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## Full Length Research Paper

# Co-infections with *Schistosoma haematobium* and soil-transmitted helminths among school-aged children in Saki, Oyo State, Nigeria

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A cross-sectional study was conducted to determine the prevalence and intensity of soil-transmitted helminthiasis and urinary schistosomiasis and the co-infection of these intestinal helminths among school children in Saki town, Oyo state, Nigeria. Early morning stool samples were collected and a Kato-Katz thick smear technique was used to examine and count parasitic load. Urine samples were also collected and examined for *Schistosoma haematobium* ova using sedimentation technique. A pre-tested structured questionnaire was used to collect socio-demographic data, knowledge attitude and practice of individuals towards disease transmission and control. The study was conducted between August and October, 2011; out of 1537 children examined, 956 (62.2%) of the study participants were infected with one or more parasites. *Ascaris lumbricoides* was the most frequently observed soil-transmitted helminths with a prevalence of 39.6% followed by hookworm (18.3%) and *Trichuris trichiura* (12.9%). *S. haematobium* was detected in 32.7% of the school children. Multiple infections were pronounced with 54.3% having double infections and 17.7% having triple infections. The most common double infections were *Ascaris* and *S. haematobium* (28.9%), while the most common triple infections were *Ascaris*, hookworm and *S. haematobium* (10.6%). Prevalence and intensity of soil-transmitted helminth and *S. haematobium* was high and there is the need for urgent intervention programmes against these parasites in the study area.

**Key words:** Soil-transmitted helminthiasis, schistosomiasis, epidemiology, prevalence, *Schistosoma haematobium*, Nigeria.

## INTRODUCTION

Soil-transmitted helminthic infections and schistosomiasis are among the widely spread chronic infections in the world. Globally, two billion individuals are infected with helminths, out of the majorities living in resource-poor settings (Noyer and Brandt, 1999; WHO, 2002). World Health Organization (WHO) estimated that 1.45 billion people are infected with *Ascaris lumbricoides*, 1.3 billion

with hookworms and 1.05 billion with *Trichuris trichiura* (WHO, 2002). Schistosomiasis is endemic in 76 countries and also it is one of the public health concerns in developing countries. Approximately 90% of the estimated 207 million cases of human schistosomiasis living in sub-Saharan Africa (Hotez and Kamath, 2009), with *Schistosoma haematobium* the most widespread of

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the causative parasites (Steinmann et al., 2006). Within sub-Saharan Africa, Nigeria is the country with the most cases of human schistosomiasis, about 29 million in 2008 (Hotez and Kamath, 2009).

The occurrence of helminthic infections is associated with socio-economic, environmental and other factors like ignorance of simple health promoting factors and overcrowding, limited access to clean water, tropical climate and low altitude (WHO, 2002). School-aged children are one of the groups at high risk for intestinal parasitic infections. Factors like poor development of hygienic habits, immune system and over-crowding contributes for infection (Jarabo et al., 1995). School-aged children are the most severely affected by polyparasitism with intestinal parasites and *Schistosoma haematobium* and continue to bear the greatest health burdens due to the infections (Drake and Bundy, 2001). The adverse effects of intestinal parasites among children are diverse and alarming. Intestinal parasitic infections have detrimental effects on the survival, appetite, growth and physical fitness, school attendance and cognitive performance of school age children (Nokes and Bundy, 1993; Stephenson et al., 1993; de Silva et al., 1997; Hadidjaja et al., 1998).

In Nigeria, intestinal parasitic infections and urinary schistosomiasis continue to constitute a major public health and developmental challenge especially among school-aged children. Several reports illustrated that ascariasis is the most prevalent intestinal parasitic infection in different communities usually occurring together with trichuriasis. Intervention against soil-transmitted helminths (STH) and *Schistosoma* infections are based on regular anti-helminthic treatment, improved water supply, sanitation and health education (World Bank, 2003; Albonico et al., 2006). Polyparasitism of STH and *Schistosoma* infections have been reported from various epidemiological settings in Africa (Tchuem Tchuenté et al., 2003; Mazigo et al., 2010; Alemu et al., 2011).

Recent studies on intestinal helminthiasis and schistosomiasis from Nigeria include those of Agbolade et al. (2007), Ugbomoiko and Ofoezie (2007) and Uneke et al. (2008), however, current prevalence of STH and schistosomiasis was not well addressed in different parts of Nigeria including our present study area. Therefore, the aim of this study was to determine the prevalence and intensity of soil-transmitted helminths and *S. haematobium* infection among school children in Saki town, Oyo State Southwest Nigeria. It is hoped that the findings of the investigation will contribute to effective disease control planning and implementation in the area of study and others in Nigeria and other tropical countries with similar heavy burdens of infectious disease.

## MATERIALS AND METHODS

### Study site

Saki is a town in Saki-West Local Government located on longitude

3°24'' East and latitude 8°40'' North with an altitude of 400 m above the sea level. The town has an estimated population of 388,255 (NPC, 2006). The climate of the area is typically tropical with a distinct dry (November-March) and rainy (April-October) seasons and a mean annual temperature of 27°C, a mean annual rainfall of 1100 mm and a mean relative humidity of 85% (Ayoade, 1982). The inhabitants are predominantly Yoruba speaking people with a mixture of different ethnic groups in Nigeria. Farming is the main occupation but some are traders, transport workers, artisans and civil servants. Although there are public taps available in the community; however, their rarity and spread mean that many of the inhabitants still depend on wells, boreholes as their primary sources of water.

### Study design

The study was carried out between August and October 2011 among school children of ages 3 to 16 years from five schools selected randomly in Saki. The children were invited to participate in the study and were registered only after the purpose of the study had been explained to them and to their parents or guardians, and full informed consent obtained. To avoid any bias, all the available children attending the selected schools were examined; almost all were permanent residents and no mass anthelmintic had been conducted in the town before this study. Faecal and urine samples were obtained from 1537 pupils. The composition of the study population by school and sex is summarized in Table 1.

### Ethical consideration

Ethical clearance for the study was given by the Ethical Committee of the Obafemi Awolowo University Teaching Hospital Complex (OAUTHC), Ile-Ife, Osun State, Nigeria. Prior to the commencement of the study, permission was sought and obtained from the Local Educational Authority of the Saki West Local Government Area.

### Sample size determination

The sample size for this study was calculated using single proportion formula at 95% confidence interval (CI) level ( $Z(1 - \frac{1}{2}\alpha) = 1.96$ ), an expected prevalence of 50% since there was no study conducted regarding this topic in the area and 5% marginal error. Then, the sample size was calculated as  $n = (Z(1 - \frac{1}{2}\alpha) 2P(1-P))/d^2$ , where  $n$  = sample size,  $P$  = proportion problem in the study area,  $Z(1 - \frac{1}{2}\alpha)$  = CI of 95%,  $d$  = Marginal error to be tolerated. By adding 10% of contingency, 1537 pupils were included in our study.

### Collection of stool samples and parasitological examination

A pre-labelled wide-mouthed screw capped plastic container with a clean wooden spatula for collection of faeces was given to each selected child with explanation on how to handle faecal samples. Urine samples were collected in pre-labelled 50 ml plastic screw-cap vials between 10.00 and 14.00 h. Stool and urine samples were collected from each pupil and transported to a laboratory at the Obafemi Awolowo University, Department of Zoology. Each urine sample was agitated to ensure adequate dispersal of eggs. 10 ml of urine were examined by microscopy for the presence of *S. haematobium* eggs. Stool samples were preserved in 10% formaldehyde and examined by a simple thick smear technique using a 41.7 mg Kato-Katz technique (WHO, 1994).

**Table 1.** Composition of the study population by age and gender.

Age (Years)	Male	%	Female	%	Total
3-4	100	48.5	106	51.5	206
5-6	137	39.6	209	60.4	346
7-8	175	43.5	227	56.5	402
9-10	137	48.8	144	51.2	281
11-12	81	46.6	93	53.4	174
13-14	43	57.3	32	42.7	75
15-16	32	60.4	21	39.6	53
Total	705	45.9	832	54.1	1537

**Table 2.** Prevalence and Intensity of Soil-transmitted helminths and *S. haematobium* in relation to gender.

Parasite	Male (n=705)	Female (n=832)	Both sexes	P-value
<b>Schistosome</b>				
<i>Schistosoma haematobium</i>	33.9(27.3±3.1)	31.7(22.1±2.2)	32.7(24.5±1.9)	ns (ns)
<b>Soil-transmitted helminth</b>				
<i>Ascaris lumbricoides</i>	39.9(2902.2±350.8)	39.4(2007.6±172..2)	39.6(2417.9±186.2)	ns (ns)
Hook worm	18.2(184.3±26.8)	18.5(200.2±27.5)	18.3(192.9±19.3)	ns (ns)
<i>Trichuris trichiura</i>	10.8(123.1±21.3)	14.7(149.4±27.5)	12.9(137.4±17.8)	0.02 (ns)

ns: Not significant at 5% level of significance; n: number examined.

### Statistical analysis

Differences in the prevalence of each parasite infection among subgroups were determined using chi-squared values from the contingency tables. Variations in mean egg counts between dichotomous variables were assessed with the student-test and One-way analyses of variance (One way-ANOVA) for explanatory variables with more than two levels. All analyses were performed using SPSS for windows version 17.

## RESULTS

### Overall infection patterns

The composition of the study population by school and sex is summarized in Table 1. In total, 956 (62.2%) children harboured at least one parasitic infection. Four species of intestinal helminths, namely, *A. lumbricoides*, hookworm, *T. trichiura* and *S. haematobium* were recovered from the children investigated. The overall prevalence of *A. lumbricoides*, hookworm, *T. trichiura* and *S. haematobium* were 39.6, 18.3, 12.9 and 32.7%, respectively with corresponding intensities of 2417.9±186.2, 192.9±19.3, 137.4±17.8 eggs per gram of faeces and 24.5±1.9 eggs per 10 ml (Table 2).

Children from LA Primary School, Ape-Abe recorded the highest prevalence of intestinal helminth infection (70.4%) which was significantly higher than the prevalence of other schools ( $\chi^2=17.942$  df=4, p=0.001). The lowest prevalence of helminth infection (55.0%) was recorded among the children attending LA Primary

School, Taba. There was no significant difference in the overall prevalence of infection between the genders (prevalence in males=61.3%; females=63.0%).

### Infection patterns relative to gender and schools

Children attending LA Primary School, Isia had the highest prevalence of ascariasis (48.0%) while the lowest prevalence of 33.2% was recorded among children attending LA Primary School, Agolabi (Table 3). There was a significant difference in prevalence and intensity of *Ascaris* infection between males and females among the children attending primary school at Apa-Abe and Isia (P < 0.05). Also, differences in the prevalence reached significant levels for hookworm in both sexes among children attending LA Primary School, Agolabi. The prevalences and intensities of other infections were comparable within each school (Table 3).

The pattern of schistosome infection was such that the prevalence and intensity were higher in males than in females (although the differences were not statistically significant) among children attending schools at Isia, Sango and Taba, while reverse was the case for children attending schools at Apa-Abe and Agolabi (Table 3).

### Age and gender patterns of infection

The age and gender distribution of intestinal helminth

**Table 3.** Prevalence and intensity of intestinal helminths in relation to gender and schools attended by the children in Saki Town, Osun State, Nigeria.

School	Gender	n	Prevalence % (Mean ± SEM)			
			<i>Ascaris lumbricoides</i>	Hook worm	<i>Trichuris trichiura</i>	<i>Schistosoma haematobium</i>
LA Pry School, Ape-abe	M	169	47.3 (7687.3±1357.2)	26.0 (396.5)	16.6 (245.2±64.2)	45.6(65.8±10.8)
	F	159	33.3 (3572.7±712.6)	23.3 (464.3±127.9)	20.1 (350.7±134.0)	46.5(51.8±7.7)
	P-value		0.01 (0.005)	ns (ns)	ns (ns)	ns (ns)
	Total	328	40.5 (5686.6±785.8)	24.7 (429.5±78.9)	18.3 (296.3±72.9)	43.9 (59.0±6.7)
LA Pry School, Agolabi	M	129	31.8 (1869±369.2)	7.8 (184.6±26.8)	7.0 (123.3±21.3)	25.6 (27.4±6.8)
	F	151	34.4 (200.5±27.5)	23.8 (200.5±27.5)	10.6 (149.4±27.6)	33.8(39.4±7.5)
	P-value		ns (ns)	0.001 (ns)	ns (ns)	ns (ns)
	Total	280	33.2 (1565.4±205.0)	16.4 (193.2±19.3)	8.9 (137.4±17.8)	30.0 (33.9±5.1)
LA Pry School, Isia	M	138	37.7 (1390.8±196.5)	18.8 (193.8±55.8)	6.5 (85.0±27.7)	29.0 (13.9±3.0)
	F	162	56.8 (2861.5±402.5)	14.8 (111.7±28.8)	13.0 (139.3±30.7)	23.5 (9.8±2.7)
	P-value		0.001 (0.001)	ns (ns)	ns (ns)	ns (ns)
	Total	300	48.0 (2184.9±238.8)	16.7 (149.5±30.0)	10.0 (114.3±20.9)	26.0 (11.7±2.0)
LA Pry School, Sango	M	117	40.2 (1342.4±221.3)	15.4 (67.3±16.6)	11.1 (75.5±30.3)	35.0 (5.9±0.9)
	F	192	42.2 (1651.6±183.0)	18.2 (110.3±22.3)	17.7 (87.5±15.5)	31.8 (5.5±0.7)
	P-value		ns (ns)	ns (ns)	ns (ns)	ns (ns)
	Total	309	41.4 (1534.5±141.3)	17.2 (93.9±15.2)	15.2 (83.0±14.9)	33.0 (5.6±0.5)
LA Pry School, Taba	M	152	40.1 (1081.7±169.6)	19.7 (107.0±20.6)	11.2 (105.4±52.5)	31.6 (13.0±2.1)
	F	168	29.8 (740.8±119.4)	13.1 (87.4±19.2)	11.3 (65.3±16.6)	28.0 (10.2±2.4)
	P-value		ns (ns)	ns (ns)	ns (ns)	ns (ns)
	Total	320	34.7 (902.8±102.4)	16.2 (96.7±14.0)	11.2 (84.4±26.4)	29.7 (11.5±1.6)

ns: Not significant at 5% level of significance; n: number examined.

infections in the schools investigated are presented in Table 4. Prevalence values of the four observed parasites, that is, *A. lumbricoides* (23.3 to 48.8%), hookworm (12.6 to 24.0%), *T. trichiura* (5.7 to 16.7%) and *S. haematobium* (22.6 to 39.3%), were more of age than gender dependent. While gender-dependent distribution of infections was comparable and followed no clear cut patterns in all age groups except those in 9 to 10 years old and 13 to 14 years for *T. trichiura* and hookworm, respectively, and age dependent patterns were pronounced. For both *Ascaris* and hookworm infections, the prevalence increased from the youngest age-group to a peak in the 7 to 8 years old for *Ascaris* and 13 to 14 years for hookworm. While for *T. trichiura* and *S. haematobium*, the lowest prevalence of infection was recorded in the oldest age group (15 to 16 years old). There was no definite pattern of intensity of infection. A significant gender-dependent intensity pattern was recorded for hookworm and *T. trichiura* infections among 13 to 14 years old and 15 to 16 years old, respectively ( $P < 0.05$ ).

### Multiple infection patterns

More than half (62.2%) of children were infected with at least one of the four parasites, while 35.5% had single infection, 54.3% had double infections, 17.7% had triple infections and 3.1% had four parasites. From the infected children, 57.0, 87.2, 28.5 and 4.9% harboured single, double, triple and four parasites, respectively. The most common double infection was the *Ascaris* and *S. haematobium* combination which accounted for 28.9%. This was followed by *Ascaris*/hookworm (16.3%) and *Ascaris*/*T. trichiura* (12.3%). The least occurring combination for hookworm and *T. trichiura* accounted for 7.9%. Of 272 (28.5%) observed triple infections, *Ascaris*, hookworm and *S. haematobium* combination accounted for 10.6%. Each of the combination of *T. trichiura*, hookworm and *S. haematobium*; and *Ascaris*, *T. trichiura* and hookworm accounted for 4.7%. The only four parasite species infection of *Ascaris*, hookworm, *T. trichiura* and *S. haematobium* combination accounted for 4.9%. The prevalence of dual infections did not differ

**Table 4.** Prevalence and intensity of intestinal helminths in relation to gender and age of school children in Saki town, Oyo State, Nigeria.

Age group (years)	Gender	n	Prevalence % (Mean ± SEM)			
			<i>Ascaris lumbricoides</i>	Hook worm	<i>Trichuris trichiura</i>	<i>Schistosoma haematobium</i>
3-4	M	100	21.0(1877.3±628.6)	9.0 (135.1±50.5)	8.0 (27.6±11.2)	28.0 (23.7±6.6)
	F	106	25.5(1628.3±464.3)	16.0 (159.4±45.8)	5.7 (52.8±21.3)	18.9 (12.4±4.3)
	P-value		ns(ns)	ns (ns)	ns (ns)	ns (ns)
	Total	206	23.3(1749.2±410.5)	12.6 (147.6±33.9)	6.8 (40.6±12.2)	23.3 (17.9±3.9)
5-6	M	137	40.1 (4569.4±1227.6)	19.7 (178.2±40.7)	12.4 (166.3±51.7)	38.7 (29.2±6.7)
	F	209	36.4 (2117.3±464.3)	12.4 (104.7±22.7)	13.9 (94.6±21.3)	27.8 (16.4±3.3)
	P-value		Ns (ns)	ns (ns)	ns (ns)	ns (ns)
	Total	346	37.9 (3088.2±563.8)	15.3 (133.8±21.2)	13.3(123.0±24.2)	32.1 (21.5±3.3)
7-8	M	175	49.1 (2837.4±574.2)	17.1 (194.5±80.7)	14.9 (175.9±55.5)	36.6 (32.0±6.0)
	F	227	48.5 (2360.5±303.6)	23.3 (319.4±86.0)	18.1 (228.6±86.8)	41.4 (33.9±5.3)
	P-value		Ns (ns)	ns (ns)	ns (ns)	ns (ns)
	Total	402	48.8 (2568.1±302.9)	20.6 (265.1±60.0)	16.7 (205.7±54.6)	39.3 (33.1±4.0)
9-10	M	137	48.2 (3007.0±868.2)	21.2 (227.0±58.1)	8.8 (98.5±46.9)	38.0 (34.5±9.8)
	F	144	43.1 (1934.4±242.3)	20.8 (182.8±43.4)	20.1 (182.7±41.1)	27.1 (19.9±5.6)
	P-value		ns(ns)	ns (ns)	0.02 (ns)	ns (ns)
	Total	281	45.6 (2457.3±441.4)	21.0 (204.4±36.0)	14.6 (141.6±31.1)	32.4 (27.1±5.6)
11-12	M	81	33.3 (2039.1±535.3)	24.7 (191.3±62.3)	8.6 (132.4±58.9)	30.9 (17.8±7.4)
	F	93	32.3 (1440.4±287.3)	15.1 (100.4±30.1)	14.0 (120.5±39.8)	41.9 (21.3±5.5)
	P-value		Ns (ns)	ns (ns)	ns (ns)	ns (ns)
	Total	174	32.8 (1719.1±292.6)	19.5 (142.7±33.3)	11.5 (126.1±34.6)	36.8 (19.7±4.5)
13-14	M	43	44.2 (2147.3±1028.4)	18.6 (136.7±55.7)	9.3 (62.0±32.1)	23.3 (10.5±4.1)
	F	32	53.1 (2904.9±1052.5)	31.2 (459.8±194.3)	9.4 (13.5±13.5)	28.1 (20.9±11.1)
	P-value		ns(ns)	0.002 (ns)	ns (ns)	ns (ns)
	Total	75	48.0 (2470.6±737.6)	24.0 (274.6±90.0)	9.3 (158.7±107.8)	25.3 (15.0±5.2)
15-16	M	32	21.9 (2071.4±805.8)	15.6 (171.1±87.4)	6.2 (112.5±112.5)	21.9 (20.1±11.1)
	F	21	28.6 (662.9±307.1)	19.0 (234.5±114.5)	4.8 (13.5±13.5)	23.8 (22.2±20.5)
	P-value		ns (ns)	ns (ns)	ns (0.035)	ns (ns)
	Total	53	24.5 (1513.3±507.2)	17.0 (196.5±69.0)	5.7 (73.3±68.0)	22.6 (20.9±10.4)

ns: Not significant at 5% level of significance; n: number examined.

significantly by gender ( $p>0.05$ ). Male children had the highest prevalence of triple infections (29.6%) compared to 27.4% of the females.

## DISCUSSION

The findings from the current study confirm that Saki town in Southwest Nigeria is highly endemic for urinary schistosomiasis and soil-transmitted helminthiasis (STH). Although intestinal helminth parasites particularly STH and schistosomes infections are neglected diseases that

occur predominantly in rural areas, the deplorable social and environmental conditions as well as inadequate basic amenities in the urban poor communities and the so-called peri-urban areas of developing countries including Nigeria are ideal for the persistence of these parasites (Drake and Bundy, 2001; WHO, 2002).

From the study, about two out of every three school children in the town were infected with one or more parasitic infections (ascariasis, hookworm, trichuriasis and schistosomiasis). In terms of prevalence and intensity, ascariasis appears the most important public health problem in the area of study. Its overall prevalence

(39.6%) is more than double the national average (18%) (Crompton et al., 1989). However, while the patterns of infection of hookworm, trichuriasis and schistosomiasis suggest a lesser public health importance, in reality they have a serious public health implication for the community. For instance, an overall prevalence of 32.7% for *S. haematobium* infection is more than 2.5 times for the national average (13.1%) (Ofoezie, 2002).

A cross-sectional survey conducted on STH among pre-school and school-aged children in Ile-Ife, Osun State, Nigeria (Sowemimo and Asaolu, 2011) reported that the overall prevalence of infection was 34.4% which is lower than the prevalence of 51.2% recorded in this study. Other study conducted on intestinal helminthic infections in school-aged children in Ilie in Olorunda Local Government Area of Osun State, Southwest Nigeria (Adefioye et al., 2011) reported overall prevalence of 52.0% for STH infection which is comparable to 51.2% recorded in this study. *A. lumbricoides* was reported to be the most prevalent parasite (36.2%) followed by hookworms (10.5%). This is similar to the result obtained in this study where *Ascaris* (39.6%) was the most frequently encountered parasite. The differences in prevalence among the different communities might be associated with environmental sanitation, water supply and socioeconomic status of households, although this needs to be verified in more extensive follow up studies. Other factors related to macro- and micro-environment, time of study, method of examination, etc., do also contribute to the differences in the prevalence and distribution of these intestinal helminths. No significant difference was obtained in infection rates between the genders of schoolchildren under consideration. This denotes a similar exposure risk to infection by these helminths and it is in agreement with previous study from Ethiopia (Alemu et al., 2011).

The high prevalence of STH and *S. haematobium* infections recorded among school children of the study area raises a serious concern. It signifies the fact that children are the highest risk groups in the community and serve as sources of infection and transmission. These parasites are well known to be associated with lowered work capacity and productivity both in children and adults and increased susceptibility to other infections. Helminths also impair the mental and physical development of children (Jardiam-Batelho et al., 2008). Again majority of wormy children are not only infected with one species of worm, but they also tend to harbour the heaviest burdens and almost two-thirds of children were infected with one or more helminths.

In this study, STH and *S. haematobium* were co-endemic in the study area. Previous studies have clearly documented the relationship between intestinal helminth infections, polyparasitism and cognitive functions, growth and malnutrition among school children (Partnership for Child Development, 2002; Jardiam-Batelho et al., 2008). Children with multiple parasitic infections especially those

with heavy infections intensity tend to experience more severe cognitive outcomes and other health problems such as malnutrition than children with only one helminth infection (Sakti et al., 1999; Jardiam-Batelho et al., 2008). Studies conducted throughout Africa and China indicate that most parasitic infections do not occur singly, but as co-infections (Raso et al., 2004; Ugbomoiko and Ofoezie, 2007; Steinmann et al., 2008). Hence, co-infections of soil-transmitted helminths and *S. haematobium* could partly be attributed to the co-endemicity of these intestinal helminths in the study area and poor sanitations.

In this study, the most common double infection was the combination of *Ascaris* and *S. haematobium* with a prevalence of 28.9%. This is in contrast with the observation of Agbolade et al. (2007) who reported the combination of *Ascaris* and hookworm to be the most common double infection. Agbolade et al. (2007) also reported that the most common triple infections were the combination of *Ascaris*, hookworms and *Trichuris*. This is in contrast with the findings in this study where the combination of *S. haematobium*, *Ascaris* and hookworm were the most common triple infection. This finding indicates that *S. haematobium* is more endemic than *T. trichiura* in the area of study.

In conclusion, the prevalences of STH and *S. haematobium* were quite high and they account for major health problem in the study area. There is the need for a control measures such as deworming programmes coupled with provision of improved water supplies and sanitation to be put in place in order to bring about reduction in the prevalence level of both diseases. There is also an urgent need for concerted efforts towards ensuring adequate control of intestinal helminthiasis and schistosomiasis in Saki town, Oyo State by the authority concerned and the community at large.

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## Conflict of interest

The author declared he has no conflict of interest.

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## Full Length Research Paper

# Distribution of enteric bacterial pathogens among patients with gastrointestinal tract infections and food vendors in Lagos, Nigeria

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Stool samples from 2,200 patients with gastrointestinal tract (GIT) infections and 900 apparently healthy food vendors were collected in Lagos, Nigeria and examined to determine incidence and distribution of bacterial pathogens using standard microbiological methods. The isolates recovered were identified to belong to seven genera which include *Salmonella*, *Shigella*, *Escherichia*, *Proteus*, *Klebsiella*, *Vibrio* and *Enterobacter*. *Salmonella typhi* was the most prevalent, followed by *Escherichia coli*, while *Klebsiella* species was the least encountered. Most of the food vendors fell within the age range of 21 years and above constituting 78.4% of the food vendors examined. This study underscores the need to monitor the carriage of enteric pathogens among patients and apparently healthy food vendors. This study further implicates food vendors as a great threat to the health of the public since some of them were carriers of the pathogenic bacteria. Therefore, it is recommended that there should be enlightenment, training for, and vaccination of the vendors accordingly as well as periodic surveillance.

**Key words:** Enteric pathogens, patients, infections, food vendors, *Salmonella* species.

## INTRODUCTION

Enteric pathogens have been implicated in most food- and water-borne infections that have been responsible for rising morbidity and mortality globally especially in Africa (Payment and Riley, 2002; Nma and Oruese, 2013; Ogunleye et al., 2013). Though some of the organisms in this group are normal microbiota of gut of man and other higher animals, they get their way into the food through environmental contamination (Karshima et al., 2013; Ogunleye et al., 2013; Kemal, 2014). They are mainly Gram-negative bacteria which cause different

gastrointestinal diseases in man while quite a number of other animals serve as either carrier or secondary host. Gastrointestinal tract (GIT) infection in humans usually originates from pets, other humans and through the ingestion of contaminated water or animal food products, most often eggs, poultry, and raw meat (Bhan et al., 2005; Centers for Disease Control and Prevention, 2005; Swanson et al., 2007; Smith et al., 2012; Karshima et al., 2013). Following ingestion of the organisms, the likelihood of infection developing, as well as the severity

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**Table 1.** Age and sex distribution of subjects examined for enteric bacterial pathogens.

Age group	Patients (%)		Vendor	Total
	Male	Female	Female	
11-20	261 (11.9)	608 (27.6)	194 (21.6)	1063 (34.3)
21 and above	590 (26.8)	741 (33.7)	706 (78.4)	2037 (65.7)
Total	851 (38.7)	1349 (61.3)	900	3,100
Grand total	2,200			

of infection, is related to the dose and virulence of the organism in question or its strain and the status of host's defense mechanisms (Payment and Riley, 2002).

In most cases, diagnosis of GIT infection is often missed or delayed, which is a reflection of the multi-system nature of the diseases. Consequent upon development and availability of modern sewage and water treatment facilities, these diseases have become rare in developed countries but remain a serious health challenge in low resource countries with inadequate sanitation and safe water supply. Although enteric fever is a major global public health problem; data on the relative risk of contracting travel-associated enteric fever is not documented in most developed world, while adequate epidemiological data are grossly inadequate in developing countries (Crump et al., 2004). Vending of street food, particularly in urban areas, is a growing and global phenomenon and today street vended foods are important sources of daily meals for massive urban populations as well as in African. However, food poisoning, food borne diseases and food safety have been declared a major public health concern by international health agencies, while in many studies, street vended foods have been associated with microbiological contamination and low hygienic standards (WHO, 2006). Hence, street food vendors play a significant role in public health since this group of individuals alone influences the life and health of thousands of people daily.

Food handlers have been reported to greatly contribute to the dissemination and distribution of pathogens due in most cases to their low level of education, poor personal and environment hygiene (Nkere et al., 2011; CDC, 2013). Moreover, some of the food vendors are carriers of most of the enteric bacterial pathogens and consequently introduce the pathogens into the food they handle (Chukwu et al., 2010; Oranusi and Olorunfemi, 2011). Food from local vendors, though most of the time are prepared under unhygienic conditions and by people with very low knowledge of hygiene, they still enjoy high patronage due essentially to their affordability, easy accessibility and claimed palatability or organoleptic quality (Karshima et al., 2013). This study therefore investigated incidence and distribution of enteric pathogens among patients with GTIs and food vendors in Lagos, Nigeria.

## MATERIALS AND METHODS

A total of three thousand and one hundred (3,100) non-repeat stool samples made up of 2,200 from patients with GITs and 900 apparently healthy food vendors were collected in Lagos, Nigeria and examined by standard microbiological procedures. Oral informed consent was obtained from the patients and vendors recruited for this study prior to sample collection. The samples were homogenized in sterile distilled water and 1.0 ml of diluted stool samples were plated on MacConkey Agar and Plate Count Agar and plated at 37°C for 24 h. *Salmonella* species was isolated by Ifeanyi et al. (2013). Faecal samples (1 g) was pre-enriched in 9 ml of buffered peptone water for 24 h at 37°C after which 0.1 ml of the pre-enriched culture was plated into Selenite Cysteine Broth (10 ml) and Rappaport-Vassilidis Broth, and incubated for 24 h at 37 and 42°C, respectively. The enriched cultures were inoculated on to Xylose Lysine Deoxycholate Agar and incubated at 37°C for 24 h. The methods Holt et al. (1994) were used to identify the isolates.

## RESULTS AND DISCUSSION

Distribution of enteric bacteria associated with GITs and food vendors in the study areas was investigated in this study. Sex and age distribution of patients and food vendors show that out of a total of 2,200 patients examined, 851 (38.7%) were male while 1,349 (61.3%) were female. In a similar study, Madukosiri et al. (2013) observed higher incidence among female than male in Port-Harcourt, Nigeria. A total of 869 (39.5%) of the patients were under 21 years of age, while the remaining 1,331 (60.5%) were above 21 years of age. All the food vendors examined were female (Table 1). Table 2 depicts 1,670 (53.9%) of the subjects with enteric fever. The incidence was higher among the patients compared with the food vendors. The incidence rate of enteric fever was higher among subjects aged above 20 years with 749 (24.2%). Out of 900 food vendors examined, 110 (12.2%) had enteric fever. This carrier rate of *Salmonella typhi* found among the vendors presents a serious health concern as this group of individuals occupies an epidemiologically strategic positions in the society (Chukwu et al., 2010; Oranusi and Olorunfemi, 2011; Nyenje et al., 2012; Nma and Oruese, 2013; Ogunleye et al., 2013).

Different bacteria were recovered from the stool samples from both patients and food vendors. These were observed to belong to eight genera of bacteria including *Staphylococcus*, *Salmonella*, *Shigella*,

**Table 2.** Age and sex distribution of enteric fever among patients and food vendors in Lagos.

Age group	Patients (%)		Vendor (%)	Total (n=3100)
	Male (n=851)	Female (n=1349)	Female (n=900)	
11-20	176 (20.7)	300 (22.2)	45 (5.0)	521 (16.8)
21 and above	336 (39.5)	348 (25.8)	65 (7.2)	749 (24.2)
Total	512 (60.2)	648 (48.0)	110 (12.2)	1670 (53.9)

**Table 3.** Distribution of bacterial isolates among patients and food vendors in Lagos.

Organism	Patients [n=2,200 (%)]	Vendors [n=900 (%)]
<i>Escherichia coli</i>	558 (25.4)	222 (24.7)
<i>Enterobacter</i> spp.	0	28 (3.1)
<i>Klebsiella</i> spp.	105 (4.8)	117 (13.0)
<i>Proteus</i> spp.	300 (13.6)	123 (13.7)
<i>Salmonella typhi</i>	885 (40.2)	87 (9.7)
<i>Salmonella</i> spp.	108 (4.9)	63 (7.0)
<i>Shigella</i> spp.	681 (31.0)	0
<i>Vibrio</i> spp.	100 (4.5)	33 (3.7)

*Escherichia*, *Proteus*, *Klebsiella*, *Vibrio* and *Enterobacter*. These organisms have been reported to be associated with food especially the vended types (Payment and Riley, 2002; Ameko et al., 2012; Chukwu et al., 2013; Nma and Oruese, 2013; Karshima et al., 2013; Ogunleye et al., 2013). *Enterobacter* species was isolated only from the food vendors while *Shigella* species was isolated from some of the patients examined. *S. typhi* was recovered from 885 (40.2%) of the patients studied, and was the predominant organism. *Escherichia coli* was isolated from 558 (25.4%) patients and 222 (24.7%) among the food vendors while *Proteus* species was isolated from 300 (13.6%) patients and 123 (13.7%) of food vendors (Table 3). The high incidence of Enterobacteriaceae has been reported to be as a result of poor personal hygiene (Ojo and Adetosoye, 2009; Esan, 2011).

It has been reported that most food vendors in the developing nations grossly lack formal knowledge of food preparation and hygiene (Mensah et al., 2002; Muinde and Kuria, 2005; Omemu and Aderoju, 2008; Adjarah et al., 2013). Omemu and Aderoju (2008) and Chukuezi (2010) reported that food vending knowledge is acquired mainly either from parents or through observation of others. They also stated that some of the food vendors in Nigeria acquired theirs by trial and error methods.

Table 4 shows the distribution of bacterial species among subjects according to their age group. Patients within 21 years age bracket and above were generally more infected with the various bacterial isolates. *S. typhi* was isolated from stool culture 825/885 (93.2%) of the patients, and from 79/87 (90.8%) of food vendors. *Salmonella* spp. was equally recovered from stool cul-

tures of 102/108 (94.4%) patients and from stool cultures of 54/163 food vendors. *Shigella* spp. was isolated only from patients with 91.0% (620/681) of the same age bracket. *E. coli* which was the third most prevalent was recovered from stool cultures of 298/558 (53.4%) patients and 174/222 (78.4%) food vendors. This trend may be a pointer to the exposure and activity of this age group who are most likely to be economically engaged to care for their households. It also goes well to point to the position this group occupies in public health and the significant role it plays in the epidemiology of the organisms (Nyenje et al., 2012). Some of the isolates are important food-borne pathogens (Mensah et al., 2002; Nkere et al., 2011; Nyenje et al., 2012; Nma and Oruese, 2013; Adeyanju and Ishola, 2014). *E. coli* has been widely implicated in cases of diarrhoea and urinary tract infections, suggesting the probability of endogenous infection within the individuals (Steffen et al., 2003; Olowe et al., 2014).

There is likelihood that the vendors are carriers of these pathogens as obvious from the result of this study and become common sources and aid easy transfer of pathogens to food they handled. There is a need for periodic monitoring of bacterial carrier state of food vendors in particular. Bacterial diseases increasingly constitute an important cause of morbidity and mortality among humans and also animals, and the impact of bacterial diseases on public health has become increasingly enormous for various reasons (Ojo and Adetosoye, 2009; Donkor, 2014; Olawale et al., 2014). Therefore, it is recommended that there should be periodic enlightenment, training for, and vaccination of the vendors.

**Table 4.** Distribution of bacterial species among subject according to their age group.

Pathogen	Age group (year)				Total	
	11-20		21 and above		PT	VD
	PT	VD	PT	VD		
<i>Escherichia coli</i>	260	48	298	174	558	222
<i>Enterobacter</i> spp.	0	5	0	13	0	28
<i>Klebsiella</i> spp.	18	26	87	91	105	117
<i>Proteus</i> spp.	15	8	285	115	300	123
<i>Salmonella typhi</i>	60	8	825	79	885	87
<i>Salmonella</i> spp.	6	9	102	54	108	63
<i>Shigella</i> spp.	58	0	620	0	681	0
<i>Vibrio</i> spp.	23	13	67	20	100	33

PT: Patients; VD: Vendor.

## Conflict of interest

The author declared he has no conflict of interest.

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*Full Length Research Paper*

# Study on community knowledge, attitude and practice of rabies in and nearby Gondar town, North West Ethiopia

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Rabies is one of the disastrous diseases for both animal and human beings. Questionnaire based cross-sectional study was conducted in and nearby Gondar town from November 2013 to June 2014. A semi-structured questionnaire was administered to 139 respondents comprised of 96 from urban and 43 from peri-urban areas to assess knowledge, attitude and practice of community about rabies. The current study generally illustrated the presence of significant difference on knowledge and practice of the respondent from urban and peri-urban areas ( $P < 0.05$ ). Although more than (96%) of the respondents were familiar with the disease, there is mis-perception about the cause and means of transmission of the disease. Starvation and thirst were mentioned by (49.6%) of the respondents as causes of the disease in dogs and 21.6% of them stated any type of contact (irrespective of the skin condition) with saliva of affected individual can transmit the diseases. The result also established that 124 (91.9%) of the respondents were aware that human and other different species of domestic animals can be affected by rabies. However, all respondents (100%) in peri-urban area perceived dog as the only source of infection for human being. Traditional medicine was stated as method of treatment in case of dog bite by 46% of the respondents whereas, 41.7% of respondent used post exposure vaccination. Only 35.8% of the respondent did vaccinate their dogs and level of low vaccination practice was higher in peri-urban area. Raising awareness about dog vaccination and improving access and affordability of the vaccine should be considered in control of the disease.

**Key words:** Attitude, dog, Gondar, knowledge, practice, rabies.

## INTRODUCTION

Rabies is a deadly disease for both animal and human beings. Rabies is a viral disease transmitted by the bite or scratch from a rabid animal (World Health Organization (WHO), 2011). Rabies virus infects the

central nervous system, causing encephalopathy and ultimately death. The virus is a single stranded RNA virus belonging to the genus *Lyssavirus* of the family Rhabdoviridae (Sherikar et al., 2011).

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Rabid dogs are the principal source for transmission to human (Williams and Barker, 2001). Transmission almost always occurs by an animal bite that inoculates virus into wounds. Virus inoculated into a wound does not enter the bloodstream but is taken up at a nerve synapse to travel to the brain, where it causes encephalitis. The virus may enter the nervous system fairly rapidly or may remain at the bite site for an extended period before gaining access to the nervous system. The approximate density of nerve endings in the region of the bite may increase the risk of developing encephalitis more rapidly. Rarely, the virus can be transmitted by exposures other than bites that introduce the agent into open wounds or mucous membranes (Sherikar et al., 2011). It is manifested by motor irritation with clinical signs of mania and an attack complex, salivation, inability to swallow and by a progressive ascending paralysis beginning in the pelvic limbs and moving forward to the trunk and thoracic limbs and death (CFSPH, 2009). Diagnosis of rabies can be made based on history of bite, clinical signs and laboratory investigations (Warner et al., 1997). The method of laboratory investigation of rabies virus comprises isolation and identification of the agent, immunological tests, serological tests and molecular techniques (Kang et al., 2007).

Rabies is endemic in developing countries of Africa and Asia. The disease causes heavy losses in human and livestock population in the endemic region. Rabies infection has a case fatality rate of almost 100%, it accounts for over 55,000 human deaths annually, with most cases in Asia and Africa (WHO, 2011). About 98% of human rabies deaths have been documented to have been caused by almost and always bite of a rabid dog (Rupprecht, 2008). The annual cost of rabies in Africa and Asia was estimated at US\$ 583.5 million, most of which is due to cost of post exposure prophylaxis (PEP) (Knobel et al., 2005).

In Ethiopia, rabies is an important disease that has been recognized for many centuries (Fekadu, 1982) and rabies remains to be one of the most feared highly endemic infectious diseases. The annual death due to rabies was estimated to be 10,000, which makes it to be one of the worst affected countries in the world (Knobel et al., 2005). The presence of high population of dogs with poor management contributes for high endemicity of canine rabies in Ethiopia (Paulos et al., 2003). In canine rabies endemic countries like Ethiopia, rabies has also significant economic importance by its effect on livestock, and in Africa and Asia, the annual cost of livestock losses as a result of rabies is estimated to be US\$ 12.3 million (Knobel et al., 2005).

Prevention and control can be achieved by strict quarantine measures, elimination of stray dogs, extension program, control of rabies in wild life, registration of dogs and prophylactic vaccination. Poor public awareness towards rabies is one of the major obstacles in any prevention and control scheme of the disease, especially in rabies endemic countries like Ethiopia. Understanding

communities' awareness of cause, mode of transmission, symptoms, treatment and possible intervention measures of rabies is an important step towards developing strategies aimed at controlling the disease and determining the level of implementation of planned activities in the future. Therefore, this study was designed to assess the level of knowledge, attitude and practices of prevention and control of rabies.

## MATERIALS AND METHODS

### Study design and population

A community based cross-sectional study design was used to assess the knowledge, attitude and practice of the community on rabies using semi-structured questionnaire by face to face interview to randomly selected respondents. The study populations were residents of Gondar town and its surrounding.

### Sample size and sampling methods

The sample size was calculated using the formula given by Arsham (2005).

$$N = 0.25 / SE^2$$

Where N = sample size, S = standard error, 5%

Accordingly, a total of 100 should be selected. However, to increase the precision we increased the sample size to 139. A simple random sampling method was employed to select the respondents from different parts of the town and peasant associations around the town. Respondents were included in the survey based on willingness and informed consent.

### Inclusion and exclusion criteria

Household who live at least 6 months as the permanent resident in the study area were included in this study and household who live less than 6 months and respondents in the households who cannot communicate and under 15 years were excluded from this study.

### Research ethics

The research proposal has been ethically evaluated and approved by the Mekelle University, college of veterinary medicine research and community service council. Each participant was informed about the purpose of the study and informed consent was obtained from each respondent. Participation in the study was voluntary and respondents were free to withdraw from the study at any time. Interviews were anonymous and data remained confidential throughout the study.

### Data collection

Data was collected using structured questionnaire through face to face interview of the respondents. The questionnaire was designed to collect information about the respondents' knowledge of the disease, treatment, attitude and prevention practices as well as household information. The total of the respondents, 96 from Gondar town and 43 from its surrounding peasants, were selected based on willingness and informed consent.

**Table 1.** Socio-demographic characteristic of respondents.

Socio-demographic characteristic	Number and percentage of respondent		Peri-urban (%) n = 43
	Total (%) n = 139	Urban (%) n = 96	
<b>Sex</b>			
Male	108 (77.7)	65 (67.7)	36 (83.7)
Female	31 (22.3)	31 (32.3)	7 (16.3)
<b>Age</b>			
15-35	65 (6.8)	45 (46.9)	20 (46.5)
36-55	65 (46.8)	46 (47.9)	19 (44.2)
56-85	9 (6.5)	5 (5.2)	4 (9.3)
<b>Education</b>			
Cannot read and write	28 (20.1)	10 (10.4)	18 (41.9)
Informal(read and write only)	4 (2.9)	4 (4.2)	0 (0)
Primary school	54 (38.9)	33 (34.4)	21 (48.8)
Secondary school	26 (18.7)	22 (22.9)	4 (9.3)
Higher education	27 (19.4)	27 (28.1)	0 (0)
<b>Occupation</b>			
Health Profession	3 (2.1)	3 (3.1)	0 (0)
Veterinarian	10 (7.2)	10 (10.4)	0 (0)
Farmer	44 (31.7)	11 (11.5)	33 (76.7)
Merchant	10 (7.2)	10 (10.4)	0 (0)
Job less	14 (10.0)	14 (14.6)	0 (0)
House wife	34 (24.5)	27 (4.2)	7 (16.3)
Others	24 (17.3)	21 (45.8)	3 (7)

KAP of community toward rabies.

### Data management and analysis

The data collected from questionnaire survey was entered into Microsoft Excel 2007 spread sheet. The data was cleaned and data generated were analyzed using the Statistical Package for Social science (SPSS) Version 16.0 to carryout descriptive analysis like percentage. Chi-square was used to evaluate the statistical significance of the differences in responses between the respondent from the urban and peri-urban areas. A p-value < 0.05 was considered significant.

## RESULTS

### Demographic characteristics of the respondent

Table 1 shows the profile of respondents from urban and peri-urban areas. Among 139 respondent, 108 (77.7%) of them were males and 31 (22.3%) were females. The majority of the respondents age groups included in the range of (15 to 35 and 36 to 55 year) and 39.4% of the respondents attended the primary school. The current study has demonstrated the presence of statistically significant difference on different types; knowledge, attitude and practice of respondent from urban and peri-

urban area (Tables 2 and 3). Among respondent 96.4% of them were familiar with the disease. Majority,69 (49.6%) of the respondents described starvation and thirst as causes of the disease in dogs and 65 (46.8%) respondents who know the disease mentioned bite and saliva as a means of transmission, while 30 (21.6%) of them perceived any type of contact (irrespective of the skin condition) with saliva of rabid individual as source of infection. Among the 139 respondents, 89.2% of them were aware that human and other different species of domestic animals can be affected by rabies. 89 (64%) of interviewers said that the sign of rabid animals was salivation and 50 (36%) have claimed sudden change in behavior. The majority of the respondents (83.4%) stated that only dog can transmit rabies to human and more than 92% of interviewers had never got training on rabies disease (Table 2).

As indicated in Table 3, 125 (89.9%) of respondents kill the animal after being rabid. The study showed that only 41.7% of respondents for those people exposed to rabies used post exposure vaccination. Conversely, 64 (46.1%) of interviewers sought traditional methods of treatment which employs the use of herbs. The respondents from

**Table 2.** Knowledge of respondent on rabies.

Parameter	Number and percentage of respondent			P-value
	Total (%) n = 139	Urban (%) n = 96	Peri-urban (%) n = 43	
<b>Awareness about rabies</b>				
Yes	134 (96.4)	95 (99.0)	39 (90.7)	0.127
No	5 (3.6)	1 (1.0)	4 (9.3)	
<b>Cause of rabies</b>				
Virus	25 (18)	21 (21.9)	4 (9.3)	0.076
Starvation and thirst	69 (49.6)	42 (43.8)	27 (62.8)	
I don't know	45 (32.4)	33 (34.4)	12 (27.9)	
<b>Species affected by rabies</b>				
Dog only	6 (4.3)	6 (6.1)	0 (0)	0.002
Dog and human	9 (6.4)	9 (9.2)	2 (4.7)	
Human and other domestic animal	124 (89.2)	83 (84.7)	41 (95.3)	
<b>Means of transmission</b>				
Bite only	35 (25.2)	27 (28.1)	8 (18.6)	0.032
Contact with Saliva only	30 (21.6)	22 (22.9)	8 (18.6)	
Bite and saliva contact with open wound	65 (46.8)	38 (39.6)	27 (62.8)	
Infected meat and others	9 (6.5)	9 (9.4)	0 (0)	
<b>Animal species Transmit rabies to human</b>				
Dog only	116 (83.4)	73 (76)	43 (100)	0.002
Dog and cat	20 (14.4)	20 (21.3)	0 (0)	
Other domestic animals	3 (2.1)	3 (3.1)	0 (0)	
<b>Sign of the disease</b>				
Salivation	89 (64)	55 (57.3)	34 (79.1)	0.013
Sudden change in behavior	50 (36)	41 (42.7)	9 (20.9)	
<b>Have you ever get training</b>				
Yes	11 (7.9)	11 (11.5)	0 (0)	0.021
No	128 (92.1)	85 (88.5)	43 (100)	

the peri-urban areas were more likely to seek treatment from traditional healers than those from urban areas. From the all respondent, 78 (56.1%) of them kill the animal which was exposed to rabies. Out of 139 respondents, only 36% of them vaccinate their dogs. According to 75 (54%) of interviewed household, vaccine was not regularly available in the clinic. children were mentioned as the most risky part of the society for rabies.

## DISCUSSION

The result of current study has revealed the importance of rabies in the study area. The questionnaire survey on public awareness indicated that 96.4% of the respon-

dents had heard about rabies from different sources. This finding was in agreement with the report (99%) from Bahirdar, Ethiopia by Tadesse et al. (2014). However, it was higher when compared with reported proportion (68.7%) in a survey of knowledge, attitudes and practices about animal bite and rabies in general community in India (Ichhupujani et al., 2006). The current study has indicated many fallacies regarding the cause and means and source transmission which were observed. In the current study, 46.8% of respondents knew the correct mode of transmission which is consistent with the finding of Tadesse et al. (2014) who reported that 45% of the respondent answered correctly concerning transmission.

Among the respondent, 49.6% of them had misunderstanding on the cause of rabies. Respondents believe



**Table 3.** Attitude and Practice of the respondents.

Parameter	Number and percentage of respondent			P- value
	Total (%) n = 139	Urban (%) n = 96	Peri-urban (%) n = 43	
<b>Action for rabid animal</b>				
Tie	8 (5.8)	2 (2.1)	6 (14)	0.002
Killing	125 (89.9)	92 (95.8)	33 (76.7)	
Do nothing	6 (4.3)	2 (2.1)	4 (9.3)	
<b>Action taken for bitten man</b>				
Post exposure vaccine	58 (41.7)	50 (52.1)	8 (18.6)	0.001
Traditional treatment	64 (46.1)	36 (37.5)	28 (65.1)	
Both	17 (12.2)	10 (10.4)	7 (16.3)	
<b>Action taken for bitten animal</b>				
Killing	78 (56.1)	65 (67.7)	13 (30.2)	0.0001
No action	4 (2.9)	2 (2.1)	2 (4.7)	
Treatment	57 (41)	29 (30.2)	28 (65.1)	
<b>Did you vaccinate your dog</b>				
Yes	50 (36)	48 (50)	2 (4.7)	0.0001
No	89 (64)	48 (50)	41 (95.3)	
<b>Availability of vaccine</b>				
Yes always	26 (18.7)	18 (18.8)	0 (0)	0.0001
Sometimes	75 (54)	63 (65.6)	12 (27.9)	
No	38 (27.3)	15 (15.6)	31 (72.1)	
<b>Dog management practice</b>				
Let free	37 (26.6)	20 (20.8)	17 (39.5)	0.0001
Kept indoor	102 (73.4)	76 (79.2)	26 (60.5)	
<b>More risky population</b>				
Children	137 (98.6)	96 (100)	41 (95.3)	0.033
Old people	2 (1.4)	0	2 (4.7)	

that the disease in dogs is caused by starvation; thirst and the misunderstanding are significantly higher in peri-urban area. This result is lower when compared with the result (39.9%) obtained from study conducted in Bahirdar (Tadesse et al., 2014), Ethiopia. This could be due to the difference in level of community awareness in the study areas. This misunderstanding could probably be explained by the opinion of asymptomatic rabies carrier dogs in which stressors like starvation and thirst might induce development of clinical rabies in these carrier dogs. But the idea of asymptomatic rabies carrier dogs by itself is a controversial issue (Wilde et al., 2009), and the association of stressors to the development of clinical rabies might be an implausible claim. Dogs were mentioned as the most frequent cause of infection for most fatal human rabies cases by 83.4% of the

respondent. In addition, rabies in other domestic animals like cattle, sheep, goats and equines were also mentioned as risk for human. These findings were also reported by Eshetu et al. (2002). Domestic dogs have been a reservoir of rabies and a source of rabies infection to humans and other animals (John, 2005; Joo et al., 2011). In many parts of the world, especially in Africa and Asia, 85 to 95% of human rabies cases were being caused by dog bite (Tang et al., 2005; Fitzpatrick et al., 2012).

A traditional method of treatment was mentioned as the best option for treatment for victims of dog bites in most of the respondent both from urban and peri-urban areas. The respondents from the peri-urban areas were more likely to seek treatment from traditional healers than those from urban areas. This could be attributed to the

low level of education and awareness of the respondents. The practice of traditional treatment was also explained by Deressa et al. (2010), Wudu et al. (2013), Abraham et al. (2013). Moreover, this exclusively demonstrated the importance of extensive public education and improving the accesses to modern treatment to reduce the high dependency of victims on traditional treatment.

Out of 139 respondents, only 36% of them vaccinate their dogs. According to 75 (54%) of interviewed household, vaccine was not regularly available in. lower rate of community participation in dog vaccination was also mentioned by Abrham et al., 2013; Lai et al., 2005. According to the response from majority of the respondents (98.6%), group of populations more risky to the disease were children. This could be due to the fact that children are closely playing with dog at home and even in streets. In addition Assefa *et al.* (2010) has declared that elders are well aware of the danger of rabies and look for medical care than children.

The current finding showed that almost all respondent (95.3) in per-urban area did not vaccinate their dogs. The reason for low dog vaccination practice in per-urban area could be due to large dependency on the traditional treatment using herbs, limitation of availability and high cost of vaccine. This is in agreement with Wudu et al. (2013) who noted that dog vaccination practice was generally very low and totally nonexistent in rural district of the current study area. Relatively high percentages (50%) of the respondent from urban areas were found to have a habit of vaccination. But the vaccination program did not meet the expected level. The management system of most respondents in urban areas were kept indoor whereas almost half of respondents from peri-urban areas let their dogs free. This indicates the presence of high risk of rabies. On the other hand, the current study illustrated that training on rabies related aspect has not been given at community level. Therefore, public extensive education about rabies should be given to community to increase their awareness. Raising community awareness level has been mentioned as important tool to control rabies by many scholars (Eshetu et al., 2002; Wudu et al., 2013).

In conclusion, the result of the current study indicates the existence of high risk of the disease and low level of awareness of the community. Dogs were mentioned as primary source of infection to human as well as animals. The presence of low vaccination coverage and high dependency on traditional medicine, especially in the peri-urban area, were also well indicated. Such type of activities pose a health hazard and makes difficult the control of rabies in the area. Hence, raising awareness about dog vaccination and improving access and affordability of the vaccine should be considered in control of the disease, as dogs are the main reservoir of the disease.

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## ABBREVIATIONS

**CDC**, Center for Disease Prevention and Control; **PEP**, post exposure prophylaxis; **RNA**, ribonucleic acid; **US**, United States; **WHO**, World Health Organization.

## Conflict of interest

The author declared he has no conflict of interest.

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*Full Length Research Paper*

# Permeability and breakage status of male condoms artificially and naturally aged in humid tropical climate, the case of Jimma town, South-western Ethiopia

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Condoms are made up of polymers of rubber latex which undergoes gradual deterioration upon exposure to environmental conditions like high heat, ultraviolet light and humidity. This natural aging can also be simulated in laboratory and comparable results observed within short time. Deteriorated condoms show poor tensile strength and higher breakage rates. The breakage rate and permeability of condoms can be tested in laboratory. This study aimed to determine the effects of high heat, humidity, sunlight and visible light on integrity and breakage of condom latex. Sample condoms were exposed to different environmental conditions and their permeability and breakage rates were tested in laboratories of drug administration and control authority of Ethiopia. The air burst test results showed some differences in bursting pressures and bursting volumes for the aged and control groups of the different branded condoms and even much higher difference between the breakage rates of the same during vaginal sex. On the other hand, there were observed closely comparable permeability status results. There was no significant effect of artificial and natural aging on permeability status of condoms. On the other hand, there was observed significant association between the artificial aging factors and condoms breakage rates in laboratory. Drug administration and control authority and other responsible bodies should promote good handling of condoms by keeping away from high heat, UV- light and humidity.

**Key words:** Condoms, artificial aging, natural aging, permeability, breakage

## INTRODUCTION

Condom distribution networks would benefit from increased knowledge of recent research findings about how to handle and store condoms to maximize their reliability. Therefore, systems to track condoms failure in field conditions and correlate these with laboratory

measures of quality should be developed (Youssef, 1993).

During the first recommendation of condoms by National government of U.S, governmental officials and scientists went into libraries and laboratories to see what

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data supported such recommendations. Government regulating agencies still have another emphasis to ensure that various laws and regulations are being met and that condom is safe. Regulators, therefore, monitor the accuracy of claims made by manufactures on its reliability. This is an extremely serious issue as it may come up with unintended pregnancy or sexually transmitted infection including Human immunodeficiency virus/ acquired immune deficiency syndrome (HIV/AIDS). In 1980s, researchers began to test condoms stored in warehouses to assess the importance of condom deterioration. Manufactures at the time knew that latex deteriorated or aged gradually overtime and that certain conditions such as intense heat humidity or moisture could accelerate the aging process (Holmes, 2004).

One way to slow the aging process of condoms and to ensure product stability is to increase attention to packaging, accordingly, major buyers including World Health Organization (WHO) and United States Agency for International Development (USAID) added package integrity test to their specifications. This test is done by subjecting the package seal to stress under a vacuum seal. This is regarded by American Society for Testing and Materials (ASTM) but not by International Organization for Standardization (ISO) and European Committee for Standardization (CEN). The other radical change on related researches is due to the use of artificial aging recently instead of the use of natural aging in the former researches. Recent research recommended that in accelerated aging measurements, the mean burst volume should not be less than 30 L. The limit might be slightly higher for condoms intended for use in hot climates and for smaller condoms. Although the intuition suggests the higher the minimum volume of burst, the better the product; there is no significant clinical data to justify raising the limit at this point (Holmes, 2004).

Sadly, the great improvements in condom design and reliability of the tests are not well known. Consumers and service providers alike continue to lack confidence in condom's ability to prevent pregnancy and disease. Despite all these, provided that the social, cultural, economic or individuals related causes for nonuse or incorrectly using of condoms is circumvented, currently available condoms, if peaked and stored correctly will maintain their quality for five years or more (Allen, 2006). The published studies do not reach the same conclusion. There is no single indicator of potential failure in human use. Moreover, because of variations in human behavior and practices and differing designs of latex condoms, there is high methodological challenge to definitive answers for reliability of condoms (Free et al., 1980; Free et al., 1986; Steiner et al., 1992).

Condoms strength testing results can be correlated with condom breakage during human use to some extent and therefore is of very great importance in determining the strength and cure of condoms artificially aged according to the literatures as concluded by a research conducted in 2009 by 'Family health international' on

topic; 'Assessment of correlation between condoms laboratory strength test results and breakage rates in human uses' (Russell-Brown et al., 1994; Speneer, 1996). A study published in 1991 used unusual design to see the results of tensile test correlated with human use during anal intercourse. Although the condoms were new and stored at optimal conditions, cool, dry and dark place, 40% of the condoms used by the participants were broken and 60% were unbroken (Gerofi et al., 1991; FHI, 1994). There are no similar studies so far in Ethiopia. This study aimed to assess the effect of artificial and natural aging of condoms on their permeability tests and their breakage in laboratory.

## **MATERIALS AND METHODS**

### **Study design**

Controlled experimental study design was employed. Two different branded condoms namely 'Sensation' and 'Hiwot Trust' condoms were collected from their usual supply drug stores, in Jimma town south west Ethiopia, Oromia regional state. The previous storage conditions of these condoms were investigated before collecting to minimize the bias on the study variables. Then some of the condoms were exposed to exaggerated conditions to facilitate accelerated aging called artificial aging. According to WHO criteria, the condoms were exposed to 70°C temperature constantly for 7 days and were then exposed to UV-light for 11 h (UNAIDS, WHO and UNFPA, 2009; National Institute of Allergy and Infectious Diseases, Department of Health and Human Services, 2001). Then these condoms along with their control group condoms which were not accelerated aged were tested for permeability test electronically and for breakage status by air burst test. The study was conducted from January to March, 2010.

### **Sampling control group condoms**

To sample among either of the branded condoms: 'Sensation' or 'Hiwot trust', as control group, non-random sampling method was used. Accordingly, the visually so inspected most intact boxes and sackets of a randomly selected batch of condoms were selected as sample in order to minimize the bias of natural aging on artificial aging process.

### **Sampling experimental group condoms**

These, on the contrary, were sampled by random systematic sampling because the amount of environmental conditions influence compared to the artificial aging conditions is very much less significant and the bias is just a little.

### **Variables and measurement of variables**

Variables are conditions to which the experimental group condoms are exposed differently while the control groups are not. The variables were then measured by appropriate instrumentation.

1. Heat: According to WHO criteria for condoms, accelerated aging condoms should be exposed to heat oven temperature of 70°C for seven days.
2. UV-light: Wherever there is assumption that the condoms might

**Table 1.** Frequency and percentage of permeability rate of sample condoms of 'Hiwot Trust' and 'Sensation' condoms before and after aging, Jimma town, Ethiopia, 2011.

Brand	Group	No	%	Yes	%	Total	%	P value and Crude odd ratio
'Hiwot Trust'	Control	313	99.36	2	0.64	315	100	P=0.563; COR=0.4984
	Aged	314	99.68	1	0.32	315	100	
'Sensation'	Control	310	98.41	5	1.59	315	100	P = 0.737; COR=0.7974
	Aged	311	98.73	4	1.27	315	100	

be exposed to sunlight during its transportation, storage and in the hands of the users, the WHO standards of condoms artificial accelerated aging also adds UV-light as a variable. Because there is less attention of preventing condoms from sunlight degradation, especially by the sellers and users in Ethiopia, UV-light should also be better included in the simulation of the artificial aging process. Sunlight exposure of the period of 11 h is selected because it is supposed to bear optimum and tangible correlation between sunlight and condoms breakage rate in laboratories as recognized from the literatures (Weller and Davis-Beaty, 2007; WHO, 2010).

3. Humidity: Because there is high chance for condoms to be exposed to humid conditions in Ethiopia, a certain amount of moisture condition exposure of the experimental condoms increases comparability of the result of the research with the actual environmental conditions. During the seven days of oven drying, moisture was also applied as water vapor in and around the oven. The moisture should not be excessive but just to imitate environmental humid conditions especially during rainy season (CDC, 2008).

#### Artificial aging

The storage condition of 70°C for seven days is an accelerated aging test derived from latex condoms standard ASTM D 329489. This condition was designed to challenge the product. When there is expectation of exposure, the condoms artificial aging also considers the exposure to humid and UV-light environmental conditions (Sexuality Information and Education Council of the United States (SIECUS), 2002).

#### Electronic testing of condoms

1. First the condoms were placed over a 'mandrel' which is a fancy way of saying grant metal dildo.
2. Then the condoms were passed through an electric field.
3. Normally, condoms do not conduct electricity.
3. The condom therefore fails if the mandrel registers any electric current even when the condom seems intact, unbroken.

#### Condoms strength testing

These tests were done to measure condoms strength and effectiveness. Aging of the condoms in oven at 70°C for seven days is a criteria for both tensile test and airburst test. WHO requires 27 L minimum mean burst volume for a batch of condoms after seven days of oven conditioning of 70°C with 1 Kpa pressure of tensile test. The equipment required for airburst test is an apparatus capable of inflating 150 mm of the condom from the closed end while for tensile test is a standard tensile tester equipped with ring test fixture.

#### Data analysis and interpretation

The data was analyzed manually using tallying methods and presented as tables showing frequency and percentages. Odd ratios were calculated manually and p-values were calculated using online chi-square calculators for permeability status of the condoms. The bursting pressures and volumes were automatically grouped and output by the computerized testing machines.

#### Ethical consideration

Before the tests were done at the drug administration and quality control authority of Ethiopia where the necessary instrumentation was available, a formal letter from Jimma University was provided to the administration office of the authority. The study was conducted by approval and support of the technical staff of the National Drug Administration and Control Authority.

## RESULTS AND DISCUSSION

The permeability of condoms solely depends on the presence of pores on condoms during their manufacturing or due to condoms damage during transportation, storage or handling (Morrow et al., 1980). Out of the total condoms electronically tested in this study, very few condoms were observed to be permeable. According to the criteria of approval of condoms impermeability of DACA, in this study 315 condoms of each of the control group and experimental group of brands 'Hiwot Trust' and 'Sensation' condoms were electronically tested in the national laboratory of DACA, Addis Ababa. In this test, 2 control and 1 aged condoms of 'Hiwot Trust' brand, 5 control and 4 aged condoms of 'Sensation' brand condoms were observed to be permeable and the corresponding distances of the holes were measured to be between 2 and 16.5 cm from the base (Table 1). From these results, the permeability rate of the control group of 'Sensation' condoms was observed to be slightly above the allowance rate of DACA's condoms approval criteria ( $\leq 2$  of 315) (DACA, 2010); 'Hiwot Trust' control group condoms being in the range of allowance of DACA. This slightly higher permeability rate of the 'Sensation' condoms than recommendations is most probably due to exposure of the condoms to unfavorable environmental conditions and thus promoting appropriate handling of condoms should be implemented in all suppliers, during

**Table 2.** Bursting volumes of artificially aged and normally stored condoms of 'Hiwot Trust' and 'Sensation' brand condoms collected from Jimma town, Ethiopia, 2011.

Brand	Group	Bursting volumes							
		<27 L		27-36 L		36 L and above		Total	
		Frequency	%	Frequency	%	Frequency	%	Frequency	%
'Hiwot Trust'	Control	10	20	30	60	10	20	50	100
	Aged	15	30	30	60	5	10	50	100
'Sensation'	Control	0	0	5	10	45	90	50	100
	Aged	0	0	40	80	10	20	50	100
	Aged	23	7.3	203	64.4	89	28.3	315	100

transportation or storage to minimize these problems. The authority should also search for possible marketing of unapproved or disapproved batches of condoms routinely. On the other hand, there was observed no significant association between condoms permeability status and aging ( $P = 0.563$ ,  $P = 0.563$ ) in both 'Hiwot Trust' and 'Sensation' condoms.

The bursting volumes of the aged condoms were found to be less than that of their control counterparts. Accordingly, 10 (20%) and 0 (0%) of the control group condoms and 15 (30%), 0 (0%) of the experimental group condoms showed bursting volumes less than 27 L for 'Hiwot Trust' and 'Sensation' condoms, respectively. On the other hand, 10 (20%) and 45 (90%) of the control group condoms and 5 (10%) and 10 (20%) of the aged condoms of 'Hiwot Trust' and 'Sensation' condoms, respectively showed bursting volumes more than 36 L (Table 2). WHO recommended that in accelerated aging measurements, the mean bursting volume should not be less than 27 L and the bursting pressure not less than 1 kpa. The limit might be slightly higher for condoms intended for use in hot climates and for smaller condoms. The intuition suggests the higher the minimum volume of burst, the better the product (Youssef, 1993).

In this study, the bursting volumes of both brands were slightly lowered after aging. Accordingly, the bursting volumes of the aged condoms were found to be less than that of their control counterparts. Accordingly, 10 (20%) and 0 (0%) of the control group condoms and 15 (30%) and 0 (0%) of the experimental group condoms showed bursting volumes less than 27 L for 'Hiwot Trust' and 'Sensation' condoms, respectively. However, no single control or aged condom showed bursting volume below Ethiopian DACA's standard for approval which is 18 L. Some gap is observed between WHO recommendation and Ethiopian DACA's approval and this gap should be lowered because the intuition suggests the higher the minimum volume of burst, the better the product. Ethiopian DACA should also consider the fact that Ethiopia is a tropical country where higher minimum bursting volume is required.

On the other hand, 10 (20%) and 45 (90%) of the

control group condoms and 5 (10%) and 10 (20%) of the aged condoms of 'Hiwot Trust' and 'Sensation' condoms, respectively could show bursting volumes more than 36 L. Generally, control 'Sensation' condoms showed higher bursting volumes than 'Hiwot Trust' control condoms as 45 (90%) of the control group condoms could show bursting volumes more than 36 L compared to only 10 (20%) for 'Hiwot Trust' condoms. 'Sensation' condoms, therefore, are supposed to have slightly better elasticity than the 'Hiwot Trust' as condoms evidenced from. On the contrary, 'Sensation' condoms were more significantly affected by aging although both brands aged by the same parameters; their bursting volume above 36 L reduced from 90 to 20% after aging compared to from 20 to 10% for condoms. This is probably due to slightly more vulnerability of 'Sensation' condoms to artificial aging parameters and thus for adverse environmental factors. Generally, however, the bursting volume decreased after aging for both brands and good handling of condoms is an indispensable idea. Accordingly, there was no single condom observed to show bursting pressure below WHO criteria of 1 kpa which contrasts their respective bursting volumes where some condoms failed to meet the criteria of WHO. The aged 'Sensation' condoms and their control counterparts showed the highest percentage of rate of aged condoms bursting pressure and the lowest percentage of rate of control condoms bursting pressures of between 1 to 2 kpa; being 0 and 70%, respectively. 'Hiwot Trust' condoms showed bursting pressures in range of 1 to 2 kpa and 2 to 2.6 kpa with percentage rates of 20 and 80%, respectively (Table 3).

Although bursting pressure cannot alone define the reliability of condoms, it is generally indicative for the strength of condoms (Steiner et al., 1992). In this study there was no single condom observed to show bursting pressure below WHO criteria of 1 kpa which contrasts their respective bursting volumes where some condoms failed to meet the criteria of WHO. The aged 'Sensation' condoms and their control counterparts showed the highest and the lowest bursting pressures; 0 and 70% of which have between 1 to 2 kpa, respectively. There was higher rate of decrease in bursting pressure after aging

**Table 3.** The bursting pressure distribution among artificially aged and normally stored condoms of 'Hiwot Trust' and 'Sensation' brand condoms collected from Jimma town, Ethiopia, 2011.

Brand	Group	Bursting pressures					
		1-2 kpa		2-2.6 kpa		Total	
		Frequency	%	Frequency	%	Frequency	%
'Hiwot Trust'	control	10	20	40	80	50	100
	Aged	15	30	35	70	50	100
'Sensation'	Control	0	0	50	100	50	100
	Aged	35	70	15	30	50	100

for 'Sensation' condoms than 'Hiwot Trust' condoms; from 0 to 50% versus 20 to 30%. Control group 'Hiwot Trust' condoms showed bursting pressures in range of 1 to 2 kpa and 2 to 2.6 kpa with percentage rates of 20 and 80%.

Generally, the bursting pressures are also decreased after aging. In case of control condoms, 'Sensation' condoms showed higher average bursting pressures than the 'Hiwot Trust' condoms. Generally, the permeability and strength of the randomly collected condoms met the standards of approval of condoms by DACA and WHO except slight deviations which might be due to the possible poor care of condom sellers and users on the appropriate handling of condoms, keeping them away from heat, sunlight and humidity. On the other hand, the recent tireless endeavors being undertaken by DACA in Ethiopia to ensure the safety and effectiveness of condoms is an extremely encouraging commitment.

## CONCLUSIONS AND RECOMMENDATIONS

From this study was identified that generally speaking, condoms in market were observed to possess acceptable impermeability, bursting pressure and bursting volume measures in Ethiopia. However, there was observed slight insufficiency of confirmation criteria of bursting volume of 18 L vs. 27 L and insufficiency in consistency of laboratory test for impermeability on some batch of condoms in market. There were also observed bursting volumes of less than 27 L of WHO standard criteria although none was shown below 18 L, which is a DACA criterion. On the other hand, aging the condoms by exposing to heat, UV light and humidity moderately reduced the bursting pressures and volumes of the same in contrast to permeability for which no association was observed with aging. This indicates the significance of optimal handling of condoms for its effectiveness and cure. The exposure of condoms to heat, UV light and humidity are environmental factors that significantly decreased the strength and elasticity of condoms which can also increase the breakage rate of condoms during human uses. The condom producers, distributors, sellers and users should handle it appropriately and protect it

from sunlight, heat and humidity during storage or distribution.

## ABBREVIATIONS

**HIV**, Human immunodeficiency virus; **AIDS**, acquired immune deficiency syndrome; **STD**, sexually transmitted diseases; **FDA**, Food and Drug Administration; **ISO**, International Organization for Standardization; **WHO**, World Health Organization; **USAID**, United States Agency for International Development; **ASTM**, American Society for Testing and Materials; **CEN**, Comité Europeas de Normalización; **UV**, ultraviolet light; **PATH**, program for appropriate technology in health; **USA**, United States of America; **C.QI**, condom quality index; **FHI**, Family Health International; **DACA**, Drug Administration and Control Authority of Ethiopia

## Conflict of interest

The author declared he has no conflict of interest.

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