Original article

Sanitary survey of residential areas using *Ascaris lumbricoides* ova as indicators of environmental hygiene, Jimma, Ethiopia

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Abstract

Background: Fecal contamination is a serious environmental health problem. The prevalence of human ascariasis is high in temperate and tropical environments.

Objective: To assess the sanitary conditions of soil using the presence of *Ascaris lumbricoides* ova as an indicator.

Methods: This cross-sectional study was conducted during July – September 2005. A total of 274 households from 6 *Kebeles* in Jimma town were assessed and interviewed on waste disposal practices, and characteristics and usage of water and latrine facilities using a structured questionnaire. Three hundred soil samples were also collected from each household and examined microscopically for *Ascaris lumbricoides* and other helminth ova using sugar flotation technique.

Results: Of the 274 respondents, 83.2% were literate, 43.8% were government employees and 33% earned less than 8 Birr/day. Of the households, 96.7% had latrines, 88.7% of which were functioning and 54.7% were pit latrines. For disposal of household waste, 163(59.5%) used open fields and 86(31.4%) used refuse pits. A majority (253, 92.3%) used piped water for drinking and sanitary purposes. *Ascaris lumbricoides* ova were isolated in 37.3% of the soil samples and the overall proportion of helminth ova recovered was 41.5%.

Conclusion: The living yards of the households were contaminated with helminth ova. Use of *A. lumbricoides* ova as an environmental health indicator could contribute to the development of surveillance tools and health protection measures in this area. A large scale study on the issue is recommended as is environmental health education for households. [*Ethiop.J.Health Dev.*2007;21(1):18-24]

Introduction

Fecal contamination is a grave environmental health problem. Three million children die of enteric diseases each year and more suffer from debilitating diseases due to intestinal parasites (1). *Ascaris lumbricoides* infects about 25% of the world's population annually (2). As a result of poor environmental hygiene, such infections may predispose one to diarrhoeal diseases and may contribute to morbidity when associated with malnutrition, vitamin A deficiency and enteric diseases (3, 4). Human ascariasis occurs both in temperate and tropical environments. The prevalence is low in arid climates, but high where conditions are wet and warm as these conditions are ideal for egg survival and embryonation. In addition, crowding, low socioeconomic status, poor environmental hygiene, and water supply contribute to the increased risk of infections due to helminthes (5-7).

Recently, there has been a considerable shift in the concept of sanitation in many countries and thus household access to latrines is no longer a good indicator of sanitation coverage. This shift in concept has emerged partly due to the failure of the water decade to achieve its intended objectives (8). Some of the reasons for the failure of the program include lack of knowledge of the modes of transmission and the role of children who do not use latrines as important sources of contamination (9). Promotion of personal and domestic hygiene can significantly reduce the incidence of diarrhoeal diseases (10, 11).

The use of *A. lumbricoides* ova as indicators of intensity of infection and prevalence has been extensively investigated by different authors (12-16). The criteria to serve as an environmental health indicator include: a) ease of obtaining, b) comprehensibility to policy makers and the public, and c) validity as a surrogate to the variables measured (16). Some of the advantages of using Ascaris as an environmental health indicator as described by Pastides (16) include: a) the eggs of Ascaris persist for many months but do not multiply and can easily be identified, b) various techniques for extracting Ascaris ova from soil samples have been described, c) Ascaris is endemic in areas where sanitation is poor and widely distributed in environments infecting about a quarter of the world's population. Parasitic, predominantly helminthic infections, are second most common causes of outpatient morbidity in Ethiopia. Several studies indicate the high prevalence of *A. lumbricoides* and other parasitic infections in the lower altitudes including southwestern Ethiopia (17, 18). Resistance of Ascaris ova to cold and desiccation facilitates the widespread distribution of the parasite in Ethiopia (19). Ethiopia has one of the lowest

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coverage of drinking water and latrines in the world. In 2000, neighboring country Kenya had 87% latrine coverage while Ethiopia had only 12% (20).

This study examines the importance of *A. lumbricoides* ova contamination of soil as an indicator of environmental hygienic conditions. Simple and directly demonstrable environmental hygiene indicators are needed in developing countries to help set priorities for action.

In Ethiopia, no study has been done to assess the environmental risks due to the presence of helminthic eggs in the soil. Previous studies on parasites concentrated on human infections. The present study aims to assess environmental sanitation using the presence of *A. lumbricoides* ova in the soil as an indicator. The study also assesses the environmental factors, behavioral and social characteristics of residents in Jimma town. It is believed that this study may create awareness and guidance for action. The indicator points out the important environmental, social and cultural variables associated with the risks of *A. lumbricoides* in the environment. The rationale is that fecal-oral transmission is likely to increase in persons with low socioeconomic status, who have poor knowledge of the transmission of the parasite. Thus, the contamination of soil by the shedding of viable ova by infected humans onto humid and shady soil is increased (9,15).

Methods

This cross-sectional, community and laboratory-based study was conducted in Jimma town during July – September 2005. Jimma, the largest town in Southwest Ethiopia, is located 335 Km from Addis Ababa, the capital city of the country. It has an altitude of 1740 m above sea level and a mean temperature of 24.9°C (21) with high humidity throughout the year. The town has a population of 138,070 (21) and is divided into 3 *Woredas,* each of which is subdivided into 3-4 *Kebeles*. There are a total of 12 *Kebeles,* with a 13th Kebele located 6 Km from the main town.

The source population for the study was residents of Jimma town and the study subjects were the households. A total of 300 houses from the 6 *Kebeles* were included in the study.

Six *Kebeles* were randomly selected by a lottery system from the 12 Kebeles. Accordingly, 2 *Kebeles* from each *Woreda* (*Kebele*s 1, 3, 4, 5, 7, 8) were included in the study. The sample size was determined using a general formula using a 5% significance level and assuming 75% prevalence of ascaris (22). Five percent non-response rate was added. With this, a sample size of 300 households was calculated. Offices, shops and other public houses were excluded.

Data were collected by 2 trained 12th grade complete persons. Data collectors did house-to-house visits to conduct interviews and evaluate domestic conditions (status of toilets, backyards, etc). Soil samples were also collected. Of the 300 households, 274 completed interviews on socio-demographic factors (awareness of environmental health), socio-economic indicators (monthly income), human waste disposal facilities and other household waste disposal systems (availabilities and use of latrines, water for general use etc). Latrine facilities were assessed using observations and a pre-tested, 28-item structured questionnaire. In addition, 300 soil samples were collected from the yard of each selected house and were examined for the presence of *A. lumbricoides* and other parasitic eggs using the sugar flotation technique as described by Groenen (23). Soil samples were collected from a selected site at a distance of 1 meter from the walls of the house by sweeping and scratching the superficial layer with a sheet of iron. Two to three hundred grams of soil were collected in plastic bags. The samples were labeled and taken to the parasitology laboratory where they were left overnight at ambient room temperature to dry. After drying, the soil was sieved using a fine sieve (pore diameter 250μm) in order to remove larger particles but allow small size particles including sticky helminthes eggs to pass. From the sieved portion, 2g of soil was placed into a 10ml test tube containing 3ml of 30% sodium hypochlorite (NaOCl) solution. The tube was shaken intermittently for 1hour. Then 5ml of concentrated saccharine solution (1000gm of white sugar in 900ml of distilled water was added and the tubes were shaken thoroughly. The tubes were then centrifuged at 1500rpm for 15min. More sugar concentrate was added to the tube to raise the meniscus and float the eggs in order to put cover glasses on the top of the tubes and wet them by the surface of the floating solution after allowing resting for 15min. After carefully removing the cover glasses from the top of the tubes and placing them on microscope slides, the slides were examined microscopically at 40x magnification for the presence of *Ascaris* ova. The investigators supervised for proper data collection and laboratory procedures.

Operational definitions of words: Status of latrines was graded as good when there were no flies, the floors and walls were clean and washed and did not require any maintenance. It was graded as fair if there were few defects and the facility was in need of minor maintenance. The latrine was graded as bad when the floors or walls were contaminated with feces, there were flies and the facility had a bad smell and needed urgent maintenance.

Data analysis: Data were entered into computer and analysed using SPSS version 12 software. The software was used to compute frequencies and means. Descriptive data analysis was mainly used and chi square tests at 95% CI and P-values at 5% were also computed.

Bivariate analysis was also done to test for associations between socioeconomic status and presence of latrine facilities.

Ethical aspects: Ethical approval was obtained from the Research and Publications Office of Jimma University. An official letter was circulated to the respective *Kebele* Administrations. Households were asked to participate in the interview and allow the collection of soil samples from their backyard. The study was conducted after informed consent was obtained from elder persons.

Results

Of the selected 300 houses, 274 households (91.3%) completed the interview and responded to all questions. The remaining 26(8.7%) were excluded because 9 refused to respond and 17 gave incomplete information. However, soil samples were collected from all 300 selected houses. The households comprised of 1397 individuals (mean = 5.39±2.26 individuals/household). There were 99 children under 5 years of age in these households, constituting 7.1% of the respondent population. Less than 40% of respondents had health education prior to the interview. Approximately 83.2% were literate, 43.8% were government employees and 25.2% were housewives. The majority, 196(71.5%) were Christians. The monthly income of households ranged from Birr 15 to 3000 and 33% were earning less than 1 USD/day or less than Birr 250/month (Table 1). There was a correlation between and presence of latrines and level of education (P<0.01).

The majority of households, 165(60.2%), did not own functioning TV sets. Only 218(79.6%) had access to health information from newspapers or pamphlets while 163(59.5%) received health education from different sources. Of these, 90(55.2%) got education through the radio, while only 3(1.8%) received heath education through educators at the *Kebele* level (Table 2).

A total of 263(96.7%) households had latrines, of which 88.7% were functional while the rest lacked any form of latrine or had filled and were non-functional. Of the latrines, 53.3% were pit, 24.6% WC and 19.5% VIP latrines types. Only 51.7% were in good condition while the rest were in bad condition and required maintenance. Concerning utilization of latrines, 2.3% of interviewed households prefer not to use them. Only 4(1.5%) of the latrines were used by children. One hundred and thirty four (50.6%) of the available latrines had unclean floors

Table 1: **Socio-demographic and socio-economic characteristics of households, Jimma, September 2005 (n =274)**

Characteristic	Number	Percent
No of children <5 years old	99	-
Education status of respondents		
Illiterate	24	8.8
Read & write	22	8.0
Grade 1-8	51	18.6
Grade 9-12	49	17.9
Grade 12 & above	128	46.7
Occupation of respondents		
Government Employee	120	43.8
Housewife	69	25.2
Merchant	32	11.7
Student	8	2.9
Other*	45	16.4
Religion		
Christian	196	71.5
Muslim	71	25.9
Not specified	7	2.5
Income (in Birr/month)		
<100	38	13.9
100-299	45	16.4
300-499	25	9.1
500-699	18	6.6
700-899	26	9.5
>900	53	19.3
Unspecified**	69	25.2
Total	**274**	**100.0**

*No specific job (includes daily laborers);
** Include those unemployed and those who do not know their incomes

Table 2: **Study participants' knowledge and awareness of environmental sanitation and access to health information, Jimma, September 2005 (n=274)**

Health education and other sources of health information	Yes	No
	Number (%)	Number (%)
Presence of functional TV set in household	109 (39.8)	165 (60.2)
Household members' access to newspapers and pamphlets	218 (79.6)	55 (20.1)*
Household members have received education on health	163 (59.5)	108 (39.4)**
Sources of the education (For those 163 who have education)		
TV	90(55.2)	
Radio	33(20.3)	
TV & Radio	3(1.8)	
Kebele	3(1.8)	
Unidentified	34(20.9)	

* 1 case was missing; ** 3 No response

and walls. Of these, 15(5.5%) were contaminated with feces and the others with paper and dirt. A total of 131(47.8%) of respondents responded negatively in regards to maintaining the cleanliness of latrines. Of these, 116(42.3%) said latrines are uncomfortable for cleaning, 8(2.9%) stated that there is no one responsible for cleaning, 7(2.6%) indicated the scarcity of water to keep latrines clean. When asked about who is responsible of the construction and maintenance of latrines, 93.8% indicated that the family is, while 5.4% responded it was the government's responsibility. The distance of the latrines from the living room was less than 10 meters in 66.4% of the households (mean 13.59m±14.28m). In 48% households, the distance between the latrine and nearby water sources was less than 10 meters, and less than 6m in 24% of households. A significant number of residents (63, 59.5%) used open fields for waste disposal, 86(31.4%) used prepared refuse pits, while only 22(8.0%) incinerated household wastes (Table 3).

Table 3: **Availability, type and condition of latrines, and refuse disposal practices of households, Jimma, September 2005**

Characteristic	Number	Percent
Availability of latrine (n =274)		
Available	265	96.7
Absent	9	3.3
Functionality		
Functional	235	88.7
Non-functional	30	11.3
Type of latrine		
Pit	145	54.7
WC	67	25.3
VIP	53	20.0
Status of latrine (n =265)		
Good; need no maintenance	137	51.7
Fair, need little maintenance	9	3.4
Bad, need urgent maintenance	119	44.9
Cleanliness of inside of latrine (Assessed by observation)		
Clean	131	49.4
Not clean	134	50.6
Area surrounding the latrine		
Contaminated with feces	15	5.7
Not Contaminated with feces	236	94.3
Reasons for lack of cleanliness (n =131)		
Uncomfortable for cleaning	116	42.3
No one is responsible to clean	8	2.9
Scarcity of water	7	2.6
Usage of latrines (n =265)		
Children	4	1.5
Elderly	30	11.3
Women	91	34.3
All	140	52.8
Refuse disposal (n = 274)		
Open field	163	59.5
Refuse pit	86	31.4
Incineration/burn	22	8.0
Not identified	3	1.1

The majority of households, 253(92.3%) used piped water while 16(5.8%) used protected wells and 1% used protected springs for their washing, drinking and other sanitary purposes. The estimated average water supply per household was 21.98±13.82L/household, with 33.1% of households getting less than 15L/day.

Of the 300 soil samples analysed for the presence of parasite ova, ova of five different soil parasite species were recovered. *A. lumbricoides* was found in 112(37.3%) soil samples, followed by *Enterobius vermicularis* in 6(2.0%) samples, hookworm in 3(1.0%), *Trichuris trichiura in* 2(0.7%), and *Strogyloides stercoralis* ova *in* 1(0.3%) sample (Table 4). Overall, helminth ova were recovered in 124(41.3%) soil samples. Each soil sample contained a combination of helminth ova. Of the 124 isolates of ova, 6(4.9%) were combinations of hookworm, *A. lumbricoides,* and *E. vermicularis,* in the following frequencies: hookworm + *A. lumbricoides (1), A. lumbricoides* + *E. vermicularis (4),* hookworm + *E. vermicularis(1).*

The intensity of parasite ova varied between the different *Kebeles*, with heavy infestation of *A. lumbricoides* eggs of up to 59 ova per slide for one Kebele (ranging from 27.8-47.9% as depicted in Table 5).

Table 4: **Prevalence of *Ascaris lumbricoides* and other parasite ova in soil samples in selected households by *Kebele*, Jimma, September 2005**

Kebele /Area	No. of HH sampled	No (%) of HH positive for *Ascaris* No (%)	*E. vermicularis* No (%)	Hook worm No (%)	*T. trichiura* No (%)	*S. stercoralis* No (%)	Total No (%)
1	14	14(35.9)	3(1.0)	-	1(0.3)	1(0.33)	18 (6.0)
3	23	23(47.9)	1(0.3)	1(0.3)	-	-	25 (8.3)
4	19	19(38.0)	1(0.3)	1(0.3)	1(0.3)	-	22 (7.3)
5	16	16(30.8)	1(0.3)	1(0.3)	-	-	19(6.3)
7	23	23(40.4)	-	-	-	-	23 (7.7)
8	17	17(31.5)	-	-	-	-	17(5.7)
Total	**300**	**112 (37.3)**	**6 (2.0)**	**3 (1.0)**	**2 (0.7)**	**1(0.3)**	**124(41.3)**

HH: household

Table 5: **Mean number and percent of *Ascaris lumbericoides* ova in selected households by *Kebele*, Jimma, September 2005**

Kebele	No. of House Holds sampled	Frequency of *A. lumbericoides* ova recovery	% Positive	Mean No of *A. lumbericoides* ova/sample	Range of ova/ slide
1	39	14	35.9	9.2	3-46
3	48	23	47.9	8.8	2-31
4	50	19	38.0	6.9	1-21
5	52	16	30.8	9.5	3-17
7	57	23	40.4	8.2	1-59
8	54	17	31.5	5.0	1-10
Total	**300**	**112**	**37.3**	**7.8**	**-**

Discussion

Helminthic infections result from ingestion of viable ova shed by infected humans on humid and shady soil. Overcrowded living conditions increase the likelihood of fecal–oral transmission. The intensity of infection is influenced by as well as hygiene, environmental and socioeconomic factors. Data from the MOH of Ethiopia indicate that about 75% of cases of out patient visits are mainly due to lack of basic sanitation (24).

About one third of the households in the present study were poor, with an income of less than 8 Birr /day (1 USD = 8.7 Birr), i.e., below the poverty line. One quarter of respondents (25.2%) had no specific or regular jobs and had no regular monthly income. This shows that about half of the respondents had low socioeconomic status. O'Lorrcain and Holland (6) indicate that low socioeconomic status is a factor for poor hygiene and parasitic infections. However, in this study, parasite ova were recovered from all households irrespective of socioeconomic status. This could be due to the limited awareness of environmental health and poor handling of latrines. Only about 40% of the respondents claimed that they have previously received health education. Of those who had some health education, only 3(1.8%) received it through educators at the *Kebele* level during occasional meetings on general health (HIV/AIDS). This shows that there is a forum to provide health education to urban residents.

Although 96.7% of the respondents had latrines, only 235(88.7%) were functional and serviceable. Despite the high coverage of latrine facilities, the presence of helminth ova in the soil indicated the poor environmental sanitation around the latrines. More than 50% of the pit latrines were in bad condition and required maintenance. Despite respondents' claim that the majority of the latrines were utilizable, the sanitary assessment found latrines to be poorly handled and in poor conditions. Latrines were exposed to flies and had bad smells, and were not comfortable to use, especially for children. Thus, children preferred to use open fields near their houses. This may be a source of environmental contamination and a point of transmission, particularly for children. Children under 5 years old have a higher risk of infection than adults because they spend more time at home and engage in risky behaviours such as playing on and with soil. Thus, domestic sanitation and hygiene are priorities for action (25). Safe disposal of fecal material and hand washing are effective barriers to transmission (11). In more than a third of the households, the surrounding areas were contaminated and infested with Ascaris ova. The humid climatic condition of the town contributes to the survival of the ova. This may aggravate the persistence, proliferation and transmission of parasites.

This amount of water is small and insufficient to maintain good sanitary purposes as compared to the standard requirement of 50 litres in urban areas as described by Kume et al (20). Additionally, there were irregularities in water supply. In these cases, people were obligated to use spring water or water from wells. Water from these kinds of sources is usually not treated with disinfectants. Thus, it could be a source of infection from different parasites. High rates of parasitic diseases were characterized by insufficient running water in homes, outdoor garbage disposal, primitive (badly handled) latrines and dirty yards (26). Due to crowded construction of houses and insufficient spaces, the distance between the water supply and latrines was less than 6 metres in 24% of households and less than 10meters in 48% of households. The bad status of latrines, compounded with the short distances between latrines and water sources and living rooms, as well as insufficient water supplies create favorable conditions for the spread of parasites and other infectious agents.

The prevalence of *A. lumbricoides* in soil in the present study was 37.3% and overall prevalence of the 5 geo-helminth ova (*A. lumbricoides, E. vermicularis, T. trichiura, S. stercoralis* and hookworm) was 41.5%. This shows that the soil is high risk for the residents, particularly for children who usually play in the backyards and stay at home for longer times during the day. A school-based study in Jimma previously showed that the high prevalence of parasitism was mainly due to lack of personal hygiene. The prevalence of ascariasis in children in one school in Jimma was 52.2% (27). In another pilot study in Brazil, 2% of soil samples were tested positive for *A. lumbricoides* eggs while the prevalence in children was 12% (14). This reflects the low proportion of soil samples testing positive for *A. lumbricoides* eggs. On the other hand, when the hygienic index is low, there is a high prevalence of ascaris eggs in the soil and the number of infected children will be high.

One striking observation in this study was the prevalence of Ascaris ova in *Kebele* 4, which has a higher frequency of residents who are more educated and have higher socioeconomic status. Among the households sampled from this *Kebele*, the majority were taken from the residential quarter of Jimma University as the university covers a huge area of the *Kebele*. These houses were better furnished with flush type toilet facilities, and by and large the residents represented the educated segment of the society. However, the prevalence of ascariasis in this area was high compared to the neighboring *Kebeles.* To interpret this anomaly, the researchers re-interviewed some of the household owners. It was learned that in some households there was only one flush type toilet and owners do not feel comfortable sharing it with other persons. Consequently, others resort to using the hedgerows as night falls. Consequently, children along with weather events like rain storms ensure the distribution and contamination of the soil with Ascaris and other helminthes ova.

In conclusion, the living yards are invariably contaminated with Ascaris ova and other helminthes, irrespective of socioeconomic differences. In a situation where scientific criteria is lacking to evaluate the impact of sanitary measures in protecting public health, use of Ascaris ova as environmental hygiene indicators has a great potential to serve as a surveillance tool in the region, thereby helping policy makers make informed decisions. The information obtained in this study provides the basis for environmental health surveillance.

As there the sampling in this study is limited and local to Jimma town, it is recommended that a larger scale study be conducted to include both urban and rural settings with different climatic conditions. We also recommend that including extensive hygiene education within the existing health extension package.

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