GEOHELMINTHIASIS: RISK FACTOR ANALYSIS, PREVALENCE AND INFECTION INTENSITY AMONG PREGNANT WOMEN IN BUNGOMA COUNTY, KENYA

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Abstract: **Geohelminthiasis are common in sub Saharan Africa. It is associated with morbidity and mortality in pregnancy. The study aimed at analyzing risk factors, prevalence and infection intensity among pregnant women in Bungoma County, Kenya. A cross sectional hospital based survey that was carried out from March 2016 to January 2017. Consecutive sampling was used to enrol 750 expectant mothers aged 18 to 45 years, seeking antenatal services at the hospital. Kato-katz technique was used to process stool for identification of eggs. Pre-tested structured questionnaire was used to collect data on socio-economic risk factors. Data was analysed using STATA Version 12. Discrete values were analysed using frequencies and percentages. Continuous variables were analysed using central tendency such as mean. Chi-square (X^2) test was used to determine association between geohelminths and different variables. Multivariable logistic regression was used to analyse the association between geohelminthiases and significant variables at bivariable analysis. Level of significance was set at < 0.05 and 95% CI. Overall prevalence of geohelminthiasis was 185 (24.7%). *Ascaris lumbricoides*, was the most prevalent 76(41.1%), *Necator americanus 73*(39.5.%), *Trichuris trichiura*, 11(5.9%), *Enterobius vermicularis*, 4(2.2%), *Schistosoma mansoni* 4(2.2%) and, mixed infection of *A. lumbricoides* and *Necator americanus* 17(9.2%). Women without geohelminths 565(75.3%). Risk factors included lack of hand washing, (AOR=3.386, 95% CI 1.664-6.079), use of borehole water for drinking (AOR 1.69, 95% CI 1.144-2.508), lack of shoes (AOR=0.412, 95% CI 210-808) and unemployed (AOR=2.295, 95% CI 1.389-3.990). The study showed a moderate prevalence of geohelminthisis in expectant mothers. Routine stool examination, provision of treated water and health education particularly on personal hygiene are important.**

Keywords: **Geohelminths, Prevalence, Intensity, Risk factors, pregnant women.**

1. INTRODUCTION

Geohelminthiasis are ranked among the most widely distributed neglected tropical diseases affecting people staying in communities with poor accessibility to safe water, sanitation and health facilities [WHO.,2017]. About 3.8 billion persons get infected with annual clinical cases and complications related mortality rate of about 720 million and 135,000 respectively. Chronic infections can result in negative birth outcomes, delayed physical and cognitive development during childhood, and reduced agricultural productivity among adults [Hotetz *et al*., 2009]. It is evident that, Anaemia is one of the most common side effects of geohelminthiasis , hookworm, in particular has been associated with moderate reductions in hemoglobin during pregnancy[Gyorkos *et al.*,2011]. Over 40 million expectant mothers are infected with geohelminths and globally and more are at an increased risk of infection [Millan *et al.*,2013]. Pregnant women are said to be vulnerable to infections because their immune system is suppressed during pregnancy [Stephen *et al.*, 2015].

A clear understanding of the epidemiology and risk of geohelminth infection is inadequate specifically among expectant mothers [Telfer *et al.*, 2010].Infection with geohelminths depends on micro geographical variation of location. For instance the risk of *Ascaris lumbricoides*, *Trichuris Trichiura*, and hookworm (*Necator americanus* and *Anclostoma duodenale*) infection are influenced by environmental conditions of a given area [Stephen *et al.*, 2015]. Exposure to single or multiple species of parasites may vary over slight distances and location, an area that needs to be addressed adequately [Stephen *et al.*, 2015]. Residential areas inhabited by Bungoma residents can be classified into three major areas i.e. urban, slum and rural inhabitants depending on environmental conditions of a given area. This therefore means that the prevalence of geohelminthiasis may differ by each area.

Studies show that participation of pregnant women in agricultural activities with ill equipped farm wear puts them at higher risk of contracting hookworm infection [Dotters, *et al.*, 2011]. Women in Bungoma County spent most of their time in farms without protective foot ware. However no study has been carried out to clearly establish the risk of protective foot wear and geohelminthiasis in this area.

Statistics from Western Kenya showed geohelminths infection to be common among expectant mothers. The prevalence differed depending on micro geographic areas and environmental conditions of each area. Van Eijik and his colleagues reported a prevalence of 76.2% [Van Eijk *et al.*,2009]and a prevalence of 15.7% among adults including pregnant women was reported by [Jonathan *et al.*,2014]. However data on the prevalence and intensity of geohelminthiasis among this vulnerable group in Bungoma County is lacking. The study therefore endeavoured to determine the prevalence and intensity of geohelminths and identified the principal risk factors associated with infection among pregnant women of Bungoma County. Information from this study provides important understanding of the realignment of geohelminthiasis control strategies among expectant mothers in this County.

2. MATERIALS AND METHODS

Study site:

The study was carried out at Bungoma Country Referral Hospital Kenya from This county lies between latitude 0° 34′0”N and Longitude 34° 34′ 0”E. The County has an estimated human population of 1,375,063 with an area of 3,032.2sq km, according to Kenya 2009, national census. It has 9 Sub counties namely Kanduyi, Bumula, Sirisia, Kabuchai, Kimilili, Webuye East, Webuye West, Tongaren and Mount Elgon. It has a tropical climate characterized by hot and humid conditions. Two rainy seasons; the long rains (April to August) and the short rains (October to December). The County comprises of three distinct community units: Urban community, Slam community and rural community dwellers. Predominant ethnic groups are Luhyas (Bukusu) Teso and Sabot, who practise subsistence farming.

Cross sectional hospital based survey was carried out from March 2016 to January 2017 at Bungoma county referral hospital. Consecutive sampling was used to recruit participants who meet inclusion criteria. The study subjects comprised of pregnant women from 18 years considered in Kenya as an adults to 45years because after 45years of age most women enter menopause. Expectant mothers in any of their trimester of pregnancy seeking antenatal services at Bungoma county referral were recruited in the study. They should have been residents of Bungoma County for the last 6 months and willing to sign informed consent to participate in the study

Study participants:

According to guidelines put forth by the World Health Organization (WHO), a sample size of 250 complying individuals in a geographically distinct community is needed to assess the prevalence and intensity of soil-transmitted helminth infections [Montresor et al.,1998, Lwanga et al., 1991]. . The study area covers three community units (described under study setting), thus an overall sample size of 750 pregnant women.

Ethics statement:

This study was approved by Masinde Muliro University of Science and Technology Institutional Review Board approval number MMU/COR403OO9 (57). Further approval was sought from Bungoma county referral hospital. Oral and written informed consent was obtained from all study participants in any of the languages (English or Kiswahili). Pregnant women were explained to the purpose of the study. They were requested to sign written individual consent. All participants were free to withdraw from the study at any time without further compulsion. Data was coded and kept strictly confidential. Information of the results were shared with study participants and those infected were treated free of charge at the hospital. Follow up was done after treatment to establish if they healed and also for reinfection. At the end of the study all participants were invited to learn about their parasitological results and were treated with albendazole (single 400 mg oral dose) if infected with *A.lumbricoides*, *T. trichiura*, *E.vermicularis* and/or *N.americanus*, and with praziquantel (single 40 mg/kg oral dose) if infected with *S.mansoni*, according to (WHO) guidelines and Ministry of Health Kenya.

Laboratory procedures

Parasitological examinations.

Prevalence of geohelminths was determined by stool examination using Kato-Katz thick smear technique [WHO,1991]. Each sttool specimen was prepared by passing through a sieve to remove debris. Two slides were labeled A and B for each stool sample. Filtered stool sample was put in a calibrated template mounted on each glass slide to contain 47.1mg of stool. Each preparation on the glass was covered with glycerine/malachite green impregnated cellophane. The preparations were then turned upside down on a flat surface and pressed gently to spread the stool sample evenly. Each slide was read by a separate a qualified laboratory technologist to limit chances of missing parasites eggs. The readings were done microscopically using x10 and x40. Average number of eggs in the two slides per participant was calculated. The slides were examined within one hour to avoid over clearing of hookworm eggs by glycerine. A percentage of those infected were calculated to determine prevalence

Culturing and identification of Hookworm species

Haratamori technique [13], was used to culture and hatch hookworm eggs. This was to differentiate the two human hookworms *Necator americanus* filariform larvae from those of *Anclostoma duodenale*.

The procedure involved the use of filter paper strips of about 5 inhes slightly tappered at one end. For each stool specimen confirmed to contain hookworm eggs, one gram of each faecal sample was smeared at the centre of the strip. Four millilitre of distil water was added to 15 millilitre conical centrifuge tube. The paper strips were inserted into the tube so that the tappered end was near the bottom of the tube such that the tapered end was near the bottom of the tube with water level slightly below the faecal point. The tube was plugged using cotton wool and allowed to stand upright in a rack at 25°C for 10 days. Small amount of the fluid was withdrawn from the bottom of the tube and a smear was prepared on a glass slide. The preparation was cover slipped and examined microscopically using 10 x objectives. Any filariform larvae were identified based on morphological features to differentiate between the two species of human hookworms.

Questionnaire survey

Pre tested, semi-structured questionnaire was developed and administered by a trained enumerator to pregnant women meeting the inclusion criteria prior to stool collection. Risk factors for geohelminth infection were assessed by Age, marital status, levels of education, residence, type of house, history of anthelminthic treatment, source of income, waste (faeces) dispose , hands washing with a detergent (soap) after visiting the latrine, source of drinking water, shoe wearing when working on the farm, soil eating. Quality control was performed by daily review of each questionnaire by the researcher for immediate remedy of any error or problems.

Data management and analysis

Data was analysed using STATA version 12 (STATA corporation college station TX USA). Discrete values were analysed using frequencies and percentages. Continuous variables were analysed using central tendency such as mean. Measures of associations were analysed using chi-square for categorical variables. Prevalence and intensity of geohelminths were calculated based on stool sample results. To calculate the intensity of geohelminths, all eggs in each preparation were identified and counted. Eggs per gram of each geohelminths were determined by multiplying the number of counted eggs by factor 24 to obtain a standardized measure of infection intensity, expressed as eggs per gram of stool (EPG). The egg counts were classified as Light infection, Moderate infection, and Heavy infection [14], as follows Ascaris light infection (1-4999 eggs/gram), Moderate infection (5000-49,999 eggs/gram), and Heavy infection (> 50,000 eggs/gram). Hookworm, light infection (1-999 eggs/gram), moderate infection (2000-3999 eggs/gram), and heavy infection (>4000 eggs/gram). *Trichuris trichiura*, light infection (1–999), moderate infection (1000–9999) and heavy infection (>10,000).

Socio-economic variables examined for their association with geohelminth infections included age, marital status, level of education, water source residence, type of house, trimester of pregnancy and soil eating. Mixed effects of logistic regression models were fitted in bivariate analysis. Multivariate logistic regressions were employed for those variables that had significant association with disease outcome to determine the main socio economic risk factors of infection. P-value ≤ 0.05 was considered significant. Odds ratios (OR) with a 95% confidence interval were computed to compare the strength of association between explanatory and outcome variable

3. RESULTS

A total of 750 pregnant women were recruited in the study and all of them produced stool samples for analysis. Majority of the participants were within the age bracket 18–27 years 541(71.1%), followed by those aged 28–37 years (192(25.6%) and those in age group 38-40 years 17(2.3%) Mean gestation age was 24.63 (24.36-25.01). The overall prevalence of the geohelminths was 185 (24.7%). *Ascaris lumbricoides* was the most prevalent species 76 (41.1%), Hookworm (*Necator americanus*) 73(39.5%), *Trichuris trichiura* 11(5.9%), *Enterobius vermicularis* 4(2.2%), *Schistosoma mansoni* 4 (2.2%) and mixed infection of *Ascaris lumbricoides* and *Necator americanus* 17 (9.2%) (Table 1)

Parasite intensity was expressed as mean egg per gram 95% CI for each species (Table 1) *Ascaris lumbricoides*, 87 (55-124) eggs per gram of faeces, (*Necator americanus*)15(13-17) eggs per gram of faeces and *Trichuris trichiura* 11(9-13) eggs per gram of faeces.

Table 1: Prevalence and intensity of geohelminth infection among pregnant women

	Prevalence	Intensity class			
Geohelminths 24.7%(n=185)		Low	Moderate	Heavy	Mean egg/gram 95% CI
	% No.	No. (%)	N0. (%)	No. (%)	
A. lumbricoides	41.1%(n=76)	53(69.7%)	20(26.3%)	3(3.9%)	88.6(53.3-123.9)
N.americanus	39.5%(n=73)	42(57.5%)	24(32.9%)	7(9.6%)	15.2(13.4-16.7)
T. trichiura	5.9%(n=11)	10(90.9%)	1(9.1%)	-	10.9(8.8-12.9)
E. vermiclaris	2.2%(n=4)	-	-	-	-
S. mansoni	2.2%(n=4)	-	-	-	-
A.lumbricoides/ (N.americanus	9.2%(n=17)	-	-	-	-

- Value for calculation not available in WHO criteria.

Risk factors for geohelminth infection (Bivariable association)

Lower education level P= 0.001, Type of house P= 0.002, Employment P= 0.007 and hand washing P=0.001, were associated with geohelminthiasis. Table 2

Table 2

	Geohelminthiasis			
Variable	Infected	Not infected	χ^2	P-value
Residence				
Rural	156(84.3%)	445(78.8%)	2.709	0.060
Urban	29(15.7%)	120(21.2 %)		
Type of house				
Semi-permanent	136(73.5%)	350(61.9%)	8.174	0.002
Permanent	49(26.5%)	215(38.1%)		
Waste disposal				
Pit latrine	175(94.6%)	507(89.7%)	3.924	0.029
Flush toilet	10(5.4%)	58(10.3%)		

Soil eating				
Eat soil	85(45.9%)	182(32.2%)	11.929	0.003
Don't eat soil	100(54.1%)	383(67.8%)		
Shoe wearing				
Does not wear shoes	161(87%)	513(90.8%)	7.454	0.024
Wears shoes	24(413%)	52(9.2%)		
Water source				
Tab water	56(30.3%)	219(38.8%)		
Bore hole	48(25.9%)	159(28.1%)	7.468	0.024
Spring water	81(43.8%)	187(33.1%)		
Education level				
Primary	102(55.1%)	219(38.8%)		
Secondary	64(34.6%)	206(36.4%)	22.786	0.001
College	19(10.5%)	140(24%)		
Employment				
Not employed	95(51.4%)	245(43.4%)	11.999	0.007
Farmer	67(36.2%)	185(32.7%)		
Employed	23(12.4%)	135(23.9%)		
Hand washing				
Does not wash	77(41.6%)	196(34.7%)		
Not regularly	53(28.7%)	223(39.5%)	38.704	0.001
Use water only	44(23.8%)	54(9.6%)		
Use water and soap	11(5.9%)	92(16.2%)		

* χ^2 = Chi-Square, P<0.05 was considered significant.

Risk Factors for Geohelminthiasis (Multivariable analysis)

Risk factors for geohelminths alone included: Lack of hand washing (AOR 3.286, 95% CI 1.669-6.476), unemployment (AOR 2.295, 95% CI 1.389-3.990), use of borehole water (AOR 1.435, 95%CI 0.948-2.173), lack of wearing protective shoes (AOR 0.0412, 95% CI 2.10-8.080), and staying in semi-permanent house (AOR 1.650, 95% CI 1.138-2.394). (Table 3)

Table 3

Variable	Geohelminthiasis		
	p-value	OR	95% CI
Waste disposal			
Pit latrine	0.050	2.002	1.001-4.002
Flash toilet	0.078	0.534	0.266-1.072
Shoe wearing			
Doesn't wear	0.010	0.412	2.10-.8.080
Wears shoes	0.630	1.216	0.548-2.699
Hand washing			
Does not	0.001	3.286	1.669-6.476
Use water only	0.003	1.653	1.299-2.777
Water and soap	0.014	0.482	1.109-2.463
Housing			
Semi-permanent	0.008	1.650	1.138-2.394
Permanent	0.092	0.286	0.071-1.238
Water source			
Tab water	0.088	1.435	0.948-2.173
Bore hole	0.009	1.694	0.488-1.851

Employment			
Unemployed	0.001	2.295	1.389-3.990
Employed	0.683	1.079	0.748-1.557
Soil eating			
Eat soil	0.001	1.799	1.284-2.519
Does not eat soil			
Education level			
Primary	0.588	1.609	0.288-8.991
Secondary and above	0.934	1.075	0.194-5.967

***** 95% CI=Confidence interval, OR= Odds ratio, P<0.05 was considered significant.

4. DISCUSSION

We determined the prevalence and risk factors of geohelminthiasis among pregnant women in Bungoma County. Overall prevalence of any geohelminths among expectant mothers was 24.7%. This result showed a moderate geohelminths infections in the study area. This finding could be attributed to the fact that all women recruited in the study had either flush toilet or pit latrine. Use of these facilities cut the lifecycle of geohelminths and reduce the infection. However, geohelminthiasis remain a major health concern among pregnant women who are often excluded from national de-worming programs. Therefore demands for the intensification of intervention measures to adequately reduce the burden of the disease.

The prevalence was comparable with what was obtained in a similar study 28.6% Ghana [Baidoo *et al.*, 2010]. The study findings are however lower than what was reported by other studies, 43.5% Ethiopia [Yashambel *et al.*, 2010], and (76.2%) Kenya [Van Eijk *et al*., 2009]. The differences in prevalence may be attributed to differences in geographical and climatic conditions that may influences parasite distribution. This finding agrees with [Pullan Rachel *et al.*,2010], whose study in Kenya partially modeled the transmission and distribution of geohelminthiasis and showed that the most affected areas included Western and Coastal region that warranted for mass drug administration. Bungoma County falls under western region of Kenya therefore may share factors that influence transmission and distribution of geohelminthiasis in this region

The species-wise distribution of geo-helminthic infections in the current study showed *Ascaris lumbricoides* as the main parasite species, followed by *Necator americanus*. *Ascaris lumbricoides* eggs are known to resist adverse environmental conditions therefore cause heavy soil pollution and sustain the transmission cycle for a longer period of time [WHO, 2017]. Prevalence of geohelminth species distribution in this study was higher as compared to *Ascaris lumbricoides* (8.5%), *Necator americanus* (4.0%), %) [Francis *et al.*, 2014]. *A.lumbricoides* 14.9%, *Necator americanus* 29.4%, *T.trichiura* 3.4% and *E.vermicularis* 1.3% Ethiopia [Millan *et al.*,2013]. People are differently exposed to different species of geohelminths and thus the prevalence differs in each individual thus, the implementation of intervention measures that reduced the transmissions is important.

In this study geohelminthiasis was more prevalent in mothers from rural residence as compared to those from urban residence. This suggests that majority of communities in rural areas are poor and may have poor sanitary facilities. These findings collaborate with (WHO) that geohelminthiasis affect the poorest and most deprived communities [WHO, 2017]. The study findings are also in agreement with other studies that found out high prevalence of geohelminthiasis in rural communities with poor sanitary conditions [Francis *et al.,* 2014, WHO, 1987].

Risk factors for geohelminthiasis in this study were lack of employment, lack of wearing protective shoes, staying in semi-permanent house and use of Borehole water. This findings collaborates a study in Gabon, [Noe Patrick *et al.*, 2018] that identified risk factors for geohelminthiasis to be drinking untreated water and living in a rural area. Although all expectant mothers recruited in the current study had either flush toilet or pit latrine facilities, majority of the infected were using borehole water. When the environment (soil) is contaminated by geohelminths eggs, it is easy for borehole water sources to get contaminated because during rain, the faecal matter can be washed off to drinking water sources.

The presence of eggs in the soil is indicative of inadequacy of toilet facilities or lack of these facilities in the study area. It is possible that the use of an unprotected water source example bore hole and the absence of water treatment were markers for soil contamination. Therefore transmission of geohelminths through water contaminated with infected faeces may be an additional source of infection. Geohelminths infections can also be reduced by educating expectant mothers on the need to treat or boil drinking water.

Individual's education level has been documented as important risk factors for parasitic infection in many studies (Toma *et al.*,1999, Phiri et al., 2000). Findings of the current study confirmed that as level of education of pregnant mothers increased the possibility of infection with geohelminths reduced significantly. There is sufficient data to show that individual behavior and exposure factors may enhance the risk of parasitic infection. (Olsen and Roepstorff, 2001). Our study findings revealed that lack of wearing protective shoes while working in farms by expectant mothers increased the frequency of exposure to infective stages of *Necator americanus.* Creation of awareness on the mode parasitic infection among expectant mothers in the study area can help in controlling these infections.

5. CONCLUSION

The study revealed a moderate prevalence rate of geohelminthiasis. Much of the exposure to geohelminthic infections was related to lack of hand washing, use of borehole water for drinking lack of shoes and unemployed. Though further studies are needed to support these observations, the results provide useful information necessary to design control strategies for geohelminths infection in pregnancy. We recommend routine stool examination to be done on all expectant mothers and those infected should be treated promptly. Provision of safe drinking water, health education and hand washing using soap and water, particularly among rural resident pregnant mothers are important.

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Author's contribution

Principal coordinator designed the study. All other authors played an important role in data collection analysis and interpretation of the findings. All authors read and approved the final manuscript

Competing interests.

Authors have declared that there is no conflict of interests

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