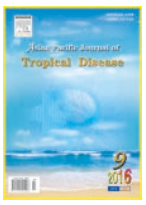
HOSTED BY

ELSEVIER

Contents lists available at ScienceDirect

Asian Pacific Journal of Tropical Disease

journal homepage: www.elsevier.com/locate/apjtd



Parasitological research doi: 10.1016/S2222-1808(16)61111-8

Two thirds of hookworm infected children were anemic at the outpatient department in Jimma Health Center, Jimma, Southwest Ethiopia

Seble Worku Kebede[1*], Dosegnaw Argaw Beyene [2], Abebe Getnet Meshesha[3], Mulusew Alemneh Sinishaw[4]

[1]*Department of Medical Microbiology, Debre Tabor University, Debre Tabor, Ethiopia*

[2]*Department of Medical Microbiology, Jimma University, Jimma, Ethiopia*

[3]*Department of medical Laboratory Technology, Bahir Dar Collage of Health Sciences, Bahir Dar, Ethiopia*

[4]*Bahir Dar Regional Health Research Laboratory Center, Bahir Dar, Ethiopia*

ARTICLE INFO

Article history:
Received 15 Jun 2016
Received in revised form 11 Jul, 2nd revised form 19 Jul 2016
Accepted 25 Jul 2016
Available online 12 Aug 2016

Keywords:
Hookworm
Anemia
Children
Jimma
Ethiopia

ABSTRACT

Objective: To assess the prevalence of hookworm infections and anemia and also measure their association among children.

Methods: A cross-sectional parasitological and hematological study was conducted on 130 children at Jimma Health Center, Jimma, Southwest Ethiopia. Stool samples were collected and processed for direct microscopic examination. Blood samples were examined by using hematocrit to determine the hemoglobin level. Data were collected using a semi-structured questionnaire from every study participant.

Results: The overall prevalence of hookworm infection and anemia was found to be 18 (13.48%) and 43 (33.07%), respectively. Anemia prevalences were 66.67% (12/18) among hookworm infected children and 33.07% (43/130) among all study participants. Hookworm had a statistically significant association with anemia and predisposing factors such as shoes wearing habits and methods of excreta disposal ($P < 0.05$).

Conclusions: Prevalences of hookworm infection and anemia were low among children. But the prevalence of anemia as compared to hookworm was too high. Attention should be given to contributing factors accordingly to reduce hookworm infection and anemia.

1. Introduction

Intestinal helminthic parasites represent an important group of infectious disease worldwide, being responsible for considerable morbidity and mortality. They are very common and endemic in tropical and sub-tropical countries due to the warm and moist climate which is suitable for the survival of many of the intestinal helminths[1].

Hookworm is one of the intestinal helminthes which is transmitted by penetration of skin by the flair form larva and ingestion of the flair form larva presenting in the soil and rarely transmitted through trans-mammary and trans-placental. It is highly prevalent in locations where there is little or no sanitation especially in rural areas of tropics and sub-tropics between 45° N and 30° S. Hookworm is the major cause of gastro-intestinal blood loss (loss of iron, proteins and vitamins) thereby resulting in iron deficiency anemia (IDA). Hookworms contribute to IDA by actively feeding on blood from the capillaries and arterioles[1-3].

Children may suffer from mental retardation and physical development due to hookworm infection for several years. In severe cases of the infection, hemoglobins may be reduced by 30% or less, which contributes to major public health problem throughout the world, especially in developing countries[4,5].

In tropics, deficiency of essential substances resulting from the effect of blood loss due to hookworm infection is one of the most important factors for reducing hemoglobin in the circulatory system of patients and causes anemia[1].

Anemia is the commonest nutritional problem worldwide, especially more common in developing countries due to poor nutrition and high prevalence of parasitic infections primarily. Hookworm becomes highly prevalent among children and pregnant women. The prevalence of IDA increased as hookworm infection became intense and intestinal blood loss increased. In general, children with hookworm infection and anemia may suffer with slow development in both physically and mentally as well as they

*Corresponding author: Seble Worku Kebede, Department of Medical Microbiology, Debre Tabor University, Debre Tabor, Ethiopia.
Tel: +251911782487
Fax: +251581410533
E-mail: workuseble@ymail.com

The study protocol was performed according to the Helsinki declaration and approved by Ethical Review Committee of the College of Public Health and Medical Sciences of Jimma University. Informed written consent was obtained from each study participant family or guardian.

The journal implements double-blind peer review practiced by specially invited international editorial board members.

have a difficulty in concentrating, learning and are more prone to be infected due to poor immune response[6,7].

Studies investigating the magnitude of hookworm infection and anemia and identifying their association are less in the study area. Hence, the present study was undertaken to assess the prevalence of hookworm infection, anemia and their associated factors among children attending at Jimma Health Center.

2. Materials and methods

2.1. Study setting and design

A health center-based cross-sectional study was conducted from September to December, 2012 at Jimma Health Center found in Jimma town, Oromia Region. Jimma is located in the southwestern part of Ethiopia, 355 km away from Addis Abeba with an altitude of 1 875 m above sea level, and has about 88 876 estimated populations. The annual temperature ranges from 20 °C–30 °C and the average annual rain fall is 800–2 500 mm^3.

2.2. Study subjects, sample size and sampling techniques

All children who visited the outpatient department (OPD) during the study period were studied because the calculated sample size was greater than the source population. Single population proportion formula was used to calculate the sample size in consideration of the prevalence of anemia among hookworm infected children in rural elementary school (20.6%) with 5% margin of error and 95% confidence interval[8]. The final sample size was 251 children. Since the flow of outpatient children were low (30/month), they were all invited to participate in the study using consecutive sampling technique.

2.3. Data collection procedure

In order to identify the determinants of hookworm, the research team interviewed the parents or legal guardians of those children to collect socio-demographic characteristics, availability of latrine, drinking water, shoe wearing habit and educational background using structured questionnaires.

2.3.1. Hematological analysis

Finger blood was collected from all outpatient children attending the health center during the study period using pricking lancet and hemoglobin (the iron-carrying part of the blood cells) value was determined using hematocrit technique.

2.3.2. Parasitological analysis

Stool samples collected during the working hours of the health center laboratory from all outpatient children attending to the health center were examined using direct microscopy by experienced laboratory technicians.

2.4. Data processing and analysis

Data were checked, sorted, categorized and coded manually. The data were entered to SPSS version 20 statistical software for analysis purpose. Data cleaning was done before analysis. Frequencies and cross tabulations were used to summarize categorical variables. A $P < 0.05$ at 95% confidence interval was considered statistically significant. Tables were used to present the data.

2.5. Ethical clearance

Permission letter was obtained from Ethical Review Committee of the College of Public Health and Medical Sciences of Jimma University. Assent was secured from each study participant family or guardian. Children found to be positive for intestinal parasites and anemia were given appropriate treatment.

3. Results

Out of the 130 outpatient children living in the centre of Jimma town, 70 (53.84%) were females. None of the respondents was illiterate. Of the 18 hookworm harboring children, 10 (14.29%) and 8 (13.33%) accounted for females and males, respectively. Anemia prevalence were 66.67% (12/18) among hookworm infected children and 33.07% (43/130) among all study participants. Anemia had statistical significant association with hookworm infection ($\chi^2 = 7.270$, $P = 0.026$) (Table 1).

Table 1

Association of hookworm infection in relation to socio-demographic status and hematocrit levels among children visiting the OPD at Jimma Health Center, Southwest Ethiopia in 2012.

Types of factors	Hookworm infection status		χ^2 and P
	Positive [n (%)]	Negative [n (%)]	
Sex			
Male	8 (13.33)	52 (86.67)	$\chi^2 = 0.246$
Female	10 (14.29)	60 (85.71)	$P = 0.875$
Age group (years)			
< 5	1 (11.11)	8 (88.89)	
6–10	9 (17.31)	43 (82.69)	$\chi^2 = 0.985$
11–15	5 (12.82)	34 (87.18)	$P = 0.805$
16–19	3 (10.00)	27 (90.00)	
Anemic status			
Anemic	12 (27.91)	31 (72.09)	$\chi^2 = 7.270$
Non-anemic	6 (6.90)	81 (93.10)	$P = 0.026$

Among the 130 outpatient children, 102 (78.46%) used latrine always, 3 (2.30%) used some times and 25 (19.23%) never used latrine (used open field for disposal of excretal). Hookworm prevalence were low 5 (4.95%) among always latrine users as compared to their counter parts (non-latrine users) [12 (46.15%)]. Children with shoe wearing habit always also showed low 10 (10.00%) hookworm prevalence in comparison to those had no shoe wearing habit [6 (60.00)]. Latrine use and shoe wearing habit revealed statistically significant association to reduce hookworm infection (Table 2).

Table 2

Association of contributing factors for hookworm infection among children visiting the OPD of Jimma Health Center, Southwest Ethiopia in 2012.

Types of factors	Hookworm infection status		χ^2 and P
	Positive [n (%)]	Negative [n (%)]	
Shoe wearing habit			
No usage	6 (60.00)	4 (40.00)	$\chi^2 = 19.350$
Sometimes	2 (10.00)	18 (90.00)	$P = 0.000$
Always	10 (10.00)	90 (90.00)	
Latrine usage habit			
No usage	12 (46.15)	14 (53.85)	$\chi^2 = 30.410$
Sometimes	1 (33.33)	2 (66.67)	$P = 0.000$
Always	5 (4.95)	96 (95.05)	
Water source			
Pipe	12 (12.77)	82 (87.23)	$\chi^2 = 3.540$
River	2 (14.29)	12 (85.71)	$P = 0.170$
Well	4 (18.18)	18 (81.89)	
Educational status			
Pre-school age	1 (11.11)	8 (88.89)	
1–4 grade	9 (17.31)	43 (82.69)	$\chi^2 = 0.990$
5–8 grade	5 (12.82)	34 (87.18)	$P = 0.805$
> 8 grade	3 (10.00)	27 (90.00)	

4. Discussion

The overall prevalences of hookworm infection and anemia among the children in this study were 13.85% and 33.07% respectively. It is lower than the prevalence figure reported by World Health Organization globally with the prevalence of 25.00% and 40.00%, respectively[3,9]. This might be due to the difference in sample size. The sample size of this study is smaller.

The wider distribution of hookworm infection in developing countries is associated with the socio-economic status, *i.e.* human occupation activities, poor environmental sanitation and personal hygienic practice including unsanitary disposal of faeces/wastes and lack of foot wear and environmental factors like temperature, moisture and soil texture[10-12]. Evidences from studies fortifies as better sanitation were associated with statistically significantly less hookworm infections[13,14].

The prevalence of hookworm in this study was lower than a study done in Tilili, Jimma and Durbetie [21.4%, 20.1% and 46.9%, respectively][15-17]. This might be due to the climatic and environmental conditions of Jimma town which could be less favorable for hookworm transmission. In addition to this, the probable reason for the lower prevalence is due to the fact that the majority of those respondents' had shoes wearing habit (76.2%) and used latrine for excreta disposal (78.09%).

The prevalence of hookworm infection in this study among the children (13.85%) depicted comparable results with the study done in Dera District among clients following their health outcome at Anbesame Health Center with the prevalence figure of 14.7%[18].

The study participants' prevalence of hookworm infection (13.85%) in this study was higher than 0.3%, 0.8%, 8.0%, 9.4% and 9.7% among elementary students of Babile town, students of Mendera Elementary School, school children at Jimma town, Jimma and a community-based survey among children after implementing the safe strategy, enhanced outreach services, among children less than five years of age and health extension program, respectively[19-23]. This could be difference in source population and interventions-bring changes.

The prevalence of anemia (33.07%) from a total study participants and among hookworm infected children (66.67%) in our study were somewhat lower than the prevalence reported by previous findings from Fenan Medical Center of East Wollega Zone 65.50% and 83.90%, respectively[24]. It has been seen around the world that micronutrient deficiency, parasitic infections (including hookworm) and inherited disorders are significantly-related problems[7].

The probable reason for low proportion of anemia in this study was done in health center setting which was located in the town. The children who came to the health center were slightly better informed with health awareness and this was supported by the fact that most of the respondents in this study responded they were literate (100%). This might be also due to the existence of lower prevalence of hookworm infection in this finding (13.85%) which could contribute for the decrement of the prevalence of anemia.

The proportion of children with anemia in this study was higher (33.07%) than the study done among school children in Boloso Sore, Southern Ethiopia (20.60%)[25]. This discrepancy might be because the patients in this study were delivered iron therapy, advised to eat iron-riched foods and treated for intestinal parasites.

This study also demonstrated that anemia was significantly associated with hookworm infection ($P = 0.026$). This finding collaborating with studies done among school children in Ethiopia revealed that hookworm infection was associated with anemia. Resettled population of Gambella which showed an association (odds ratio = 2.65) between low haematocrit level and hookworm infection among school children in Vom showed a relationship between hookworm infection and hemoglobin ($P < 0.05$), and hookworm was associated with anemia among patients visiting Fenan Medical Center in east Wollega zone[24, 26-28], which indicated that hookworm caused iron deficiency[29].

This finding also supports previous studies that hookworm infection and anemia had significant association with the predisposing factor for hookworm like shoe wearing habit and latrine usage ($P = 0.000$). Similar reports were observed from a study conducted among school children in Tilili town that hookworm infection was significant in children who did not wear shoes regularly ($P < 0.05$). Among school children in Ethiopia, hookworm infection was significantly associated with participants not using a latrine, unclean fingernails and walking barefoot, since they were more vulnerable from the hookworm infections[18,26,30]. This might be due to the fact that areas surrounding them were not outside defecation free.

The prevalence of anemia among hookworm infected children was too high. Hookworm had statistically significant association with anemia, and predisposing factors like shoes wearing habits and methods of disposal of excreta ($P < 0.05$). Even though their prevalence was low, both hookworm and anemia have an adverse impacts on the health of children, since the prevalence of anemia was too high among hookworm infection and other causes of anemia including micronutrient deficiencies, infestation other than hookworm like other intestinal helminthes, malaria and HIV, and inherited disorders should also be considered even though hookworm infection and anemia are significantly associated. Moreover, this study also revealed that shoe wearing habit and excretal disposal among the predisposing factors for hookworm infection are still contributes for hookworm infection.

In general, even though the prevalence of both hookworm and anemia was low, anemia among hookworm infected remained to be the major significant health problem of children in the area, which needs attention and urgent intervention by the concerning bodies and the community itself to alleviate the extent of the problem due to their serious complication on the health of children and mothers.

Hookworm infection is something that can be easily prevented and yet it is still causing serious complication on the health of children, so that health education should be given regarding on the mode of transmission and prevention of hookworm infection and improved personal and environmental hygienic practice should be encouraging, especially safe excreta disposal and shoe wearing habit should be given great emphasis.

Since hookworm infection in children is significantly related with anemia, health professionals should consider hookworm a possible cause of anemia and hence all children coming to the health center should be given appropriate medication. In addition, they should be advised to eat iron-riched foods.

Finally, further studies should be conducted to determine the causes of anemia other than hookworm and their magnitude.

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgments

The authors would like to take the opportunity to thank Jimma University for the chance given to conduct this research, avail internet connections and cover financial issues, and we also thank staff members of Jimma Health Center for their cooperation. Finally, our great gratitude goes to those study participants for their volunteer participation.

References

[1] Kasper DL, Braunwald E, Fauci A, Hauser S, Longo D, Jameson JL, et al. *Harrison's principles of internal medicine*, 16th ed. Columbus: McGraw-Hill Professional; 2004, p. 1256-60.

[2] Cheesbrough M. *District laboratory practice in tropical countries, (Pt. I)*, 2nd ed. Cambridge: Cambridge university press; 2005, p. 1-462.

[3] Casey GJ, Phuc TQ, Macgregor L, Montresor A, Mihrshahi S, Thach TD, et al. A free weekly iron-folic acid supplementation and regular deworming program is associated with improved hemoglobin and iron status indicators in Vietnamese women. *BMC Public Health* 2009; **9**: 261.

[4] Tedla S. *Introduction of parasitology: protozoan and helminth parasites of Man*. Addis Ababa: Addis Ababa University press; 1986, p. 8-9.

[5] DeMaeyer E, Adiels-Tegman M. The prevalence of anaemia in the world. *World Health Stat Q* 1985; **38**(3): 302-16.

[6] Ali I, Mekete G, Wodajo N. Intestinal parasitism and related risk factors among students of Asendabo Elementary and Junior Secondary school, South Western Ethiopia. *Ethiop J Health Dev* 1999; **13**(2): 157-61.

[7] Cheesbrough M. *District laboratory practice in tropical countries: part II*. 2nd ed. Cambridge: Cambridge university press; 2006, p. 1-442.

[8] Erosie L, Merid Y, Ashiko A, Ayine M, Balihu A, Muzeyin S, et al. Prevalence of hookworm infection and hemoglobin status among rural elementary school children in Southern Ethiopia. *Ethiopian J Health Dev* 2002; **16**(1): 113-5.

[9] World Health Organization. Iron deficiency anemia: assessment, prevention and control. Geneva: World Health Organization; 2001. [Online] Available from: http://www.who.int/nutrition/publications/micronutrients/anaemia_iron_deficiency/WHO_NHD_01.3/en/ [Accessed on 21st March, 2016]

[10] Parija SC. *Textbook of medical parasitology: protozoology and helminthology*, 4th ed. Chennai: All Indian Publishers and Distributors; 2013.

[11] Orkin SH, Nathan DG, Ginsburg D, Look AT, Fisher DE, Lux SE. *Nathan and Oski's hematology of infancy and childhood*, 7th ed. Philadelphia: Elsevier, Health Sciences Division; 2008.

[12] Wondimagegnehu T, Woldemichael T, Assefa T. Hookworm infection among the Melka Sedi banana plantation residents, middle Awash Valley, Ethiopia. *Ethiop Med J* 1992; **30**(3): 129-34.

[13] Grimes JE, Tadesse G, Mekete K, Wuletaw Y, Gebretsadik A, French MD, et al. School water, sanitation, and hygiene, soil-transmitted helminths, and schistosomes: national mapping in Ethiopia. *PLoS Negl Trop Dis* 2016; **10**(3): e0004515.

[14] Ziegelbauer K, Speich B, Mäusezahl D, Bos R, Keiser J, Utzinger J. Effect of sanitation on soil-transmitted helminth infection: systematic review and meta-analysis. *PLoS Med* 2012; **9**(1): e1001162.

[15] Kure A, Mekonnen Z, Dana D, Bajiro M, Ayana M, Vercruysse J, et al. Comparison of individual and pooled stool samples for the assessment of intensity of *Schistosoma mansoni* and soil-transmitted helminth infections using the Kato-Katz technique. *Parasit Vectors* 2015; **8**: 489.

[16] Yami A, Mamo Y, Kebede S. Prevalence and predictors of intestinal helminthiasis among school children in Jimma zone; a cross-sectional study. *Ethiop J Health Sci* 2011; **21**(3): 167-74.

[17] Alelign T, Degarege A, Erko B. Soil-transmitted helminth infections and associated risk factors among schoolchildren in Durbete Town, Northwestern Ethiopia. *J Parasitol Res* 2015; **2015**: 641602.

[18] Shiferaw MB, Mengistu AD. Helminthiasis: hookworm infection remains a public health problem in Dera District, south Gondar, Ethiopia. *PLoS One* 2015; **10**(12): e0144588.

[19] Tefera E, Mohammed J, Mitiku H. Intestinal helminthic infections among elementary students of Babile town, Eastern Ethiopia. *Pan Afr Med J* 2015; **20**: 50.

[20] Tefera E, Belay T, Mekonnen SK, Zeynudin A, Belachew T. Therapeutic efficacy of different brands of albendazole against soil transmitted helminths among students of Mendera Elementary School, Jimma, Southwest Ethiopia. *Pan Afr Med J* 2015; **22**: 252.

[21] Debalke S, Worku A, Jahur N, Mekonnen Z. Soil transmitted helminths and associated factors among schoolchildren in government and private primary school in Jimma Town, Southwest Ethiopia. *Ethiop J Health Sci* 2013; **23**(3): 237-44.

[22] G/hiwot Y, Degarege A, Erko B. Prevalence of intestinal parasitic infections among children under five years of age with emphasis on *Schistosoma mansoni* in Wonji Shoa Sugar Estate, Ethiopia. PLoS One 2014; **9**(10): e109793.

[23] King JD, Endeshaw T, Escher E, Alemtaye G, Melaku S, Gelaye W, et al. Intestinal parasite prevalence in an area of Ethiopia after implementing the SAFE strategy, enhanced outreach services, and health extension program. *PLoS Negl Trop Dis* 2013; **7**(6): e2223.

[24] Dori GU, Tullu KD, Ali I, Hirko A, Mekuria G. Prevalence of hookworm infection and its association with anemia among patients visiting Fenan Medical Center, East Wollega Zone, Ethiopia. *Ethiop Med J* 2011; **49**(3): 265-71.

[25] Erosie L, Merid Y, Ashiko A, Ayine M, Balihu A, Muzeyin S, et al. Prevalence of hookworm infection and haemoglobin status among rural elementary school children in Southern Ethiopia. *Ethiop J Health Dev* 2002; **16**(1): 113-5.

[26] Mahmud MA, Spigt M, Mulugeta Bezabih A, López Pavon I, Dinant GJ, Blanco Velasco R. Risk factors for intestinal parasitosis, anaemia, and malnutrition among school children in Ethiopia. *Pathog Glob Health* 2013; **107**(2): 58-65.

[27] Bulto T, Meskal FH, Endeshaw T, Dejene A. Prevalence of hookworm infection and its association with low haematocrit among resettlers in Gambela, Ethiopia. *Trans R Soc Trop Med Hyg* 1992; **86**(2): 184-6.

[28] Odebunmi JF, Adefioye OA, Adeyeba OA. Hookworm infection among school children in Vom, Plateau State Nigeria. *Am-Eurasian J Sci Res* 2007; **2**: 39-42.

[29] Tadesse G. The prevalence of intestinal helminthic infections and associated risk factors among school children in Babile town, Eastern Ethiopia. *Ethiop J Health Dev* 2005;**19**(2): 140-7.

[30] Abera A, Nibret E. Prevalence of gastrointestinal helminthic infections and associated risk factors among schoolchildren in Tilili town, Northwest Ethiopia. *Asian Pac J Trop Med* 2014; **7**(7): 525-30.