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Original Research Article

Prevalence of Tungiasis and Its Associated Factors among Residents of Kipkelion West Sub-County; Kericho County, Kenya

Chiuri Waruguru[1], Peter Mwaniki[2], Mohamed Karama[1], Lawrence Muthami[2]

[1]Institute of Tropical Medicine and Infectious Diseases, Jomo Kenyatta University of Agriculture and Technology, P.O Box 62000-00200, Nairobi, Kenya
[2]Center for Public Health Research, Kenya Medical Research Institute, P.O Box 20742 - 00200, Nairobi, Kenya

Corresponding Author: Chiuri Waruguru

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ABSTRACT

Background: Tungiasis is a parasitic skin disease caused by penetration of the female sand flea *Tunga penetrans*, also called jigger flea, into the epidermis of its host. It is highly prevalent where people live in extreme poverty, occurring in many Latin American and African countries. In Kenya it is endemic in several areas where its prevalence and associated factors have not been intensely studied. Objectives: This study was aimed at determining the prevalence of tungiasis, establishing factors associated with tungiasis among residents of Kipkelion West Sub-county and establishing health seeking behavior among those that were found to be infested.

Material and Methods: A total of 428 randomly selected households were visited. Pretested questionnaires were administered to household heads and household members were examined for the presence of tungiasis. The level of statistical significance was set at P- value <0.05. Binary logistic regression was performed to determine the independent factors associated with tungiasis.

Results: The prevalence of Tungiasis was (129)30.1%. Factors that were independently associated with occurrence of tungiasis included: living in close proximity to domestic animals [AOR=6.58; 95%CI:3.42-12.65; P<0.001], staying barefoot [AOR=9.94; 95% CI: 4.18-23.61; P<0.001], wearing slippers outdoors,[AOR=6.45; 95% CI: 2.78-14.98; P<0.001], presence of waste products near residential buildings [AOR=3.73; 95% CI: 2.01-6.91; P<0.001], living in houses with cracks on the walls [AOR=6.92; 95% CI: 3.25-14.70; P<0.001], rearing chicken in the main house [AOR=8; 95% CI: 2.74-23.33; P<0.001], rearing free range chicken [AOR=6.59; 95% CI: 1.37-31.67; P<0.001] and presence of rats in the compound [AOR=2.18; 95% CI: 1.09-4.36; P=0.028]. None of those infested sought healthcare.

Conclusion: An integrated approach addressing factors that were established to be significant in occurrence of Tungiasis in the study area needs to be designed and implemented by an interdisciplinary team (that is the populace, community leaders, health professionals, non-governmental institutions and policy makers).

Keywords: Tungiasis, jigger infestation, *Tunga penetrans*, ectoparasitosis.

INTRODUCTION

Tungiasis is a disease caused by the sand flea *Tunga penetrans*. This parasitic infestation is commonly found in developing countries, especially in resource-poor communities and where basic hygiene

standards are poor. The female sand flea penetrates into the skin of its hosts where it grows rapidly in size. Some of the hosts include a variety of mammals, such as humans, dogs, cats, pigs and cattle. [1,2] It feeds on the host's blood, produces eggs which are expelled into the environment, and eventually dies in situ. Tungiasis results in considerable morbidity, manifesting itself in a number of symptoms such as intense local inflammation, deformation and loss of nails, formation of fissures and ulcers, deformation and auto-amputation of digits, gangrene, difficulty walking and gripping (when lesions are located on the hands), as well as sleep disturbances due to severe itching and pain. [3,4] Tungiasis lesions may serve as an entry port for *Clostridium tetani*, [5] rendering non-immunized individuals susceptible to tetanus. Individuals with a high parasite burden are therefore more vulnerable to severe disease. Why some individuals are heavily parasitized, but others harbour only a few sand fleas remains unknown. Tungiasis is common in resource-poor populations throughout Latin America, the Caribbean, and sub-Saharan Africa. In Africa, epidemiological data on this ectoparasitosis are scarce. [6] Epidemiological data on tungiasis in Kenya where 2.6 million people are estimated to be at risk of infestation are scanty. [7] In an effort to fill this gap, a cross-sectional study was conducted in Kipkelion West Sub-County, Kericho County; Kenya.

MATERIALS AND METHODS

The study was conducted in Kipkelion West Sub County where data collection was done at household level. Kipkelion West Sub County is one of the sub counties that form the expansive Kericho County. According to the Population and Housing Census (2009) the district population was 110,566 persons.

Cross-sectional descriptive study design was employed in the study. A sample of 428 participants determined using the single population proportion formula as used by Fisher et al, 1998. The study was conducted between 30th January and 28th March, 2014. Data was collected using pre-tested semi-structured questionnaire designed in English then translated into Swahili, Kikuyu and Kalenjin. Questionnaires were administered to the household heads followed by thorough visual clinical examination. Administration of the questionnaires and visual clinical examination was done by the principal investigator and four research assistants with clinical background and trained on basic research.

Data captured in questionnaires was double entered into a computer database designed using MS- Access application. Regular file back-up was done to avoid any loss or tampering. Data cleaning and validation was performed in order to achieve a clean dataset that was exported into a Statistical Package format (using SPSS version 20.0) ready for analysis. Descriptive analysis was done for the demographic variables using frequencies and proportions. Pearson's Chi-square test was used to establish the association between the dependent variable (presence of tungiasis) and independent variables in order to determine which ones had significant association. Unadjusted and adjusted Odds ratio (OR) with corresponding 95% confidence interval was estimated. The level of statistical significance was set at p-value <0.05. Binary logistic regression analysis was performed to adjust for confounding factors in the relationship between occurrence of tungiasis and the independent variables. The significant factors with p-value <0.05 at bivariate analysis were subjected to binary logistic regression by specifying 'backward conditional'

progressive stepwise method with removal at $p<0.05$. Approval to carry out the study was sought and obtained from Kenya Medical Research Institute (KEMRI) Scientific/Steering and Ethical Review Committees. Only those residents, who met the study requirements, verbally consented and voluntarily signed the consent forms were enrolled into the study

RESULTS

A total of 428 respondents with a mean age of 38.34 (SD $\pm$ 11.8) years participated in the study. The respondents were grouped into four age categories of 18 to 29 years (29.4%), 30 to 39 years (26.6%), 40 to 49 years (23.6%) and 50 and above years (20.3%). More males (56.1%) than females (43.9%) participated in the study. Majority (76.2%) of the respondents were married. Level of education was generally low with 12.9% having not attended school at all and 64.5% of the respondents attended school up to primary level. Majority of the participants had a form of religion with 78.3% of them being Christians. (Table 1)

Table 1: Distribution of respondents by socio-demographic characteristics

Socio-demographic characteristics	Frequency (n=428)	Percentage (%)
Mean age ($\pm$SD) = 38.34($\pm$11.8)		
Age in years		
18-29	126	29.4
30-39	114	26.6
40-49	101	23.6
50 and above	87	20.3
Sex		
Male	240	56.1
Female	188	43.9
Marital status		
Married	326	76.2
Single	58	13.6
Widowed	32	7.5
Divorced/separated	12	2.8
Level of education		
Not attended	55	12.9
Primary	276	64.5
Secondary and above	97	22.7
Religion		
Christian	335	78.3
Hindu	5	1.2
Traditional	52	12.1
No Religion	36	8.4

Socio-economic characteristics of the respondents

Table 2 below shows the distribution of socio-economic characteristics among the respondents. Most (69.4%) of the study participants were farmers. Majority (50.2%) of the respondents slept on a mattress on bed while the rest slept on either a mat or mattress on the floor. Well/river/stream was the major source of water used by majority (80.8%) of the respondents. Paraffin lamp was the major (80.1%) type of lighting used by the respondents.

Table 2: Socio-economic characteristics among respondents

Socio-economic characteristics	Frequency (n=428)	Percentage (%)
Occupation		
Unemployed	88	20.6
Farmer	297	69.4
Business man	31	7.2
Civil servant	12	2.8
Sleeping place		
Mat on floor	178	41.6
Mattress on floor	35	8.2
Mattress on bed	215	50.2
House lighting		
Paraffin lamp	343	80.1
Solar/Electricity	85	19.9
Source of water		
River stream	316	73.8
Well	26	6.1
Borehole	26	6.1
Piped	60	14.0

Environmental and hygiene factors

Waste management in majority of households was done through burning and disposal in compost pits (51.6% and 56.1% respectively).The state of the compound in majority (99.8%) of the households was dry or dusty. A large percentage (97.9%) of respondents lived in semi-permanent and temporary housing structures with an earthen floor and an average of two rooms. Majority (51.4%) of the respondents were either barefoot or in slippers while outdoors and 58.4% were in slippers while indoors. A pit latrine was available in 81.1% of the households. (Table 3)

Table 3: Distribution of environmental and hygiene factors

Factors	Frequency (n)	Percentage (%)
Waste product disposal		
Yard	92	21.5
Back yard	96	22.4
Compost pit	240	56.1
Waste burning		
No	207	48.4
Yes	221	51.6
Wastes near the house		
Yes	113	26.4
No	315	73.6
State of the compound		
Dry/dusty	427	99.8
Bushy	1	0.2
Footwear in the house		
Barefoot	141	32.9
Slippers	250	58.4
Closed shoes	37	8.6
Footwear outdoors		
Barefoot	107	25
Slippers	113	26.4
Closed shoes	208	48.6
Availability of latrine		
No	81	18.9
Yes	347	81.1
Type of house construction material (wall)		
Mud	35	8.2
Mud and wood	209	48.8
Mud/ Cement	6	1.4
Iron sheet	48	11.2
Wood only	121	28.3
Bricks/stone building	9	2.1
Presence of cracks on the walls		
Yes	210	49.1
No	218	50.9
Number of rooms		
1 room	140	32.7
2 rooms	201	47
3 rooms	66	15.4
4 rooms and above	21	4.9
Floor Construction material		
Earthen	366	85.5
Cemented/tiled/wooden	62	14.5
Roofing type		
Grass	98	22.9
Iron sheet	330	77.1

Presence of domestic animals

Chicken and dogs which have been documented as key reservoirs of the sand flea were present in majority of the households. Other animals that were reared but considered not to be reservoirs of the sand fleas included: goats, cows and sheep. It was observed that more than half (55.8%) of the respondents had their domestic animals live in close proximity to their residential buildings (Table 4).

Table 4: Distribution of presence of domestic animals

Factors	Frequency (n)	Percentage (%)
Chicken ownership		
Yes	303	70.8
No	125	29.2
Number of chicken present		
More than 5 chicken	109	36.0
1 to 5 chicken	194	64.0
Living place for chicken		
Main house	76	25.1
Free range	24	7.9
Poultry house	203	67.0
Presence of dogs		
Yes	241	56.3
No	187	43.7
Number of dogs		
1-2 dogs	218	50.9
3-5 dogs	25	5.8
None	185	43.2
Living place for dogs		
Free roaming	178	41.6
Kennel	65	15.2
Presence of rats		
Yes	264	61.7
No	164	38.3
Presence of other animals		
Cow	177	41.4
Sheep/goat	98	22.9
None	153	35.7
Domestic animals living near premises		
Yes	239	55.8
No	187	43.7

Prevalence of Tungiasis

The prevalence of Tungiasis was 30.1% with 95% confidence interval of 25.75% to 34.45%.

Stages and sites of infestation

Foot toes, soles and heels were identified to be the preferred sites for jigger infestation. There was minimal infestation on the arms.

Symptoms

The most common symptoms among those that were infested were itching (86%), pain upon pressure (84.5%) and difficulty in walking (44.2%)

Distribution of number of lesions (severity) among those infested Tungiasis

Majority of the respondents (70.5%) had between 6-30 lesions, while 17.8% had less

than 5 lesions and 11.6% had more than 30 lesions.

Bivariate analysis

Association between socio-demographic characteristics and occurrence of Tungiasis

Table 5 shows the bivariate analysis of relationship between socio-demographic characteristics and occurrence of Tungiasis. There was a statistically significant association between level of education and occurrence of tungiasis. There was a significantly higher prevalence of Tungiasis among those who did not attend school at all 28(50.9%) [OR=6.7; 95% CI: 3.05-14.73; P<0.001] and among those who attended primary school 88(31.9%) [OR=3.03; 95% CI: 1.60-5.72; P=0.001] than those attended secondary and above 13(13.4%). However, there was no statistically significant association (P > 0.005) between age, sex, marital status, religion of the respondents with jigger infestation.

Table 5: Distribution of socio-demographic characteristics and prevalence of Tungiasis

Socio-demographic characteristics	Jigger/Tunga		χ^2 value	*P value	*OR	95%CI	
	Infected, n (%)	Not infected, n (%)				Lower	Upper
Age in years							
18-29	37(29.4%)	89(70.6%)	1.70	0.192	0.68	0.38	1.21
30-39	32(28.1%)	82(71.9%)	2.18	0.140	0.64	0.35	1.16
40-49	27(26.7%)	74(73.3%)	2.68	0.102	0.60	0.32	1.11
50 and above (Referent)	33(37.9%)	54(62.1%)			1		
Sex							
Male	77(32.1%)	163(67/9%)	0.98	0.322	1.24	0.81	1.88
Female (Referent)	52(27.7%)	136(72.3%)			1		
Marital status							
Married	89(27.3%)	237(72.7%)	1.15	0.283	0.53	0.16	1.70
Single	21(36.2%)	37(63.8%)	0.13	0.722	0.80	0.22	2.82
Widowed	14(43.8%)	18(56.2%)	0.02	0.901	1.09	0.28	4.17
Divorced/separated (Referent)	5(41.7%)	7(58.3%)			1		
Level of education							
Not attended	28(50.9%)	27(49.1%)	22.4	<0.001	6.70	3.05	14.73
Primary	88(31.9%)	188(68.1%)	11.6	0.001	3.03	1.60	5.72
Secondary and above (Referent)	13(13.4%)	84(86.6%)			1		
Religion							
Christian	99(29.6%)	236(70.4%)	0.66	0.417	0.74	0.361	1.524
Hindu	2(40.0%)	3(60.0%)	0.03	0.866	1.18	0.174	7.998
Traditional (Referent)	15(28.8%)	37(71.2%)	0.52	0.473	0.72	0.29	1.776
No Religion	13(36.1%)	23(63.9%)			1		
OR = Odds Ratio, CI= Confidence Interval, *Significant P value and OR Bolded							

Relationship between socio-economic characteristics and occurrence of Tungiasis

Relationship between socio-economic characteristics and jigger infestation is summarized in Table 6. Occurrence of Tungiasis was significantly higher among respondents who slept on mats on the floor 95(53.4%) [OR=11.81; 95% CI: 6.78-20.58; P<0.001] than in those who slept on mattress on bed 19(8.8%). Similarly, respondents who slept on mattress on floor were significantly more likely to be jigger infested 15(42.9%) than in those who slept mattress on bed (8.8%), [OR=7.74; 95% CI: 3.41-17.54; P<0.001]. The type of house lighting used was also examined and Tungiasis was significantly higher among those who used paraffin lamp 124(36.2%) [OR=9.06; 95% CI: 3.58-22.96; P<0.001] than among those who used solar or electricity 5(5.9%). Source of water was not a statistically significant factor in occurrence of Tungiasis (P>0.05).

Table 6: Relationship between socio-economic characteristics and Tungiasis

Socio-economic characteristics	Jigger/Tunga		χ^2 value	*P value	*OR	95%CI	
	Infected, n(%)	Not infected, n(%)				Lower	Upper
Occupation							
Unemployed	31(35.2%)	57(64.8%)	0.49	0.486	1.63	0.41	6.47
Farmer	92(31.0%)	205(69.0%)	0.19	0.661	1.35	0.36	5.09
Business man	3(9.7%)	28(90.3%)	1.58	0.208	0.32	0.06	1.88
Civil servant (Referent)	3(25.0%)	9(75.0%)			1		
Sleeping place							
Mat on floor	95(53.4%)	83(46.6%)	75.89	<0.001	11.81	6.78	20.58
Mattress on floor	15(42.9%)	20(57.1%)	24.00	<0.001	7.74	3.41	17.54
Mattress on bed (Referent)	19(8.8%)	196(91.2%)			1		
Source of water							
River stream	103(32.6%)	213(67.4%)	1.34	0.247	1.45	0.77	2.72
Well	6(23.1%)	20(76.9%)	0.36	0.849	0.90	0.31	2.66
Borehole	5(19.2%)	21(80.8%)	0.34	0.562	0.71	0.23	2.23
Piped (Referent)	15(25.0%)	45(75.0%)			1		
House lighting							
Paraffin lamp	124(36.2%)	219(63.8%)	29.64	<0.001	9.06	3.58	22.96
Solar/Electricity (Referent)	5(5.9%)	80(94.1%)			1		
OR = Odds Ratio, CI= Confidence Interval, *Significant P value and OR Bolded							

Relationship between environmental and hygiene factors and occurrence of Tungiasis

Analysis of the relationship between environmental and hygiene factors and occurrence of Tungiasis is shown in Table 7. There was no significant association between the site of waste product disposal and occurrence of Tungiasis. However, respondents who did not burn their waste products had significantly higher prevalence of Tungiasis [OR=1.68; 95% CI: 1.11-2.55; P<0.005] compared to respondents burned waste products. Respondents that had waste products near the house had significantly higher proportion of jigger infestation 67(59.3%), [OR=5.94; 95% CI: 3.73-9.48; P<0.001] compared to without waste products near the house 62(19.7%). Latrine availability was a significant factor in occurrence of tungiasis. Prevalence of Tungiasis was higher among study participants who did not have a pit latrine in the compound 32(39.5%) [OR=1.68; 95% CI: 1.02-2.78; P<0.005] than in those with a latrine 97(28%).

Footwear was statistically significant factor in occurrence of tungiasis. Respondents who were barefoot while indoors had a significantly higher prevalence of jigger infestation 85(60.3%) [OR=12.52; 95% CI: 4.21-37.29; P<0.001] than those who wore closed shoes 4(10.8%). In addition, respondents that stayed barefoot and those that wore slippers while outside the house [64(59.8%) [OR=20.63; 95% CI: 10.60-40.14; P<0.001] and 51(45.1%) [OR=11.40; 95%CI: 5.91-21.99; P<0.001] respectively had significantly higher occurrence of Tungiasis when compared to those that wore closed shoes outside the house 14(6.7%).

Presence of cracks on the walls of the house was a significant factor in occurrence of tungiasis [116(55.2%) [OR=19.46; 95% CI: 10.44-36.29; P=0.001]. Floor type was also a statistically significant factor. Respondents that lived in houses with earthen type of floor had significantly increased chance of jigger infestation 125(34.2%), [OR=7.52; 95% CI: 2.67-21.19; P<0.001] compared to cemented or wooden 4(6.5%).

Roofing type was also a statistically significant factor with those living in thatched houses having a higher risk of jigger infestation 47(48.0%), [OR=2.79; 95% CI: 1.75-4.45; P<0.001] compared to using iron sheet 82(24.8%).

Table 7: Relationship between environmental and hygiene factors with occurrence of Tungiasis

Factors	Jigger/Tunga		χ^2 value	*P value	*OR	95%CI	
	Infected, n (%)	Not infected, n (%)				Lower	Upper
Waste product disposal							
Yard	23(25.0%)	69(75.0%)	0.16	0.163	0.68	0.40	1.17
Back yard	27(28.1%)	69(71.9%)	0.39	0.394	0.80	0.47	1.34
Compost pit (Referent)	79(32.9%)	161(67.1%)			1		
Waste burning							
No	74(35.7%)	133(64.3%)	5.99	0.014	1.68	1.11	2.55
Yes (Referent)	55(224.9%)	166(75.1%)			1		
Wastes near the house							
Yes	67(59.3%)	46(40.7%)	61.97	<0.001	5.94	3.73	9.48
No (Referent)	62(19.7%)	253(80.3%)			1		
Availability of latrine							
No	32(39.5%)	49(60.5%)	4.16	0.043	1.68	1.02	2.78
Yes (Referent)	97(28.0%)	250(72.0%)			1		
Wearing shoes in the house							
Barefoot	85(60.3%)	56(39.7%)	20.61	<0.001	12.52	4.21	37.3
Slippers	40(16.0%)	210(84.0%)	0.66	0.417	1.57	0.53	4.68
Closed shoes (Referent)	4(10.8%)	33(89.2%)			1		
Wearing shoes outdoors							
Barefoot	64(59.8%)	43(40.2%)	79.33	<0.001	20.63	10.60	40.1
Slippers	51(45.1%)	62(54.9%)	52.72	<0.001	11.40	5.91	21.9
Closed shoes (Referent)	14(6.7%)	194(93.3%)			1		
Presence of cracks on the walls							
Yes	116(55.2%)	94(44.8%)	123.34	<0.001	19.46	10.44	36.3
No (Referent)	13(6.0%)	205(94.0%)			1		
Number of rooms							
1 room	53(38.1%)	86(61.9%)	0.95	0.330	1.64	0.61	4.46
2 rooms	56(27.9%)	145(72.1%)	0.03	0.953	1.03	0.384	2.76
3 rooms	14(21.2%)	52(78.8%)	0.55	0.558	0.72	0.24	2.18
4 rooms and above (Referent)	6(27.3%)	16(72.7%)			1		
Floor Construction material							
Earthen	125(34.2%)	241(65.8%)	19.32	<0.001	7.52	2.67	21.2
Cemented/tiled/wooden (Referent)	4(6.5%)	58(93.5%)			1		
Roofing type							
Grass	47(48.0%)	51(52.0%)	19.17	<0.001	2.79	1.75	4.45
Iron sheet (Referent)	82(24.8%)	248(75.2%)			1		
OR = Odds Ratio, CI= Confidence Interval, *Significant P value and OR Bolded							

Association between presence of domestic animals and occurrence of Tungiasis

Table 8 shows the relationship between ownership of domestic animals and occurrence of Tungiasis. There was no statistically significant association between prevalence of Tungiasis and ownership of chicken at the household level (P>0.05). However, the living place for chicken was significantly associated with jigger infestation. Tungiasis was significantly higher among respondents whose chicken lived in the main house 56(73.7%) and in free-range chicken 9(37.5%) than in respondents whose chicken lived in a poultry house 28(13.8%), {[OR=17.5; 95% CI: 9.16-33.45; P<0.001] and [OR=3.75; 95% CI: 1.50-9.39; P<0.001] respectively}. Occurrence of tungiasis was higher among respondents who had their domestic animals live in close proximity to their living premises102 (42.7%) than in those whose animals lived away from the living premises 26, (13.9%) [OR=4.61; 95% CI: 2.83-7.5; P<0.001]. Presence of rats in the compound increased the risk of infestation 108(40.9%) compared to living in compounds without rats 21(12.8%), [OR=4.71; 95% CI: 2.80-7.93; P<0.001].

Table 8: Relationship between presence of domestic animals and occurrence of Tungiasis

Domestic animals	Jigger/Tunga		χ^2 value	*P value	*OR	95%CI	
	Infected, n(%)	Not infected, n(%)				Lower	Upper
Chicken ownership							
Yes	93(30.7%)	210(69.3%)	0.15	0.698	1.10	0.69	1.73
No (Referent)	36(28.8%)	89(71.2%)			1		
Number of chicken present							
More than 5 chicken	32(26.9%)	87(73.1%)	1.33	0.248	0.74	0.45	1.23
1 to 5 chicken	61(33.2%)	123(66.8%)			1		
Living place for chicken							
Main house	56(73.7%)	20(26.3%)	74.96	<0.001	17.50	9.16	33.45
Free-range	9(37.5%)	15(62.5%)	7.97	0.005	3.75	1.50	9.39
Poultry house (Referent)	28(13.8%)	175(86.2%)			1		
Presence of dogs							
Yes	67(27.8%)	174(72.2%)	1.43	0.232	0.78	0.51	1.18
No (Referent)	62(33.2%)	125(66.8%)					
Number of dogs							
3-5 dogs	7(28.0%)	18(72.5%)	0.003	0.960	1.02	0.41	2.58
1-2 dogs	60(27.5%)	158(72.5%)			1		
Living place for dogs							
Free roaming	52(29.2%)	126(70.8%)	0.90	0.343	1.38	0.71	2.66
Kennel (Referent)	15(23.1%)	55(76.9%)			1		
Presence of rats							
Yes	108(40.9%)	156(59.1%)	34.21	<0.001	4.71	2.80	7.93
No (Referent)	21(12.8%)	143(87.2%)			1		
Domestic animals living near premises							
Yes	102(42.7%)	137(57.3%)	37.81	<0.001	4.61	2.83	7.50
No (Referent)	26(13.9%)	161(86.1%)			1		
OR = Odds Ratio, CI= Confidence Interval, *Significant P value and OR Bolded							

Multivariate analysis

Multiple regression analysis was performed in order to identify factors independently associated with occurrence of Tungiasis. Fifteen variables (15) with P value <0.15 during bivariate analysis were subjected to a multiple regression analysis. Upon fitting all these factors using binary logistic regression and by specifying *'backward conditional'* progressive stepwise method with removal at P<0.05, six (6) factors retained in the final model were established to be independently associated with tungiasis (Table 4.9).

Staying barefoot and wearing slippers outdoors significantly increased jigger infestation by 10 times [AOR=9.94; 95% CI: 4.18-23.61; P<0.001] and 6.45 times respectively [AOR=6.45; 95% CI: 2.78-14.98; P<0.001] compared to staying with closed shoes.

Respondents that had domestic animals live near their living premises were 7 times more likely to acquire tungiasis than those who did not live in close proximity to their domestic animals [AOR=6.58; 95% CI: 3.42-12.65; P<0.001]. Presence of rats in the compound also increased the risk of jigger infestation among the respondents by 2.18 times when compared to living in compounds without rats [AOR=2.18; 95% CI: 1.09-4.36; P=0.028]. The likelihood of jigger infestation among respondents who kept their chicken in the main house was 8 times higher than to those who kept their chicken in a poultry house [AOR=8; 95% CI: 2.74-23.33; P<0.001]. Similarly, jigger infestation was 7 times higher among respondents who reared free range chicken than in those who reared their chicken in a poultry house [AOR=6.59; 95% CI: 1.37-31.67; P<0.001].

Presence of waste products near the house was 4 times more likely to predispose respondents to jigger infestation [AOR=3.73; 95% CI: 2.01-6.91; P<0.001]

compared to living in a compound without waste products. Respondents living in houses with cracks on the walls were 7 times more likely to acquire Tungiasis when compared to respondents who lived in houses without cracks on the wall [AOR=6.92; 95% CI: 3.25-14.70; P<0.001].

Table 9: Factors associated with Tungiasis at multivariate analysis

Factors	AOR	95%CI		Chi square test
		Lower	Upper	P value
Wearing shoes outdoors				
Barefoot	9.94	4.18	23.61	<0.001
Slippers	6.45	2.78	14.98	<0.001
Closed shoes	1.00			
Wastes near the house				
Yes	3.73	2.01	6.91	<0.001
No	1.00			
Presence of cracks on the walls				
Yes	6.92	3.25	14.70	<0.001
No	1.00			
Living place for chicken				
Main house	8.00	2.74	23.33	<0.001
Free range	6.59	1.37	31.67	0.019
Poultry house	1.00			
Domestic animals living near premises				
Yes	6.58	3.42	12.65	<0.001
No	1.00			
Presence of rats				
Yes	2.18	1.09	4.36	0.028
No	1.00			

Health seeking behavior and practices towards Tungiasis

Most of the respondents and their household members determined that they were jigger infested by itching (90.7% and 86.7% respectively).Two methods of dealing with jigger infestation were reported i.e. removing and removing and application of products. Majority of the participants reported to use removal method. (14.5% (62) of those infested reported that they used needles to remove jiggers, 16.1% (69) used thorns while 0.2% (1) used a blade. Due to stigma associated with tungiasis, no respondent or household members visited a health facility for treatment.

DISCUSSION

The results of this cross-sectional study show that tungiasis is a problem of public health concern in the study area. This is similar to recent studies from Nigeria and Cameroon which indicated that it is a major public health problem in West Africa. [8] The level of education was generally low with majority of the respondents having acquired education up to primary level. Majority of the participants were married Christians who lived in semi permanent houses with earthen floors. Farming emerged to be the main economic activity practiced by majority of the household heads that participated in the study. Previous findings of tungiasis being a disease of the poor were further confirmed in this study where higher odds of infestation were observed in the participants whose household heads were unemployed compared to those whose care givers were employed. This may be attributed to affordability of some basic commodities including soap, water and insecticide regarded as protective factors in a Nigerian study. [9]

An overall point prevalence of 30.1% was established in this study. This is within the prevalence rate range of between 21% and 43% documented in a few similar studies done in Nigeria. [10-12] Distribution of infestation by gender was not statistically significant. However, similar to previous studies in a rural setting in Nigeria, [9] the proportion of male infested was slightly higher than female. This could probably be attributed to higher exposure as males spend more time outside (mostly barefooted) and different disease related behavior; that is, the female were observed to be more skilful in carrying out flea extraction for their friends and younger children. Itchiness, pain upon pressure and sleep disturbance were identified to be the main symptoms experienced by majority of those infested in the study area. Majority (70.5%) of those infested had moderate infestation. The young and the elderly were the most vulnerable age groups to tungiasis in

Kipkelion West Sub County and this similar to findings of other studies conducted in Nigeria, Brazil and others regions in Kenya. [9,2,13,14]

The importance of housing conditions for transmission of tungiasis has been described previous studies. In the Brazilian study, living in a house built on dune, living in a house made of palm products and having a floor of sand or clay inside the house were important risk factors for infestation in multivariate analysis. Similar to studies conducted in Nigeria and Murang'a the house type was not an independent factor associated with occurrence of tungiasis but was confounded by the type of floor inside the house and presence of cracks on walls. Earthen floor found in majority (85.5%) of the houses in Kipkelion West Sub County provides an ideal breeding environment for the jigger flea. Earlier studies have indicated house lighting to influence the hide places' for the jigger flea. This was confirmed in this study where majority of the households found to be infested used paraffin lamp. A source of water which has been reported in a previous study in Nigeria to have an indirect relationship with tungiasis was assessed in this study. [9] Most households (80.8%) used well, river or streams which were more than a kilometer from the households. This was assumed to influence their hygiene standards. Pit latrine (81.1%) was the major type of toilet used and 51.6% of the participants' used burning as the waste disposal method. Improving sanitation and waste collection discussed as a factor to reduce the incidence of tungiasis in a Nigerian study may also be applicable in the study area. [15]

Animal reservoirs of the jigger flea investigated in this study included chicken, dogs and pigs. Majority of the households visited had at least one of the mentioned animals. It is known that the animal reservoirs play an important role in transmission in endemic communities. Dogs, chicken, cats and rats have particularly been reported to be commonly infested. [15] Data from the study indicate that rats and chicken ($P < 0.001$) were the most significant animal reservoirs in Kipkelion West Sub County. This is unlike studies in Nigeria and Cameroon where pigs were emphasized to be the most important animal reservoirs. [9,16] Similar to a Brazilian study, [13] pigs did not play a role in transmission in Kipkelion West Sub County mainly because free roaming pigs were absent. Similar to the Nigerian and Murang'a studies but contrary to the Brazilian study dogs, ($P > 0.005$) were not identified to increase the prevalence in the study area. [9,2,14,15]

Use of closed shoes whenever the feet touch contaminated soil has been previously reported to prevent tungiasis in Brazil. [17] Its consistent use has also been reported to reduce infestation rate by half in Nigeria. [18] Similarly, lack of regular use of footwear emerged to be a very significant factor ($P<0.001$) associated with occurrence of tungiasis.

Efforts to determine knowledge on what should be done in case of jigger infestation revealed that communities suffering from tungiasis do not recognize it as an important health problem. This is similar to published data from north-east Brazil. [17] Despite severe disease being present among the residents of Kipkelion West Sub County, those infested do not seek heath care. With regard to action taken when infested, majority of respondents reported to either remove or remove and apply products. None of the respondents reported use of insecticides to fumigate the houses and to dust domestic animals which have been described as protective measures in the Nigerian and Brazilian studies. [15,17]

Other socioeconomic factors like level of education, roofing type and

availability of latrine in the compound indicated an indirect relationship in occurrence of tungiasis.

Although this is an observational study, the strength of association observed together with biological plausibility indicates a causal relationship even in the presence of unknown confounders.

CONCLUSION

The prevalence of tungiasis in the study area was 30.1%. Factors independently associated with occurrence of tungiasis in Kipkelion West Sub County included: chicken ownership, presence of rats in the compound, presence of cracks on walls of the residential houses, presence of waste products near the living premises, domestic animals living close to the residential houses and regular use of footwear. Due to stigma associated with the disease, none of those infested sought health care.

Control of tungiasis in the study area and other regions where the disease is endemic is only possible if a multi-disciplinary approach involving all stakeholders (i.e. the populace, community leaders, health professionals, non-governmental institutions and policy makers) is implemented.

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Competing Interests

The authors declare that they have no competing interests.

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