. To measure the height, a child stood with his/her back against the board, his/her heels, buttocks, shoulders and head touching a flat upright sliding head piece. The child's legs are placed together with the knees and ankles brought together. Children were asked to take in a deep breath. The child's height measurement was taken when the child had a maximum inspiration. The headpiece is brought down onto the upper most point on the head and the height was recorded to the nearest 0.1 cm at the examiner's eye level.

Stool specimen was collected from all children to assess the re-infection in Polyethylene screw cupped stool container. The collected specimen was transported to Chencha hospital on the same day of specimen collection. Each specimen was prepared

by kato-katz thick smear technique with a template of 41.7 mg as recommended by world health organization and examined by trained laboratory technologist systematically within 30 to 60 minutes after preparation. The number of helminthes eggs counted for each parasite species and the number obtained were multiplied by 24 in order to obtain the number of parasites per gram of stool. Egg counts were utilized to classify the intensity of infection into light, moderate or heavy infections [22].

Ethical consideration

Before study is conducted, ethical clearance letter was obtained from Institutional Research ethics review committee of Arba Minch University. Permission to conduct the research was taken from Chencha district health and education offices. Informed assent was obtained from guardian or parents of the children included in the study. Children who became infected by any of the three STHs were given triple dose of Albendazole for three consecutive days by trained nurses.

Data analysis

All collected data, both by questionnaire and laboratory investigation, were checked before entry into computer using EpiData version 3.1 software. Then, it was exported from EpiData to STATA version 11 statistical software for analysis. For nutritional status height-for-age (HAZ) and BMI-for-age (BAZ) standard deviation scores (z-scores) were calculated by Anthrop plus software as recommended by WHO [23]. Children whose BAZ and HAZ values below -2SD were considered as malnourished. Pearson chi-square and logistic regression were used to assess the association between nutritional status and STHs re-infection. P-values <0.05 were considered as statistically significant for all variables included in bivariate and multivariate logistic regression.

Results

A total of 406 students were involved in this study with the male to female ratio of one to one. The mean age of students was 9.8 years and all school children involved were Christian in religion (52% protestant and 48% Orthodox). Majority of students' mothers were uneducated. Just above 83% of mothers were illiterate or completed up to grade 4 levels. Concerning occupation of the students' mothers, 49.8% were housewife and 31% were farmers. The detail socio demographic characteristics of mothers and their school-age children were presented in **Table 1**.

Both height and weight of children in Chencha district were normally distributes with the corresponding mean and standard

Table 1 Association between Socio demographic characteristics and nutritional status of school-age children in Chencha primary school, southern Ethiopia.

Variable	Stunted f (%)		$\chi 2$	P-value	Underweight		$\chi 2$	P-value
Religion	Yes	No			Yes	No		
Orthodox	16(8.1)	181(91.9)	0.3	0.598	12(6.1)	185(93.9)	3.4	0.064
protestant	20(9.6)	188(90.4)			5(2.4)	203(97.6		
Sex								
Female	20(9.8)	185(90.2)	0.4	0.524	9(4.4)	196(95.6)	0.04	0.837
Male	16 (8.0)	185(92.0)			8(4.0)	193(96)		
Age in years								
05-Sep	1(0.6)	175(99.4)	26.5	<0.001	9(5.1)	167(94.9)	0.7	0.415
Oct-14	35(15.2)	195(84.8)			8(3.5)	222(96.5)		
Household size								
≤5	1(1.1)	94(98.9)	10.1	0.001	7(7.4)	88(92.6)	3.3	0.067
>5	35(11.9)	258(88.1)			9(3.1)	284(96.9)		
Educational status of child's mother in grade								
≤4	34(9.2)	335(90.8)	1	0.608	17(4.6)	352(95.4)	1.3	0.522
05-Oct	2(11.1)	16(88.9)			0	18(100)		
>10	0	9(100)			0	9(100)		
Occupation of student's mother								
employee	0	11(100)	15.7	0.003	0	11(100)	10	0.04
Daily labourer	0	12(100)			0	12(100)		
Farmer	7(5.5)	120(94.5)			9(7.1)	118(92.9)		
Housewife	29(14.4)	173(85.6)			3(1.5)	199(98.5)		
Merchant	0	46(100)			4(8.7)	42(91.3)		
Had domestic animals								
No	15(12.9)	101(87.1)			9(7.8)	107(92.2)	5.1	0.024
Yes	21(7.3)	268(92.7)			8(2.8)	281(97.2)		
Students greases domestic animals after school								
No	9(7.1)	118(92.9)	0.02	0.894	3(2.4)	124(97.6)	0.2	0.697
Yes	12(7.5)	148(92.5)			5(3.1)	155(96.9)		

deviation (SD) of 128 cm (SD=10) and 27.5 kg (SD=5.8) respectively. The mean (SD) height-for-age-z score of the children was -1.3 (2.1). The overall prevalence of stunting was 8.9% (95%CI: 6.3% to 12.1%) and it was slightly higher among females (9.8%) than males (7.8%) but this difference was not statistically significant (P=0.524). The mean (SD) BMI-for-age-z-score of children was -0.3(SD=1.7) and the prevalence of underweight was 4.2% (95%CI: 2.5% to 6.6%). None of children from urban area were stunted and the frequency distribution of stunting with respect to place of residence was depicted in the **Figure 1** below. All children under-weighted were from mothers whose education level was less than elementary or illiterate (had no formal education) while all stunted children were born from mothers whose occupation is either housewife or farmer.

The overall prevalence of STH re-infection within three months' post mass drug administration and malnutrition among primary school children in Chencha district were 36.8% (95%CI: 32.1% to 41.6%) and 12.3% (95%CI: 9.7% to 16.5%) respectively. The prevalence of STH re-infection was slightly higher among none stunted children (37.7%) than stunted ones (25%). Unlike stunting, Underweight children were more likely to be re-infected (53%) than children not (35.8%). However, neither stunting nor under-weight significantly associated with re-infection among SAC in Chencha district. The prevalence of re-infection by all or specific species of STH with different nutritional level of SAC were presented in the table below **(Tables 2 and 3)**.

Discussion

Our finding indicates that nutritional status of schoolchildren in Chencha district had no association with STHs re-infection. Both stunting and underweight were not significantly associated with STH re-infection though underweighted children were more likely to be re-infected than none underweighted ones. The same thing was true with specific species of parasites causing soil-transmitted helminthiasis. Stunting of children differ with occupation of the mother, their age and household size. Children age greater than 10 years and those living in household with family size above 5 individuals were more likely stunted.

There were limited literatures assessing natural nutritional status of children with soil-transmitted helminth re-infection. Most studies focused on effect of nutritional supplements on the rate of re-infection by any or specific species of STHs. In some article reviewed by yap and collogues, either natural nutrition or supplementation had association with the re-infection by STH but others conclude as there is no association [24]. The natural nutritional status as well as iron or other micronutrient supplementations provided to students has no influence on the rate of re-infection by soil-transmitted helminthes in Kenya [18,25] and Zambia [19].

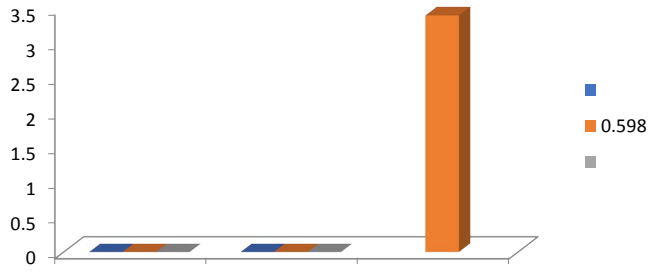

Figure 1 Frequency distribution of stunting by place of residence among primary school-children in Chencha district, southern Ethiopia, 2015.

There are also findings which support the hypothesis that nutritional status has association with STH re-infection. Unlike the finding of the present study, studies with different study approaches have indicated the positive association between STH re-infection and malnutrition. Gier and his co investigators had found that nutrition has modest effect on the STH re-infection [20]. In Malaysia, stunting has positive association with both initial and repeated infection by STH among school-age children [10,17]. Similar to findings from Malaysia, a prospective study conducted among school children in Brazil has indicated that the prevalence of STH re-infection among poorly nourished children was higher than well-nourished counter parts within one year of follow-up [21]. This difference between studies conducted in Malaysia and Brazil could be emanated from the design of the study and difference in the time used to assess the re-infection rate after deworming.

Nutritional status of schoolchildren is an indicator of the wellbeing of the general population in the community. Moreover, children in low socioeconomic group were undernourished as compared to those from higher economic class [14]. As compared to the reference interval set by world health organization [26], the nutritional status of SAC in Chencha district was good and children originating from families owning domestic animals were less likely stunted than those from families who had not domestic animals. This might be due to children from families where domestic animals exist might be overburdened by rearing such animals.

The estimated prevalence of stunting in the present study area was lower than other parts of the country and developing countries reviewed. It was significantly lower than the estimate made in Addis Ababa [27], Gonder town [28], Kenya [25], Tanzania [29], Pakistan [14], Philippines [7] and Malaysia [10]. The difference between these studies and the present study may be due to difference in the dietary diversity of children or economic status in the general population. Unlike these, it was higher than the estimate made in America. For example, the prevalence of stunting among schoolchildren in Honduras was significantly lower than the present study which may be due to lower socio economic status in the present study area as compared to the population in Honduras [12,30].

In some articles reviewed nutritional status differs with sex and age of the children. In our study, there was no association between sex and nutritional status in similar to the study carried out in Addis Ababa [27]. However, children age equal to or above 10 years were more likely to be stunted than younger children. In corroboration to a study in Malaysia [10] and contrast to India [31], the prevalence of stunting is higher among older school children than younger ones. This difference might be due to difference in the prevalence of stunting in the preschool children

Table 2 Association of stunting and underweight with soil-transmitted helminth re-infection within three months post mass drug administration among schoolchildren in Chencha district, southern Ethiopia.

Re-infection by	Stunted				Wasted			
	≠yes (%)	≠ No (%)	χ^2	P-value	≠ yes (%)	≠ No (%)	χ^2	P-value
A. lumbricoides	5 (13.9)	88 (23.9)	1.8	0.177	5(29.4)	88 (22.6)	0.4	0.514
T. trichuira	4 (11.1)	61(16.5)	0.7	0.398	5(29.4)	60(15.5)	2.3	0.125
All STHs	9 (25)	139 (37.7)	2.3	0.132	9 (53.0)	139(35.8)	2.1	0.151

Table 3 Univariate and multivariate logistic regression of factors associated with stunting and underweight among school-age children in Chencha district, southern Ethiopia.

Variable	Stunted		COR (95% CI)	P_ value	AOR(95%CI)	P_ value
	≠ yes (%)	≠ No (%)				
Age of the child in years						
05-09	1(0.6)	175 (99.4)	1	0.001	1	0.001
10-14	35(15.2)	195(84.8)	31.4(4.3-231)		26.7(3.6-199.7)	
House hold size in number of individuals						
≤5	1(1.1)	94 (98.9)	1	0.013	1	0.024
>5	35(11.9)	258 (88.1)	12.7(1.7-94.4)		10.5(1.4-81.3)	
Association with underweight						
Variable	underweighted		C. OR (95% CI)	P_value	A. OR (95%CI)	P_ value
	≠ yes (%)	≠ No (%)				
Had domestic animals						
No	9(7.8)	107(92.2)	2.9(1.1-7.9)	0.03	2.4(0.8-6.6)	0.094
Yes	8(2.8)	281(97.2)	1		1	

because it continues to the school age level.

This study is carried out with certain limitation and therefore, it has to be interpreted in light with these limitations. One of the limitations stem from the study design, cross-sectional, which may not indicate the cause and effect relationship of under nutrition and Soil-transmitted helminth re-infection. The other limitation comes from the sample size since the sample size we have used was not calculated for the present study rather; it was taken from a study for soil-transmitted helminth re-infection among school children in Chencha district.

Conclusion

There was no association between soil-transmitted helminth re-infection within three months' post mass drug administration among school-age children in Chencha district with stunting and under-weight of children. Children originating from rural kebeles and born from mothers who were less educated, housewife or farmers were at higher risk for malnourishment. Further prospective studies with long duration of follow-up in different settings shall be conducted.

Acknowledgement

The authors would like to thank Arba Minch University for funding this research. In addition, our gratitude goes to Medical laboratory personnel in Chencha district hospital for their involvement and support during laboratory diagnosis of stool.

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