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The impact of house clustering density on the prevalence and intensity of Soil-Transmitted Helminthes infection in a semi-urban community, southwest Nigeria.

OA Oluwatoba[1], HO Dada-Adegbola[1] and RI Nwuba[2],
Department of Medical Microbiology and Parasitology[1], College of Medicine, University of Ibadan and Cellular Parasitology Programme[2], Cell Biology and Genetics Unit, Department of Zoology, Faculty of Science, University of Ibadan, Nigeria.

Abstract

Background –Large proportion of Soil-Transmitted Helminthes (STH) infection remain in tropical and subtropical regions of Asia, China, India and sub-Saharan Africa. The implementation of preventive strategies depends on availability of adequate information on the prevalence of the disease in the community. However, little is known about how house clustering density affects the prevalence and intensity of STH infection. Hence the study was aimed at determining the effect in a semi-urban community in southwest Nigeria.

Methods- This is a cross-sectional study of geographically mapped and randomly selected households in Igbo-ora, Ibarapa local government, Oyo State. Demographic, observational risk factors and stool samples were collected from 508 participants. Prevalence of STH infection was expressed in percentage, and intensity was measured by Egg count Per Gram (EPG). Bivariate and multivariate logistic regression was calculated using Odds ratio at 95% CI, with significant level at $p<0.05$.

Results –The overall prevalence of STH was 28.1%. Hookworm was 18.7% prevalent, *Ascaris lumbricoides* 16.9%, *Strongyloides stercoralis* 3.0% and *Trichuris trichiura* 0.8%. *Ascaris lumbricoides* and hookworm infection was highest among the preschool age group (<1-5 year). However, *Ascaris lumbricoides* prevalence was highest in the two communities representing the low density areas and intensity of infection increased significantly with age. Those that live in high density area are 2.39 more likely to be infected with hookworm infection than those in the low density areas (OR: 2.39, 95% CI (1.23 – 4.63), $p<0.01$). Strong evidence that living in crowded room, with >4 individuals, predisposes human to STH infection was found (OR: 2.19, 95% CI (0.54 -3.25), $p< 0.01$) and houses built with mud (OR: 1.67, 95% CI (1.02- 2.74), $p<0.04$) predisposes to hookworm infection. Interestingly, lack of toilet facility, walking bare-feet, and open defecation did not significantly increase the risk for hookworm infection in this study.

Conclusion: The result from this study showed that house structure density and building materials are major contributing risk factors for hookworm infection. Hence the use of mud for building should be discouraged. Intensive health education on how house structure relate to health, with mass deworming programme should be prioritized to achieve a durable reduction of STH infection.

Keywords- *Soil-transmitted helminthes, hookworm, Ascaris, high density, crowded room.*

Résumé

Contexte -Grande proportion des infectionshelminthes transmise par le sol(HTS) restent dans les régions tropicales et subtropicales de l'Asie, la Chine, l'Inde et l'Afrique sub-saharienne. La mise en œuvre des stratégies de prévention dépend de la disponibilité d'une information adéquate sur la prévalence de la maladie dans la communauté. Cependant, on sait peu sur la façon dont la densité de regroupement desmaisons affecte la prévalence et l'intensité de l'infection HTS. D'où l'étude visait à déterminer l'effet dans une communauté semi-urbaine au sud-ouest du Nigeria.

Méthodes- Ceci est une étude transversale des ménages géographiquement mappés et choisis au hasardàIgbo-ora, Gouvernement Local d'Ibarapa, Etat d'Oyo. Les démographiques, les facteurs de risque et d'observation des échantillons de selles ont été recueillies auprès de 508 participants. La prévalence de l'infection HTS a été exprimée en pourcentage, et l'intensité a été mesurée par le compte d'Œuf par Gramme (ŒPG). Bi-variées et régression logistique multi-variée a été calculé en utilisant Odds ratio à 95% IC, avec un niveau significatif à p <0,05.

Résultats -La prévalence entière de HTS était de 28,1%. Ankylostome était de 18,7% répandue, 16,9% d'Ascarislombricoïdes, 3,0% de Strongyloïdes et

Correspondence: Mrs. O.A. Oluwatoba, Department of Medical Microbiology and Parasitology, Faculty of Basic Medical Sciences, College of Medicine, University of Ibadan, Ibadan, Nigeria. E-mail: ooluwatoba@cartafrica.org; oluwatobang@yahoo.com

Trichuris trichiura 0,8%. Ascaris lombricoïdes et l'ankylostomiase était les plus élevés dans le groupe d'âge préscolaire (<1-5 ans). Cependant, la prévalence d'Ascarislombricoïdes était le plus élevé dans les deux communautés représentant les zones de faible densité et l'intensité de l'infection a augmenté de façon significative avec l'âge. Ceux qui vivent dans une zone à haute densité sont 2.39 plus susceptibles d'être infectés par une infection de l'ankylostome que ceux dans les zones de faible densité (OR: 2,39, IC à 95% (1,23 à 4,63), p <0,01). Des preuves solides que la vie dans une salle bourrée, avec> 4 personnes, prédispose l'être humain à infectionHTS a été détectée (OR: 2,19, IC à 95% (0,54 -3,25), p <0,01) et les maisons construitesavec de la boue (OR: 1,67, 95% CI (1.02- 2.74), p <0,04) prédisposent à l'infection de l'ankylostome. Fait intéressant, le manque de toilettes, marcher à nu-pieds, et la défécation en plein air n'a pas augmenté de manière significative le risque d'infection de l'ankylostome dans cette étude.

Conclusion: Le résultat de cette étude a montré que la densité des structures de bâtimentsles matériaux de constructionsont les principaux facteurs de risque contribuant à l'infection d'ankylostome. D'où l'utilisation de la boue pour la construction devrait être découragée. L'éducation sanitaire intensive sur la façon dont les structures de bâtiments se rapportent à la santé, avec le programme de déparasitage de masse devrait être une priorité pour parvenir à une réduction durable de l'infection HTS.

Mots-clés: *Helminthes transmis par le sol, l'ankylostome, ascaris, haute densité, salle bondée.*

Introduction

Soil transmitted helminthiasis remains an important cause of morbidity and sometimes mortality in developing tropical countries [1]. They are one of the world's most important causes of physical and intellectual growth retardation in children [1], and are part of the parasitic infections listed by World Health Organisation as Neglected Tropical Diseases [2].

The important helminthes includes; *Ascaris lumbricoides, Trichuris trichiura, Strongyloides stercoralis* and the hookworms which are *Ancylostoma duodenale* and *Necator americanus*. Helminthic infection is acquired, either by ingestion of feacally contaminated food or drink and also through skin penetration, during contact with infective larvae stage in the soil where they thrive in the warm and moist part of the world's tropical and subtropical countries. Adult worm can live for years in the human gastrointestinal tract [3]. Soil Transmitted Helminthes (STH) have been associated with reduced physical and intellectual abilities, anaemia, poor nutritional status, and stunted growth. This negatively impacts on school performance and attendance, and future economic productivity [4]. The morbidity of STH has been linked with the worm burden, which is the number of adult parasites inhabiting the intestine [5].

An estimate of about 1.5 billion people of the world's population are infected with Soil-Transmitted helminthes infections and the greatest number of STHs infections occurs in the tropical and subtropical regions such as sub-Saharan Africa, China, India and east Asia [2]. The burden of the disability adjusted life years (DALYs) is around 39 million annually [6]. The burden of disease from STH is mainly attributed to their chronic and insidious impact on the health and quality of life of those infected which often does not lead to mortality (death), in fact, most infected individuals are usually asymptomatic, as it is possible they have light infections [7]. This asymptomatic infected population are continuous source of infection to their environment and themselves, especially in areas where environmental sanitation is poor and open field defecation still take place. It is also important to note that the health impact of these infections is more pronounced in children, who are more susceptible, mainly due to health related practices especially constant exposure to contaminated soil [8].

Following the resolution passed by World Health Assembly in 2001, most of the studies were focused on school-aged children and pregnant women, with only a few among preschool and adult populations. In Nigeria, prevalence of STH has been majorly linked with poor environmental situation, sanitation measures, gross environmental pollution with agrochemical and industrial waste, domestic waste, plus steady contamination of surface and underground water [9-13]. However, only few studies have taken into consideration the effect of family size on the prevalence and intensity of STH infection [14, 15]. This study therefore, determines the impact of house clustering density on the prevalence and intensity of STH infection in the communities.

Methods

Study area and population

The study was conducted in Igbo-Ora town in Ibarapa local government area of Oyo State, southwestern Nigeria. Igbo-Ora is located in the savannah area of the country, which is heavily cultivated with numerous small streams. Igbo-Ora town have six local communities, and each community have a traditional leader referred to as 'Baale'. This community was chosen because, despite being a research community for the University of Ibadan for over 5 decades, a study of this nature has not been carried out in the community.

Study design and data collection
This study is a cross-sectional study and was carried out between April and November 2013. The town was mapped using a Geographic information System. The map revealed the clustering density of households which resulted into three density areas; low, medium and high, depending on the cluster of household in each area. Seven clusters of house density was identified which comprise of 4 low, 2 medium and 1 high density areas. A multi-stage random sampling selection of clusters was done to select four community areas: 2 low density areas (Igbole and Pako) and 1 medium density area (Isale–Oba), while the only one high density area (Saganun) was included in the study. Households from each density area were randomly selected for the study. Each selected household in the study was given a code number and each participant was allotted a Personal Identification Code (PIC). Participants were interviewed using standardized structured questionnaire, and demographic information such as age, sex, education, occupation, past history of worm infection and treatment were recorded. Observational checklist was used to collect information on environmental condition and health habit such as walking barefoot and long or dirty finger nails.

Ethical consideration
Approval for this study was obtained from the UI/UCH Ethics Committee of the College of Medicine, University of Ibadan, Nigeria. Likewise, the community leaders and household heads were consulted and permission was obtained for the study. Inclusion criteria were; (i) residence in the selected area over the last 24 months and (ii) willingness to participate and gave both written and verbal consent to the study and in case of a minor, the parent or guardians gave consent on his/her behalf while any child above 3 years also give their accent.

Stool sample collection and examination
The participants were given container with their PIC for collection of their stool sample the next day. Uneducated participants were asked to give a mark or symbol on the sample bottles, by which they could recognize each child's/ward's container. Their ability to recognize their names was counter-checked. Each subject was instructed to scoop a thumb size stool sample using a provided wooden spatula into the container. Parents and guardians were also instructed to monitor their children during the sample collection to ensure that they place their stool samples into the right containers.

The presence of any parasite was determined by using normal saline wet preparation methods, and Kato-Katz thick smear technique ([16, 17]. For the intensity of infection, egg counts from the Kato-Katz thick smear readings were multiplied by a factor of 24 and expressed as Eggs Per Gram of stool (EPG). Two slides were taken from each stool sample and examined within 45 minutes of slide preparation. Prevalence of infection was expressed as percentage, and intensity was classified as given by WHO into light, moderate and heavy. The WHO classification is as follows: For *Ascaris lumbricoides*; 1g stool with 1-4,999 ova as light intensity, 5,000 -49,999 ova as moderate and $\geq$50,000 ova as heavy intensity. For *Trichuris trichiura* as 1-999, 1000-9,999, and $\geq$ 10,000 as light, moderate and heavy intensity respectively, while hookworm were 1-1,999, 2,000-3,999 and $\geq$ 4,000 as light, moderate and heavy intensity respectively [1].

Data analysis
All collected parasitological and questionnaire data was double-entered into SPSS15.0 (SPSS Inc. IL., USA) and exported to STATA 10 (Stata Corp., College Station, TX, USA) software for analysis. Statistical analysis were carried out at 5% significance level ($P<0.05$) and confidence interval (CI) set at 95%. Descriptive analyses were performed to determine the demographic characteristics and prevalence of STH infection in the study populations using frequencies and proportions. Multivariate logistic regression models were used to estimate the odds ratio (OR) and 95% CI for the association between the risk factors and presence of soil helminthes. For inclusion into the adjusted models, risk factors that were significant in bivariate analysis ($p<0.05$) were considered.

Results

Socio-demographic factors of the participants.
A total of 673 participants were recruited from the four house density cluster areas. 508 participants (75.5%) provided complete demographic and behavioural information and proper stool samples. Two hundred and thirteen (42%) of this were male and two hundred and ninety five (58%) were female (M: F = 1:1.4) with the age range 7 months to 86 years (mean 22.8 ± 1.8). Majority of the participants

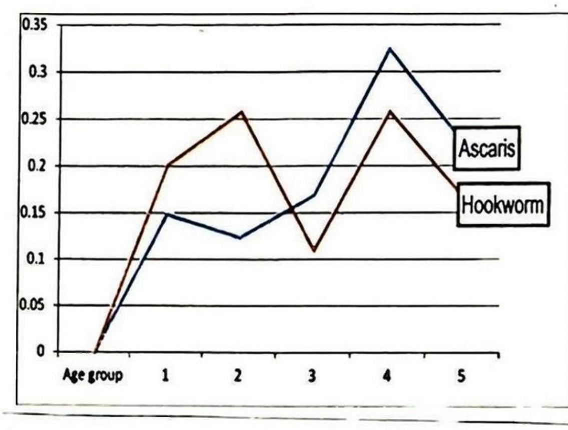
were in age group 6-15years (225, (44.3%)), while pre-school age group <1-5years were 10.2% (52). The demographic characteristics of the study population are presented in table 1.

Table 1: Baseline characteristics of the study population in Igbo-Ora (N=508)

Characteristic/ Categories	N	Percent (%)
Sex		
Male	213	42
Female	295	58
Age		
≤1-5	52	10.2
6- 15	225	44.3
16-29	92	18.1
30- 49	74	14.6
≥50	65	12.8
Occupation		
Student	319	62.8
Civil Servant	16	3.1
Skilled worker	30	5.9
Unskilled worker	93	18.3
Unemployed	50	9.8
Level of Education		
Primary	216	42.5
Secondary	168	33.1
Tertiary	34	6.7
No formal education	90	17.7
Marital status		
Single	349	68.7
Married	139	27.4
Divorced	16	3.2
Widowed	4	0.8
Community density		
Low density area	219	43.1
Medium density area	108	21.3
High density area	181	35.6

Prevalence and Intensity of Soil-transmitted helminthes infection in the sampled population.

The overall prevalence of STH in the four communities sampled was 28.1%. Hookworm infection was the most predominant STH infection with 18.7% followed by *Ascaris lumbricoides* 16.9%, *Strongyloides stercoralis* 3.0% and *Trichuris trichiura* 0.8% in the population from the four communities sampled. Multiple infections were observed in 10.2% of the population in double and triple helminthes infections, this were 94.2% and 5.8% respectively. *A. lumbricoides*+hookworm was 89.8% of the double helminthes infections while *A. lumbricoides* +*S. stercoralis*, hookworm+*S. stercoralis* were 4.1% each and *A. lumbricoides* +*T. trichiura* was 2.0%. Triple helminthes infections were *A. lumbricoides*+hookworm+*S. stercoralis* with 66.7% prevalence, and *A. lumbricoides* +hookworm+*T. trichiura* was 33.3%. However, majority of the infection were of light intensity in all the house clustering density areas (Table 2). In this study intensity of *Ascaris lumbricoides* and hookworm increases with age and its peak in adult (Fig.1).



Age group: 1=<1-5 years, 2=6-15 years, 3=16 -29 years, 4= 30 -49years, 5 = ≥50 years

Fig. 1: The intensity of *Ascaris lumbricoides* and hookworm infection with age group

House clustering density and prevalence of helminthes-specific STH infection

Table 3 shows prevalence of each specific STH parasite within the different house clustering density areas. The prevalence of hookworm infection was highest and there was a significant association between hookworm infection and the high density area (p= 0.01). There was no significant association between other STH parasite and house density areas.

The risk factors for STH infection

The result of the univariate analysis showed that, people who lived in high-density area are 2.4 times likely to be infected with hookworm infection than those in the medium density area (OR 2.39 95% CI 1.23 -4.63; p<0.01). When compared with people who lived in low-density area, people who lived in medium density area had higher odds of 1.99 times (95% CI 0.93 – 4.24, p=0.07). Living in overcrowded room with more than four people in a room had higher odds of hookworm infection (OR 2.2 95% CI 1.39 – 3.49; p<0.001). Access to toilet facility, living in mud houses and defecating in bushes around the house were significantly associated with hookworm infection (p <0.05)

Table 2: Intensity of STH infection in the four GIS mapped community of Igbo-Ora

STH infection	Intensity	Low density area		Medium density area	High density area
		Igbole(n)	Pako (n)	Isale-Oba(n)	Saganun(n)
Ascaris lumbricoides	Light	23	16	10	17
	Moderate	1	1	-	2
	Heavy	1	2	4	9
Hookworm	Light	15	16	8	39
	Moderate	2	2	1	4
	Heavy	2	1	3	2
Strongyloides stercoralis	Light	5	3	4	3
	Moderate	-	-	-	-
	Heavy	-	-	-	-
Trichuris trichiura	Light	1	2	-	-
	Moderate	-	-	-	-
	Heavy	-	-	-	-

Ascaris lumbricoides: 1-4,999 ova light intensity, while 5,000 -49,999 ova moderate intensity and ≥50,000 ova heavy intensity.
Trichuris trichiura: 1-999 ova light, 1000-9,999 ova moderate and ≥ 10,000 ova heavy intensity.
Hookworm: 1-1,999 ova light, 2,000-3,999 ova moderate and ≥ 4,000 ova heavy intensity.

Table 3: Prevalence of specific STH parasites and association with community density area in Igbo-Ora

STH parasite	Community density areas			Total	p-value
	LowN (%)	MediumN (%)	HighN (%)	N (%)	
Ascaris lumbricoides	44 (19.6%)	14 (13.0%)	28 (15.5%)	86 (16.9%)	0.220
Hookworm	37 (17.0%)	12 (11.1%)	45 (24.9%)	95 (18.7%)	**0.010**
Strongyloides stercoralis	8 (3.6%)	4 (3.7%)	3 (1.7%)	15 (3.0%)	0.439
Trichuris trichiura	3 (1.4%)	0	0	3 (0.6%)	0.137

Table 4: Factor associated with hookworm infection in the study population of Igbo-Ora.

Variables	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Density low (Reference)				
Medium	1.99 (0.93 - 4.24)	0.07	0.91 (0.39 - 2.13)	
High	2.39 (1.23 - 4.63)	0.01	2.12 (1.23 - 3.65)	0.01
Shoewear Yes (Reference)				
No	1.16 (0.74 - 1.81)	0.52	0.62 (0.41 - 1.09)	0.12
Living in crowded room ≤ 4 (Ref.)				
>4	2.20 (1.39 - 3.49)	0.001	2.19 (0.54 - 3.25)	0.01
Have access to toilet facility Yes (Ref.)				
No	1.64 (1.03 - 2.59)	0.04	11.6 (0.62 - 21.8)	0.1
House type concrete (Ref.)				
Mud	1.87 (1.19 - 2.94)	0.01	1.67 (1.02 - 2.74)	0.04
Toilet type water closet (Ref.)				
Pit latrine	1.99 (0.93 - 4.24)	0.07	1.39 (0.62 - 3.08)	0.41

Walking barefooted, handwashing before eating and after using the toilet were not significant risk factors for hookworm infection in this study. Result of multivariate logistic regression showed that, living in high-density area, living in overcrowded room and living in mud houses were consistently associated with hookworm infection ($p<0.05$) as seen in table 4.

Discussion.

Neglected Tropical Diseases (NTDs) is of public health importance and Soil Transmitted helminthes being one of the diseases. This study showed that house clustering density is an important correlate for hookworm infection among the population studied. The overall STH prevalence of 28.1% observed from this study is lower than 50% prevalence observed from a study by Kirwan *et al.*, [18]. Similar finding reported by Kaliappan *et al.*, [19] in a tribal area of south India had 39% STH prevalence and hookworm was the predominant helminths. Hookworm was the predominant STH and showed a significant association with living in high density area ($p<0.01$). The high density area was structured in such a close proximity that there are no spaces between the houses such as the last room in a building lead directly to the entrance of another house. Likewise, about 50% of the participants in this area have no toilet facilities in their homes and defecation takes place in the bushes and open field around the house and many do not wear shoes, thus increasing the risk of acquisition of infection, although these known risk factors were not statistically significant for STH infection in this study. In the same vein, living in overcrowded room with more than four people had a significant correlate with hookworm infection, this showed that STH generally infect people who live in poverty with poor sanitary condition [20]. From this study, houses built with mud also had significant effect on hookworm infection; studies have shown that socioeconomic status factors are significantly associated with STH infections [21].

Ascaris lumbricoides had the highest prevalence in the low-density area, this may be explained from the infection acquisition point, because many of the houses in this area were not congested, with plots of land around homes/houses used as vegetables gardens as well as for defecation thereby increasing the acquisition of infection by feaco-orally acquired helminthes, such as *Ascaris lumbricoides, Trichuris trichiura*. Interestingly, *Enterobius vermicularis* was conspicuously absent, despite deliberate effort to elicit its presence clinically from history and physical examination, the reason for the absence in this environment is not clear. Likewise, no *Trichuris trichiura* infection was found in medium and high density area of this community, this could be due to the geographical distribution, because structural lay out of the low density area resemble that of the urban setting in terms of house structure and arrangement, and studies have shown that *Trichuris trichiura* are predominant in urban areas [19, 22].

Majority of infection were of light intensity in all the STH infection and in all the house density areas. *Ascaris lumbricoides* and Hookworm have little moderate and heavy intensity in all the house density areas. However, *Trichuris trichiura* and *Strongyloides stercoralis* were of light intensity in all density areas. Similar findings was reported by Kirwan *et al.*,[18] where 85.7% and 14.1% was recorded for light and moderate intensity in *A. lumbricoides* respectively. Similarly, Pullan *et al.*, [23] reported a light intensity for hookworm in their population study in a rural community in Uganda. In this study, intensity of *Ascaris lumbricoides* and hookworm increased with age and its peak was found in adult (Figure 1). Other studies have demonstrated that intensity of infection increases with age, and children aged 5-15 years usually have heavier worm burdens [18, 23, 24].

Multiple infections were observed in one-third of the infected population with double and triple helminthes infections. Similar report was given in a study carried out by Dada-Adegbola *et al.*, [25] in rural communities in Nigeria where 49.1% of the infected population had multiple helminthes infection. The high prevalence of hookworm infection in this study and its correlation with high density area appears to be associated mainly with socio-economic status of the participants. Majority of the participants are student, followed by unskilled workers; who are either a farmer or a petti trader and 17.7% of the participant had no formal education (Table 1). Likewise, the significant increase of *Ascaris lumbricoides* with age indicate that mass deworming programme should not be targeted towards pre-school and school aged children alone, but all age groups should be targeted in order not to retain the infection in those not treated.

In conclusion, findings of high prevalence of STHs in this semi-urban community corroborate the justification for the listing of STHs as Neglected tropical diseases which should be tackled with more commitment by all stakeholders. Also, this study showed that house structure density and building materials are major contributing risk factors for hookworm infection. Hence the use of mud for building should be discouraged.

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