

Prevalence and Associated Factors of Soil-Transmitted Helminth Infections among Children Living with and without Open Defecation Practices in Northwest Ethiopia: A Comparative Cross-Sectional Study

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Abstract. Soil-transmitted helminth (STH) infections cause devastating effect in human health. School-age children (SAC) account for the highest prevalence of STH infections in sub-Saharan Africa. Open defecation practicing might be the major contributing factor, and creating an open defecation-free (ODF) declared community is also a big challenge. This study aimed to assess the prevalence of STH infections and associated factors among SAC in ODF declared and open defecation-practicing kebeles. A comparative cross-sectional study was conducted among 806 SAC from January 2019 to April 2019. Questionnaire-based data were collected using a structured questionnaire. Stool samples were collected and processed via the Kato-Katz technique. Prevalence and associated factors were computed with descriptive statistics and regression, respectively. Variables with a P -value < 0.05 were considered as significantly associated. This study revealed that the prevalence of STH infections in open defecation-practicing and ODF declared kebeles were 39.0% and 30.0%, respectively. Wearing open shoes, wearing shoes sometimes, and playing with soil were significantly associated ($P < 0.01$) with STH infections in ODF declared kebeles. Similarly, wearing shoes sometimes, not using latrine, and playing with soil were also significantly associated ($P < 0.01$) with STH infections in open defecation-practicing kebeles. In conclusion, lower prevalence of STH infections was recorded in ODF declared than in open defecation-practicing kebeles. Wearing shoes sometimes, playing with soil, and not using latrine were associated with STH infections. Therefore, creating an ODF environment and community awareness should be strengthened.

INTRODUCTION

Soil-transmitted helminths (STHs) are intestinal nematodes that are transmitted through contaminated hands, foods, soil, and water. The major STHs that infect humans include *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworm species (*Necator americanus* and *Ancylostoma duodenale*).¹ Globally, an estimated 4.5 billion individuals are at risk, 1–2 billion individuals are infected,² and more than five million disability-adjusted life years (DALYs)³ are lost because of STH infections. The greatest number of STH infections occurs in Latin America, tropical and subtropical regions of Asia, and sub-Saharan Africa.^{2,4}

The high prevalence of STH infections in the developing countries is mainly due to open defecation practice, limited water source, and poor hygienic conditions, which are widespread problems of the rural community.⁵

School-age children (SAC) have the highest prevalence of STH infections worldwide. Around 400 million SAC are infected with STHs in the world.⁶ Soil-transmitted helminth infections are considered as the leading cause of sickness, school absenteeism, DALY lost,⁷ and physical and intellectual growth retardation, especially in SAC.⁸

Although the global target is to eliminate morbidity due to STH infections in children by 2020,¹ still, these infections cause huge health problems in countries like Ethiopia and affect millions of SAC.⁹ Improving water sanitation and hygiene (WASH), community mobilization and health education, integration of WASH, with mass drug administration (MDA) is still limited in many endemic areas.

In our study area, these control mechanisms are implemented especially improving WASH by using community-led

total sanitation and hygiene (CLTSH) strategies to create open defecation-free (ODF) declared environments in collaboration with Plan International Ethiopia and Federal Ministry of Health (FMOH). Bahir Dar Zuria woreda health office annual health management information system report indicated that 16 of the 32 kebeles of Bahir Dar Zuria district are ODF declared kebeles, whereas the rest are still open defecation-practicing (ODP) kebeles by the FMOH criterion. However, the role of creating ODF declared environments in reducing STH infection prevalence has not been assessed in the district so far. Besides, factors associated with STH infections in ODP and ODF declared areas are not well addressed in the study area. Therefore, this study aimed to compare the prevalence of STH infections in ODF declared and ODP kebeles as well as determine the factors associated with STH infections in Bahir Dar Zuria Woreda district.

METHODS AND MATERIALS

Study design, area, and period. A community-based comparative cross-sectional study was conducted among SAC in ODF declared and ODP kebeles of Bahir Dar Zuria district, northwest Ethiopia, from January 2019 to April 2019. The study area is located at 564 kilometers away from Addis Ababa. Bahir Dar Zuria district contains 32 rural kebeles, of which 16 kebeles have been announced and certified ODF during the years 2014–2016 by Bahir Dar Zuria Health Office in collaboration with Plan International Ethiopia and Organization for Rehabilitation and Development in Amhara.

Sample size determination. The sample size of the study was calculated using double population proportion based on findings of a study performed in rural Bahir Bar, northern Ethiopia (Hailu et al.¹³). Assuming the difference between ODF declared and ODP was 10%, where the proportion of STH infections from ODF declared kebeles was 33% and the

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proportion of STH infections from ODP kebeles was 43%. Using 95% CI, 80% power of test, and 10% contingency, the sample size was 403 for each group. The ratio between ODF declared and ODP kebeles was 1:1. Then, the total sample size was 806.

Sample size per group = $P1(1 - P1) + P2(1 - P2) \times f(\alpha, \beta)$

$$\begin{aligned} & \frac{(P1 - P2)^2}{(0.33 - 0.43)^2} \\ & = 0.43(1 - 0.43) + 0.33(1 - 0.33) \times 7.85 = 403 \end{aligned}$$

Total sample size = 806 (we took 403 individuals in each group)

while $P1 = 0.43$, $P2 = 0.33$, and power of 80%— $f(\alpha, \beta) = 7.85$.

Sampling technique. A stratified sampling technique was used to stratify Bahir Dar Zuria district into ODF declared and ODP kebeles, and three kebeles were selected randomly in each stratum. Screening of households which have SAC and list 1–Nth using family folder at health posts (community-based information system) was performed. The households with SAC were selected with a systematic random sampling technique. The study participants in each kebele were proportionally allocated based on the population of households which have SAC. A systematic random sampling technique was conducted to select the study participants or SAC. If there were two or more children in the same household, only one child was selected by the lottery method to participate in the study.

Data collection. A structured questionnaire was used to collect the sociodemographic data and environment- and behavior-related factors through face-to-face interviews. Following the questionnaire, approximately 2 g of fresh stool was collected using a stool cup. Each child was supplied with a plastic screw cup, applicator stick, and toilet paper, and was given appropriate instructions on how to bring fresh stool samples of their own. The stool samples were collected, labeled with a specific code number, and transported within 6 hours to Bahir Dar University Microbiology and Parasitology laboratory. Two Kato–Katz slides were prepared for each stool sample with 41.7 mg of stool.¹⁰

In the Kato–Katz technique, the stool was pressed through a mesh screen to remove large particles. A portion of the sieved sample was transferred to the hole of a template on a slide. After filling the hole, the template was removed, and the remaining sample was covered with a piece of cellophane that was previously soaked in glycerol. The slides were examined, and the number of eggs was calculated per gram of feces.¹¹

Quality control. All data collectors were trained before data collection, and the pretest was performed to validate the data collection instrument before conducting the study. During data collection, kebeles were coded and regular supervision was performed during the fieldwork. Each data collector checked the questionnaires for completeness before leaving each study participant's house. All filled questionnaires were reviewed at the end of the day by the supervisor. The reliability of the laboratory was assured by implementing quality control measures during the pre-analytical, analytical, and post-analytical steps. All materials, equipment, and procedures were adequately controlled. Each stool cup was properly labeled with their identification key. To minimize bias, each

Kato–Katz slide was examined by two laboratory personnel independently. From all of the slides, 10% was randomly selected and reexamined, and the discordant results were cross-checked by the principal investigator.

Statistical analysis. Data were entered and analyzed by SPSS version 21. The prevalence of STH infections was computed by descriptive statistics, whereas the associations of independent variables with the prevalence of STH infections were calculated by univariate logistic regression analysis. All variables with a P -value < 0.25 in the univariate analysis were run in a multivariate logistic analysis at 95% CI to resolve the confounding effects.¹² $P < 0.05$ was considered to be statistically significant.

Ethical consideration. The research proposal was ethically approved by the Ethical Review Committee of Bahir Dar University, College of Medicine and Health Sciences. Permission letters were obtained from Amhara Public Health Institute and Bahir Dar Zuria district Health Office. The purpose of the study and the entirely voluntary nature of the participants were clearly explained to the study participants/household heads before obtaining consent or assent. Study participants who tested positive for intestinal parasitic infections were communicated to the nearby health center and treated accordingly.

RESULTS

Sociodemographic characteristics of study participants.

A total of 806 (403 in each ODF declared and ODP kebeles) children were recruited for this study. More than half (54.3%) of the participant children were females. The mean, range, and SD of the study participants' age were 10.3, 6–14, and 2.29 years, respectively. The educational status of most children (89.9%) was 0–4 classes (92.8% in ODF declared and 87.1% in ODP) (Table 1). All the study participants were rural inhabitants. Only one child was a Muslim religion follower, whereas all others were from an orthodox family.

Three hundred children, among 806 participants, were infected with at least one intestinal helminth (37.2%; 95% CI: 33.95–40.61). Five intestinal helminths were detected, of which the most frequently detected was hookworm (237/806), followed by *A. lumbricoides* (72/806). *Schistosoma mansoni* (20/806), *Entrobios vermicularis* (14/806), and *Hymenolepis nana* (1/806) were the other helminths detected. The prevalence of helminth infections in ODF declared and ODP kebeles accounted for 32.8% (95% CI: 28.37–37.48) and 41.7% (95% CI: 36.98–46.56), respectively. Soil-transmitted helminth infections accounted for 34.5% (95% CI: 31.29–37.84) prevalence among the whole ($n = 806$) study participants. The prevalence of STH infections in ODF declared and ODP Kebeles were 30.0% (95% CI: 25.8–34.7) and 39.0% (95% CI: 34.3–43.8), respectively, with high prevalence (34.5%) in Yiloma kebele in ODF declared kebeles (Table 1).

The occurrence of STH infections in ODF declared kebeles was 31.2% in the 11–14 age-group, 31.7% in females, and 30.2% in grade level 0–4 students. The increased prevalence of STH infections in ODP (41.1%) was also recorded in the 6–10 age-group, 45.3% in males, and 39% in children with 0–4 grade level (Table 1).

From the total intestinal helminth infections, *A. lumbricoides* and hookworm parasites accounted for 34.5%. Hookworm was the most common STH infections in both ODF declared (27.5%) and ODP (31.3%) kebeles. Single and double

TABLE 1

Sociodemographic characteristics and distribution of soil-transmitted helminth infections prevalence of school-age children in selected ODF declared and ODP kebeles in Bahir Dar Zuria district, northwest Ethiopia, 2019 ($n = 806$)

Variable	Category	ODF declared		ODP		Total (ODF declared and ODP)	
		N (%)	Pos (%)	N (%)	Pos (%)	N (%)	Pos (%)
Age-group (years)	6–10	230 (57.1)	67 (29.1)	224 (55.6)	92 (41.1)	454 (56.3)	159 (35.0)
	11–14	173 (42.9)	54 (31.2)	179 (44.4)	65 (36.3)	352 (43.7)	119 (33.8)
Gender	Male	198 (49.1)	56 (28.3)	170 (42.2)	77 (45.3)	368 (45.7)	133 (36.1)
	Female	205 (50.9)	65 (31.7)	233 (57.8)	80 (34.3)	438 (54.3)	145 (33.1)
Children grade level	0–4	374 (92.8)	113 (30.2)	351 (87.1)	137 (39.0)	725 (89.9)	250 (34.5)
	5–8	29 (7.2)	8 (27.6)	52 (12.9)	20 (38.5)	81 (10.1)	28 (34.6)
ODF kebele	T/laguna	119 (29.5)	35 (29.4)	–	–	–	–
	Chenta	168 (41.7)	46 (27.4)	–	–	–	–
	Yiloma	116 (28.8)	40 (34.5)	–	–	–	–
ODP kebele	Debranta	–	–	113 (28.0)	45 (39.8)	–	–
	Sekelet	–	–	114 (28.3)	45 (39.5)	–	–
	Wonjeta	–	–	176 (43.7)	67 (38.1)	–	–
Total		403 (100)	121 (30.0)	403 (100)	157 (39.0)	806 (100)	278 (34.5)

ODF = open defecation-free; ODP = open defecation-practicing; N = number examined; T/laguna = Tenta laguna.

(hookworm + *A. lumbricoides*) infections in the whole study participants ($n = 806$) were found with infection rates of 30.6% and 3.9%, respectively. Single infections were more common incidents among ODP kebeles children (34.5%). Double infections were higher in ODP (4.5%) kebeles than in ODF declared (3.2%) kebeles (Table 2).

The intensity of STH infections. All STH infections were with light intensity in both ODF declared and ODP kebeles. The mean intensity of hookworm and *A. lumbricoides* was 205.6 and 122.1 eggs count per gram of stool, respectively, at ODF declared kebeles. In the same way, the mean intensity of STH infections of hookworm and *A. lumbricoides* at ODP kebeles was 300.9 and 142.5 eggs count per gram of stool, respectively.

Factors associated with STH infections in ODF kebeles. The multivariate logistic regression model revealed that children who wore open shoes were 2.30 times more exposed to STH infections than children who wore covered shoes (AOR = 2.30; 95% CI: 1.46–3.64). Likewise, children who wore their shoes sometimes were at 2.56 times higher risk of STH infections than children who always wore shoes (AOR = 2.56; 95% CI: 1.25–5.25). In the same way, children playing with soil were 1.81 times more exposed to STH infections than children who could not play with soil (AOR = 1.81, 95% CI: 1.12–1.93) (Table 3).

Factors associated with STH infections in ODP kebeles. Multivariate logistic analysis on ODP kebeles also showed that children wearing shoes sometimes were 12.09 times more exposed than children who always wore their shoes (AOR = 12.09; 95% CI: 6.46–22.62). Similarly, children who were not using latrine had 2.15 times higher risk of STH infections than children who used the latrine (AOR = 2.15; 95% CI: 1.20–3.84).

In the same way, children playing with soil were 4.62 times more exposed than children who did not play with soil (AOR = 4.62; 95% CI: 2.59–8.24). Children living in ODF declared kebeles had 49% decreased risk of infection with STHs (AOR = 0.51; 95% CI: 0.33–0.79) as compared with children living at ODP kebeles (Table 4).

DISCUSSION

Soil-transmitted helminth infections are the most common public health problem among SAC in developing countries. To minimize the impacts of STH infections, proper planning, implementation, and evaluation of intervention programs like ODF declared in endemic areas are very important. In the present study, the overall prevalence of STH infections was 34.5%. This result was lower than the previous result obtained (43.0%) in rural Bahir Dar,¹³ (69.2%) in rural Amhara region,¹⁴ and (49.0%) in Jimma town.¹⁵ This result was also higher than the previous report obtained (12.6%) in Ambo, west Ethiopia.¹⁶ This difference might be due to differences in diagnostic methods, environmental hygienic conditions, the difference in age-group, and WASH practice; for example, the study conducted in Jimma included 5–18 age-groups.

Proper utilization of latrine, good personal and environmental hygiene, and sanitation significantly decrease the prevalence of STHs in an institution or community.¹⁷ Implementation and application of ODF also decrease the prevalence of STH infections in a community by breaking the life cycle of STH infections. In the present study, the prevalence of STH infections in ODF declared kebeles (30%) was low as compared with ODP (39.0%) kebeles. A similar study

TABLE 2

Distribution of STHs identified from ODF and ODP kebeles children in Bahir Dar Zuria district, northwest Ethiopia, 2019

Types of STHs	ODF kebeles infected children, N (%)	ODP kebeles infected children, N (%)	Total, N (%)
Hookworm	111 (27.5)	126 (31.3)	237 (29.4)
<i>A. lumbricoides</i>	23 (5.7)	49 (12.2)	72 (9.0)
Single infection	108 (26.8)	139 (34.5)	247 (30.6)
Double infection of hookworm and <i>A. lumbricoides</i>	13 (3.2)	18 (4.5)	31 (3.9)
Total	121 (30.0)	157 (38.9)	278 (34.5)

A. lumbricoides = *Ascaris lumbricoides*; ODF = open defecation-free; ODP = open defecation-practicing; N = number examined; STH = soil-transmitted helminth.

TABLE 3

Univariate and multivariate logistic regression analyses of factors associated with STH infections among school-age children in ODF declared kebeles in Bahir Dar Zuria district, northwest Ethiopia, 2019 ($n = 403$)

Variable	N	STH infections, N (%)	COR (95% CI)	P-value	AOR (95% CI)	P-value	
Gender	Male	198	56 (28.3)	0.85 (0.55–1.30)	0.45	–	–
	Female	205	65 (31.7)	1			
Age-group (years)	6–10	230	67 (29.1)	1	0.65	–	–
	11–14	173	54 (31.2)	1.10 (0.72–1.70)			
Grade level of children	5–8	29	8 (27.6)	1	0.76	–	–
	0–4	374	113 (30.2)	1.14 (0.49–2.64)			
Family size	≥ 5	235	79 (33.6)	1.52 (0.98–2.36)	0.06	1.39 (0.87–2.21)	0.17
	< 5	168	42 (25)	1		1	
Latrine use	No	129	48 (37.2)	1.63 (1.04–2.55)	0.03*	1.17 (0.71–1.92)	0.55
	Yes	274	73 (26.6)	1		1	
Types of shoes worn	Open	191	78 (40.8)	2.71 (1.74–4.22)	0.00*	2.30 (1.46–3.64)	0.00*
	Covered	212	43 (20.3)	1		1	
Shoes worn	Sometimes	39	21 (53.8)	3.08 (1.58–6.02)	0.00*	2.56 (1.25–5.25)	0.01*
	Always	364	100 (27.5)	1		1	
Drinking water source	Tap water	221	58 (26.2)	1	0.07	1	0.10
	Others	182	63 (34.6)	1.49 (0.97–2.28)		1.48 (0.93–2.37)	
Handwashing before meal	No	4	2 (50)	2.35 (0.33–16.90)	0.39	–	–
	Yes	399	119 (29.8)	1			
Washing vegetable	No	103	33 (32.0)	1.14 (0.70–1.84)	0.60	–	–
	Yes	300	88 (29.3)	1			
Playing with soil	No	192	44 (22.9)	1	0.03*	1	0.02*
	Yes	211	77 (36.5)	1.93 (1.25–2.99)		1.81 (1.12–1.93)	
Nail trimming	Not trimmed	131	49 (37.4)	1.66 (1.06–8.68)	0.03*	1.18 (0.72–1.93)	0.52
	Trimmed	272	72 (26.5)	1		1	

ODF = open defecation-free; ODP = open defecation-practicing; STH = soil-transmitted helminth. N = number examined; COR = Crude Odds Ratio; AOR = Adjusted Odds Ratio.
* $P < 0.05$.

conducted in India showed the prevalence of worm infection was higher (44%) in the ODP villages than (36%) in the ODF declared villages.¹⁸ The present result was also supported by a study carried out in Coted'Ivoire that showed the successful implementation of CLTSH in a community decreases the STH infection prevalence.¹⁹ The present low prevalence of STH

infections in ODF declared kebeles was supported by studies conducted in governmental and private schools in Jimma²⁰ and Nigeria.²¹ In these studies, the sanitation and hygiene practice is better in private schools which showed a low prevalence of STH infections. Generally, this study justified as the prevalence of STH infections might be highly dependent

TABLE 4

Univariate and multivariate logistic regression analyses of factors associated with STH infections among school-age children in ODP kebeles in Bahir Dar Zuria district, northwest Ethiopia, 2019

Variable	N	STH infections, N (%)	COR (95% CI)	P-value	AOR (95% CI)	P-value	
Gender	Male	170	77 (45.3)	1.58 (1.06–2.38)	0.03*	1.01 (0.56–1.83)	0.96
	Female	233	80 (34.3)	1		1	
Age-group (years)	6–10	224	92 (41.1)	1	0.33		
	11–14	179	65 (36.3)	0.82 (0.55–1.23)			
Grade level of children	5–8	52	20 (38.5)	1	0.98		
	0–4	351	137 (39.0)	0.98 (0.54–1.78)			
Family size	≥ 5	231	90 (38.9)	1.00 (0.67–1.50)	0.99		
	< 5	172	67 (38.9)	1			
Latrine use	No	225	116 (51.6)	3.56 (2.30–5.50)	0.00*	2.15 (1.20–3.84)	0.01*
	Yes	178	41 (23.0)	1		1	
Types of shoes worn	Open	243	115 (47.3)	2.52 (1.64–3.89)	0.00*	0.83 (0.43–1.61)	0.59
	Covered	160	42 (26.3)	1		1	
Shoes worn	Sometimes	202	137 (67.8)	19.08 (11.03–32.99)	0.00*	12.09 (6.46–22.62)	0.00*
	Always	201	20 (9.9)	1		1	
Drinking water source	Tap water	170	53 (31.2)	1	0.01*	1.00 (0.56–1.79)	0.99
	Others	233	104 (44.6)	1.78 (1.18–2.69)		1	
Handwashing before meal	No	5	3 (60)	2.38 (0.39–14.39)	0.35		
	Yes	8	154 (38.7)	1			
Washing vegetable	No	89	53 (59.6)	2.97 (1.83–4.82)	0.00*	1.69 (0.86–3.32)	0.13
	Yes	314	104 (33.1)	1		1	
Playing with soil	No	211	34 (16.1)	1	0.00*	1	0.00*
	Yes	192	123 (64.1)	9.28 (5.80–14.86)		4.62 (2.59–8.24)	
Nail trimming	Not trimmed	165	94 (56.9)	3.68 (0.83–2.13)	0.00*	1.61 (0.90–2.86)	0.11
	Trimmed	238	63 (26.5)	1		1	
Group	ODP	403	157 (38.9)	1.49 (1.11–1.99)	0.01*	0.51 (0.33–0.79)	0.00
	ODF	403	121 (30.0)	1		1	

ODF = open defecation-free; ODP = open defecation-practicing; STH = soil-transmitted helminth. N = number examined.
* N = number examined.

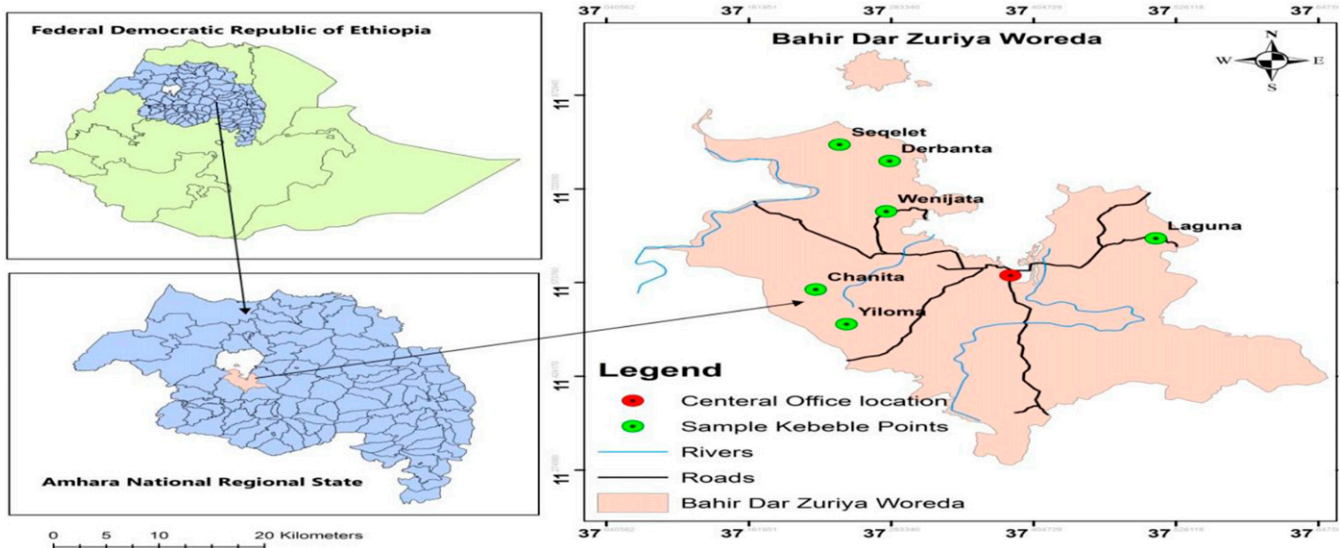


FIGURE 1. Map of the Bahir Dar Zuriya woreda and the study sites. This figure appears in color at www.ajtmh.org.

on the sanitation practice taking place at the individual, institutional, and community levels.

Children are highly at risk for hookworm infections. They acquire hookworm infections when they walk barefoot and

play with soil which contains the infective stages (larvae). Similarly, children get *A. lumbricoides* infections through the ingestion of contaminated food, water, and soil, because the soil is contaminated with ova of *A. lumbricoides* and

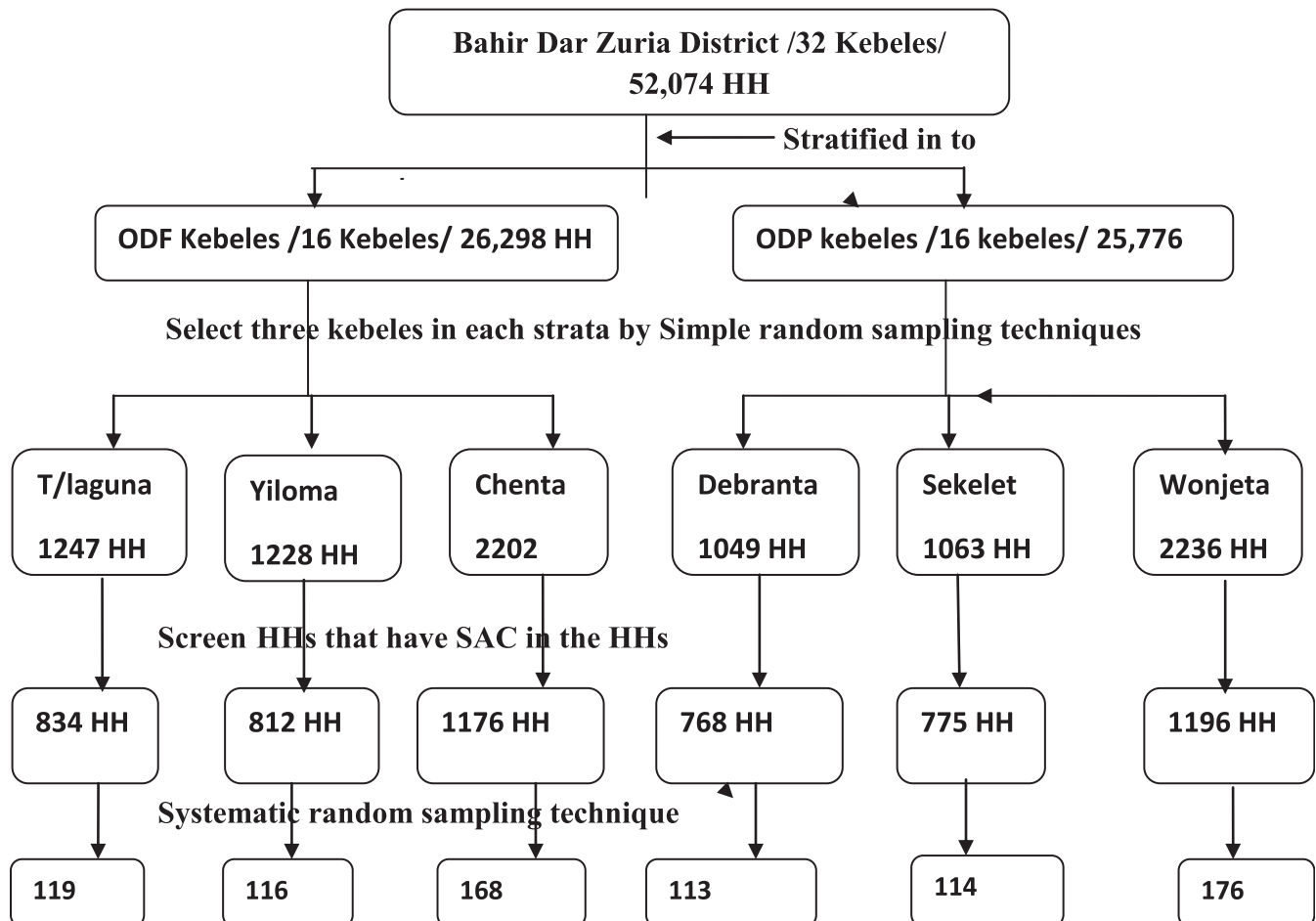


FIGURE 2. Participant flowchart showing participant selection. * FF = family folder; HP = health post; HH = household; N = total number of selected households; K = interval b/n households.

hookworm parasites through open defecation. Creating the ODF environment helps to prevent contamination of soil with hookworm larvae and decrease the prevalence. In the present study, hookworm infections were the commonest in children living in ODF declared (27.3%) and ODP (31.6%) kebeles, and the prevalence decreases in ODF declared kebeles. This result was consistent with the previous finding conducted among individuals in ODF declared (16.3%) and ODP (20.9%) villages in India.¹⁸

Hookworm infections remain common throughout much of sub-Saharan Africa, ranging from 2.3% in Eritrea to 30.5% in the Central African Republic.²² In the present study, hookworm was the most frequent STH infections (29.4%). This result was consistent with the previous findings performed in rural Bahir Dar,¹³ and in rural highlands of northwest Ethiopia¹⁴ and India,²³ but higher than the previous result obtained in Ambo town in western Ethiopia.¹⁶ The difference might be due to the difference in diagnostic method, sample size, and geographical location.

Ascaris lumbricoides is the predominant STH infection globally.²² The prevalence of *A. lumbricoides* infections among the study participants in the present study was 8.9%. This result was consistent with findings of 8.5% and 7.8% obtained in rural highlands of northwest Ethiopia¹⁴ and Ambo town, western Ethiopia,¹⁶ respectively. However, it was lower than previous records that obtained 23.4% and 52% in Jimma town¹⁵ and Bahrin state of India,²³ respectively. The difference might be due to the low levels of sanitation facilities and practice. For example, the study conducted in India showed that only 17% of the participants had a toilet.

The intensity of parasitic infections is very crucial for parasite infectivity and transmission. In the present study, the mean intensity of hookworm and *A. lumbricoides* infections were 205.6 and 122.1 at ODF declared kebeles, respectively. Similarly, the mean intensity of hookworm and *A. lumbricoides* infections were 300.9 and 142.5 at ODP kebeles, respectively. This result was lower than the previous study carried out in India, 1803 for *A. lumbricoides* and 416 for hookworm.²⁴ This difference might be due to different environmental hygienic conditions, sample size, deworming, and difference in the data collection time. According to the WHO classification, in the current study, only light infections were observed in all positive SAC; it might be due to the administration of MDA every 6 months in the study area. This result was similar to the study carried out in Ambo town.¹⁶

In the current study, the odds of children who wore open shoes were 2.30 times more exposed to STH infections than children who wore covered shoes (AOR = 2.30; 95% CI: 1.46–3.64). The possible justification might be due to the absence of full protection of soil contamination with open shoes as covered shoes. In the same way, children who wear shoes sometimes were 2.56 times at a higher risk of STH infections than children who wore shoes always (AOR = 2.56, 95% CI: 1.25–5.25). This result was consistent with the previous study conducted in Durebet town, northwest Ethiopia.²⁵ Similar to the present study, previous studies have shown that wearing shoes reduces hookworm infection by 71%¹⁷ and is 2.1 times more protective for STH infections.²⁶

Absence of latrine utilization ($P = 0.01$), occasionally/not wearing shoes ($P = 0.00$), and playing with soil ($P = 0.00$) were associated factors for STH infections in ODP kebeles. The proper utilization of latrine decreases the prevalence of STH

infections. In the present study, children not using latrine were 2.15 times more exposed to STH infections than children using latrine in ODP kebeles (AOR = 2.15; 95% CI: 1.20–3.84). A similar study showed that proper latrine use decreased STH infections.^{17,27,28} This can be justified that awareness of STH infections and effective utilization of latrine are the target of creating ODF which leads to a decrease in environmental contamination with human feces.

Our environment is contaminated with the ova of STHs because of open defecation. As a result, children contaminated their hands when they play with soil.²⁹ In the present study, children playing with soil were 4.62 times more exposed to STH infections than children who did not play with soil (AOR = 4.62; 95% CI: 2.59–8.24). The possible justification might be that children living in our study area played with soil and mud, drilled holes in the soil, and played volleyball and football, which lead to parasitic infections.

The limitation of this study was using a single stool sample that has a low chance of getting the parasites in the Kato–Katz technique and unable to determine the contamination rate of soil in the ODF declared and ODP kebeles.

CONCLUSION AND RECOMMENDATION

The prevalence of STH infections was lower among children living in ODF declared kebeles than in ODP kebeles. All STH infections were with light intensity in both ODP and ODF declared kebeles. Open shoe wearing, wearing shoes sometimes, and playing with soil were associated with STH infections in ODF kebeles, and wearing shoes sometimes, playing with soil, and not using latrine were associated with STH infections in ODP kebeles. Therefore, upgrading ODF strategies in ODP kebeles, coupled with close follow-up and monitoring, sustains ODF environment free of STHs; proper awareness creations aiming to change the knowledge, attitude, and practice of the community should be strengthened in the study area.

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