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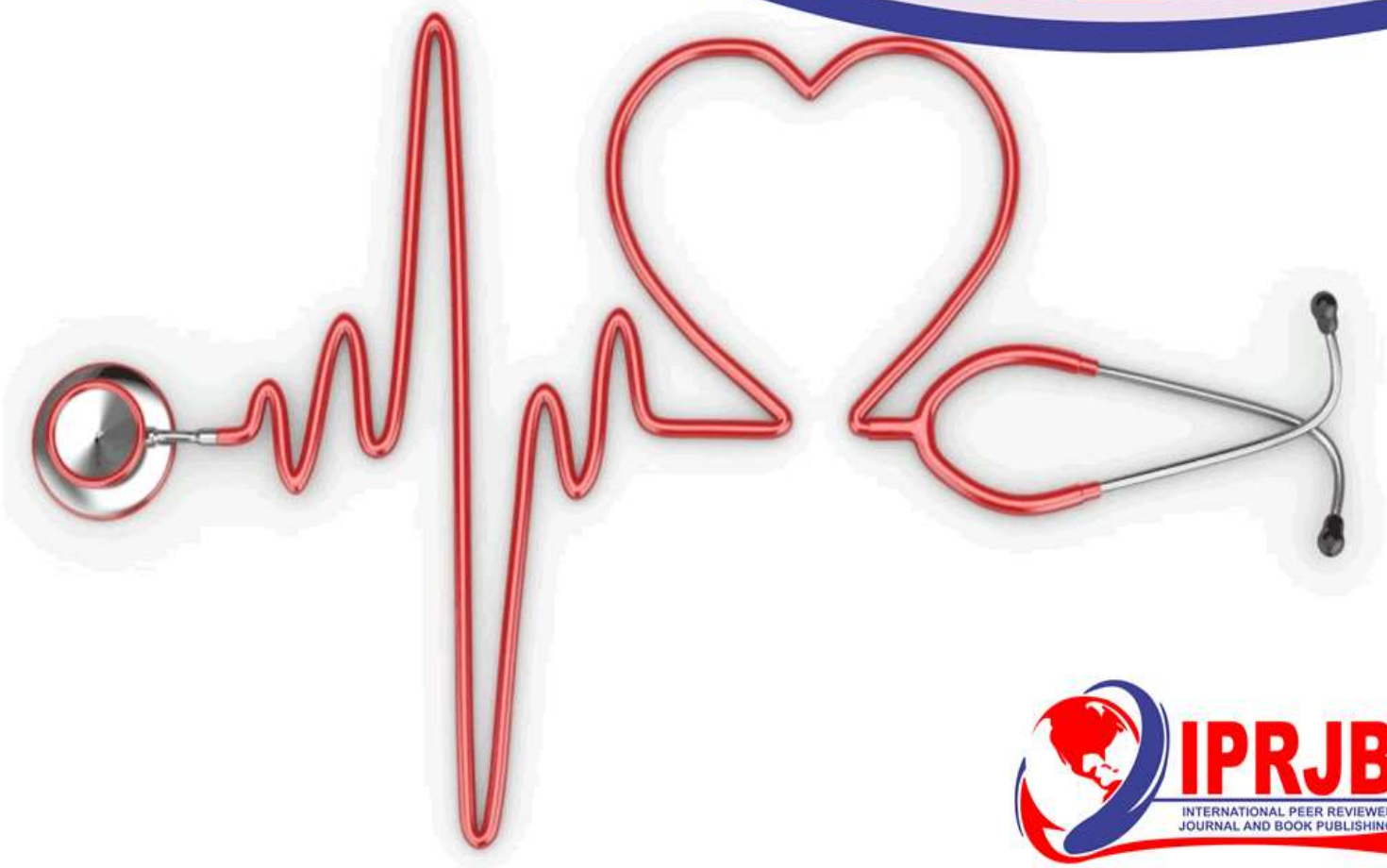
Jacob Mwangi Wangari, Dr. Simon Muriu (PhD) and Dr. Ezekiel Onyonka Mecha (PhD)



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Social Demographic Factors Influencing the Prevalence of High Tungiasis Infestation among Kilifi Residents, Kenya

[1*]Jacob Mwangi Wangari (Msc)
Department of health, Kilifi County

[2]Dr. Simon Muriu (PhD)
Department of Biological Sciences, Pwani University

[3]Dr. Ezekiel Onyonka Mecha (PhD)
Department of Biochemistry, University of Nairobi

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Abstract

Purpose: The aim of the study was to determine social demographic factors influencing the prevalence of high tungiasis infestation among Kilifi Residents, Kenya

Methodology: Cross sectional study design was used to carry out the study. Semi-structured questionnaires were used to collect quantitative data on the social demographic factors associated with high tungiasis infestation from 184 participants with tungiasis. Data was analyzed using R. Statistical software versions (R v3.4.4). Data was presented in frequency tables.

Findings: From the findings; living in mud walled house (OR 2.14; 95% CI: 1.3, 7.14; $p < 0.05$), schooling in earthen and dusty floor classrooms for school going children (OR 35.00; CI: 9.15,113.8; $p < 0.05$), living with domestic animals under one roof (OR 3.43; 95% CI: 1.03 ,12.81; $p < 0.05$) and jiggers mechanical extraction using thorns (OR 7.13, 95% CI: 1.76, 36.43; $p > 0.05$) were the most important independent risk factors for higher jigger infestation

Unique Contribution to Theory, Practice and Policy: The study recommends that enhanced efforts to further understand the infection and other routes of potential elimination would greatly consolidate government efforts for universal basic education in the country in line with the SDGs.

Keywords: *Social Demographic Factors, High Tungiasis Infestation, Influence*

JEL Codes: I15, O15, Q54

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INTRODUCTION

Tungiasis is a cutaneous parasitic infection mainly caused by penetration of the female sand flea, *Tunga penetrans* into the epidermis of the host (Eisele *et al.,* 2003). It is a zoonosis affecting humans and animals a like (Heukelbach *et al.,* 2001). Infections occurs when skin comes into contact with soil or floor where adult sand fleas have developed and it usually take place inside the house or in classrooms without solid floors (Pilger *et al.,* 2008). The young female sand flea burrows into the skin, toes, lateral rim of the foot and heel being a predilection sites (Eisele *et al.*, 2003). A burrowed female sand flea is fertilized by a male only after it has started to feed on blood (Nagy *et al.,* 2007). The flea's hindquarters remain in contact with air providing an avenue for breathing, defecating and egg expulsion. In 4-6 weeks the embedded sand flea undergoes different developmental stages, produces eggs and eventually dies *in situ*. Eggs expelled fall onto the ground which eventually hatch and develop to adult (Heukelbach *et al.,* 2004).

The Infection is usually accompanied by Itching and local irritation as the female fleas develop fully and increase their body volume by a factor of 2000 within two weeks (Eisele *et al.,* 2003). Through these itching, some lesion develops into which 99% of them occur at the feet. Other may occur in different parts of the body like fingers, heel, hands and if heavily infested on battocks (Thielecke *et al.*, 2013).

Tungiasis is more prevalent in resource-poor rural settings that are characterized with low levels of sanitations and dusty soil. A study conducted in Brazil by Winter *et al.,* (2009), majority of the participants associated the occurrence of *Tunga penetrans* with sand soil (72%) and (23%) mentioned walking barefoot as a reason for being affected by tungiasis. Twelve percent (12%) were convinced that there was kind of relationship between the occurrence of *Tunga penetrans* and the blossoming of cashew trees around September. Although there were no explanation how these two observations were linked, some persons assumed that cashew flowers and fruits fallen on the ground would attract reservoir animals (pigs and dogs), which in turn would spread *Tunga penetrans*. Tungiasis shows a highly characteristic pattern of seasonal variation with a peak in the middle of the dry season when cashew trees blossom (Heukelbach *et al.,* 2005*)*. Others believed that the off-host-stage of *Tunga penetrans* would propagate better if the soil was littered with decaying cashew fruits.

In a study that was done in Erekiti Western Nigeria, Ugbomoiko *et al.,* (2007) reported high prevalence rates (45.2%, n=557) of *Tunga penetrants* infestations being more prevalent among children of between 5 and 14 years with a decline among adults and an increase among the elderly. As in many resource-poor settings in Africa, it was common to find domesticated animals such as pigs, goats, dogs, cats and others that live in close proximity to their homes (Ruttoh *et al.,* 2012). This could be attributed to the lack of adequate land to shelter animals, fear of theft or cultural practices. Due to their domesticated nature and interactions with people, including sharing of common resting places, these animals serve to spread the jigger flea and ultimately the tungiasis disease (Ugbomoiko *et al.,* 2007).

Wafula *et al.,* (2016) did a study to determine the tungiasis prevalence in Mayuge district, Eastern Uganda**.** In their study they found that living in a mud dusty walled house with earthen, rough, dusty, dirty and cracked floors creates a conducive environment for survival of sand flea hence increase the prevalence of tungiasis. Littered and dusty compounds also leads to increase of tungiasis infestation (Pilger *et al.,* 2008). The compounds attract stray dogs, cats, and

rodents which are important reservoirs for sand flea. Organic material contaminating the soil may provide a sheltered environment for the development of the free-living stages (larvae) of a sand flea (Wafula *et al.*, 2016).

The overall prevalence of tungiasis in Kandara Muranga, central Kenya was found to be at 40% among children aged 5-14 years (Kimani *et al.*, 2012). The young children were more jigger infested by the fact that they have limited knowledge about the parasites and usually play in dirty, dusty environment where the parasite thrives. Parents and children suffering from severe tungiasis were terrified of the removal process using sharp instruments. Some the children suffering from Tungiasis chose to have the embedded female *T.penetrans* than bear the pain of the removal process (Kimani *et al.*, 2012). Poor hygiene and sanitation were found to increase in tungiasis level of infestation in children who were younger aged below 11years (Ngunjiri *et al.*, 2015).

In Murang'a Kenya, Zablon, (2017) in his study indicated lack of enough water for basic hygiene standards as a major risk factor to tungiasis. Most households in the area (71.9%) were fetching water for domestic use from rivers some of which were far from their homestead making it difficult to ensure adequate supply of water for personal hygiene. Dirty feet and clothes provide a conducive environment for *Tunga penetrans* to survive and hide (Ehrenberg & Ault, 2005).

In Gitugi location in Muranga county, Jigger infestation was associated with witchcraft. This referred to the manipulation by malicious individuals of powers inherent in spiritual entities and substances, to cause harm to others. The motivation behind witchcraft in their own situations was typically jealousy. People with a grudge could act in mysterious ways with the intent to cause harm to their enemies. This would take the form of *T. penetrans* infestation so severe that it would result in prolonged suffering and sometimes death (Kimotho *et al.*, 2015).

Statement of the Problem

Tungiasis is a neglected tropical disease that is more prevalent in resource-poor rural and urban communities, where animal reservoirs are present and people live in poverty (Chadee, 1998). In 2010, it was estimated (AHADI Kenya, 2010) that the jigger flea had infected over 2.6 million Kenyans with school going children been unable to participate in learning activities at the same level as their un-infected peers. Their inabilities become a source of ridicule and scorn by their peers, both in and out of school (Kimani *et al.*, 2012). High intensity of tungiasis in adults hampers their working capacity due to reduced mobility which confines them to a non-productive life and poverty. This study therefore was carried out to understand the social demographic factors influencing high prevalence of tungiasis in Kilifi in a view to addressing the gap that exist.

METHODOLOGY

The cross sectional study focused on the residents of the Ganze and Kilifi North sub counties who were having tungiasis lesions.. The data was collected from 184 participants both in households and primary schools where there were tungiasis reported cases. Data was collected from jigger infested individuals only. Data collection involved; physical examination of participants, interview of participants (parents/guardians/ head teacher for children) and visual examination of the houses in which the respondents were living in and school environments for the pupils. A semi-structured questionnaires was adopted. Data was analyzed using R. Statistical software versions (R v3.4.4). Data was presented in frequency tables.

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RESULTS

Social Demographic Information

A total of 184 questionnaires were administered to participants with tungiasis. This consisted of (n = 108, 58.7%) from four villages in Ganze sub county which is in rural area of Kilifi County while the rest (n = 76, 41.3%) from four villages in Kilifi North which is a peri – urban area. From Ganze sub county, Lwandani village contributed to 35.2% (n = 38), Mulungu wa mawe (n = 18, 16.7%), Kolongoni (n = 33, 30.1%) and Ziwa la Wimbi (n = 19, 17.6%). From Kilifi North, Konjora village contributed to (n = 28, 36.8%), Tezo had (n =21, 27.6%), Shingila had (n = 16, 21.1%) while Kiwandani (n =11, 14.5%).

Results of social demographic characteristics associated with tungiasis are shown in Table 1 below. Majority of the participants, (n=113, 61.4%) were male. In general, higher number of participants reported living in mud walled houses (n = 131, 71.2%), regularly walked bare footed (n = 168, 91.3%) and living with domestic animals like chicken, duck, goats and calves under the same roof (n =109, 59.3%). The infestation was found more in children of between 1- 10 years as compared to other age groups, (n=115, 62.5%). Majority reported attending classes in schools with earthen and dusty floors (n =109, 73.6%) and frequently extracted jiggers using unsterile sharp objects or thorns (n =99, 53.8%). Treatment of lesions with local trees extract is also practiced by most of the participants (n=103, 56 %).

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Table 1: Descriptive Analysis of the Social Demographic Characteristics Associated With Tungiasis

Factor	Kilifi North		Ganze		Overall	
	Number	%	Number	%	Number	%
Gender (n = 184)						
Male	46	36.3%	72	63.7%	113	61.4%
Female	35	49.2%	36	50.7%	71	38.6%
Age of the respondents (n = 184)						
1-10 years	47	40.9%	68	59.1%	115	62.5%
11-20 years	19	42.2%	26	57.7%	45	24.5%
21-30 years	1	20.0%	4	80.0%	5	2.7%
31– 40 years	1	50.0%	1	50.0%	2	1.1%
> 40 years	8	47.1%	9	52.9%	17	9.2%
Type of the house wall (n = 184)						
Mud	43	28.9%	88	67.2%	131	71.2%
Wooden	30	60.4%	21	39.6%	51	27.6%
Iron sheet	2	100%	0	0	2	1.2%
Putting on shoes (n = 184)						
Yes	9	59.2%	7	40.8%	16	8.7%
No	67	39.8%	101	60.2%	168	91.3%
Jigger treatment using local trees extract (n = 184)						
Treat with local trees extract	43	53.1%	38	46.9%	81	44.0%
Do not treat with local tree extract	33	32.0%	70	68.0%	103	56.0%
Jigger extraction method (n = 184)						
Use sterile Needles	15	57.6%	11	42.3%	26	14.1%
Use thorns and sharp objects	54	40.3%	80	59.7%	134	72.8%
Do not extract	7	29.2%	17	70.8%	24	13.0%
Participants living with animals under one roof (n = 184)						
Yes	28	25.7%	81	74.3%	109	59.3%
No	48	64.0%	27	36.0%	75	40.7%
Distance to water source (n = 184)						
3 Kms	39	100%	0	0	39	21.2%
4 -5 Kms	37	39.4%	57	60.6%	94	51.1%
6 Kms and above	0	0	51	100%	51	27.7%
Nature of school classroom floors (n =148)						
Earthen	34	29.3%	82	70.7%	116	78.4%
Cemented	23	71.8%	9	28.1%	32	21.6%

Bivariate Comparisons of Social Demographic Factors With Jigger Infestation Rate

Five variables namely; types of houses walls the respondents were living in, methods of extracting jiggers, living with domestic animals under one roof, nature of the classrooms floor and jiggers treatment with local tree extract (commonly Neem leaves extracts) were found to be statistically significant in association to the high level of tungiasis ($p > 0.05$) as shown in Table 2. The respondents who were living with animals in their houses were over 4 folds more likely to have high jigger's infestation than those who did not (OR 4.37; 95% CI: 2.05, 9.69; $p < 0.05$). Those living in a mud wall house (OR 3.52; 95% CI: 1.20, 10.89, $p < 0.05$) were over 3 folds more likely to have higher jigger infestation levels compared to those who resided in wooden walled houses. Occurrence of tungiasis was over 43 folds significantly higher among those who reported schooling in earthen floored classrooms (OR 43.29, 95% CI: 16.79, 128.5; $p < 0.05$). Tungiasis was more than10 times higher among those extracting jiggers with

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unsterile sharpened wood or thorns (OR 10.65; 95% CI: 4.62, 25.79; $p < 0.05$). Use of local trees extract (OR 0.21; 95% CI: 0.10, 0.81; $p < 0.05$) was found to significantly reduce jigger infestation rate by more than half. There was no association between level of tungiasis infestation with gender ($p > 0.05$), site of infestation on the body ($p > 0.05$) and walking with bare feet ($p > 0.05$).

Table 2: Bivariate Regression of Social Demographic Factors Associated With Jigger Infestation Rate

Factor	Examined (n= 184)	High infested (n= 138)	Low infested (n=46)	OR (95% confidence interval	P value
Gender					
Female	71	51	20	Reference	
Male	113	87	26	1.31 (0.66- 2.58)	0.43
Age					
1-10 years	115	88	27	Reference	
11-20 years	45	31	14	0.67 (0.32 – 1.48)	0.32
21 -40 years	7	6	1	1.84 (0.29 – 35.56)	0.57
>40 years	17	13	4	0.99 (0.32 -3.76)	0.96
Type of the House walls					
Wooden/ iron sheet	53	35	18	Reference	
Mud	131	103	28	3.52(1.20-10.89)	< 0.05
Body Site					
Hands	12	10	2	Reference	
Leg	172	128	44	0.58(0.09 -2.32)	0.50
Walking bare footed					
No	168	128	40	Reference	
Yes	16	10	6	0.52(0.18-1.61)	0.23
Jiggers treatment with local trees extract (neem tree leaves extracts)					
No	103	90	13	Reference	
Yes	81	48	33	0.21 (0.1 - 0.81)	< 0.05
Jiggers Extraction methods					
Sterile Needle	25	10	14	Reference	
Thorns	134	115	19	10.65(4.62- 25.79)	< 0.04
Do not extract	24	13	11	1.65 (0.97- 2.13)	0.24
Living with domestic animal under one roof					
No	75	44	31	Reference	
Yes	109	94	15	4.37(2.05 -9.69)	< 0.05
Distance of water source					
>3 Kms	145	106	39	Reference	
≤3 Kms	39	32	7	1.68 (0.92 - 8.33)	2.79
Nature of school's classrooms floor					
Cemented	32	12	20	Reference	
Earthen and Dusty	116	98	18	43.79 (16.79 -128.59)	< 0.05

Multivariate Comparisons of Social Demographic Factors With High Tungiasis Infestation

In the multivariate logistic regression analysis, living in mud walled house (OR 2.14; 95% CI: 1.3, 7.14; $p < 0.05$), schooling in earthen and dusty floor classrooms for school going children (OR 35.00; CI: 9.15,113.8; $p < 0.05$), living with domestic animals under one roof (OR 3.43; 95% CI: 1.03 ,12.81; $p < 0.05$) and jiggers mechanical extraction using thorns (OR 7.13, 95% CI: 1.76, 36.43; $p > 0.05$) were the most important independent risk factors for higher jigger infestation as demonstrated in Table 3 below. However treatment of jiggers with local trees

extract (OR 0.64; 95% CI: 0.19 – 2.15; $p < 0.47$) was not an independent social demographic factors.

Table 3: Multivariate Regression of Factors Associated With High Jigger Infestation

Factor	OR (95% confidence interval)	*P* - value
Gender		
Male	1.51 (0.47 - 5.12)	0.49
Type of the House walls		
Mud	2.14 (1.30 - 7.14)	< 0.05
Walking bare footed		
Yes	4.43 (0.45 - 56.59)	0.22
Jiggers treatment with local trees extract		
Yes	0.64 (0.19 - 2.15)	0.47
Jiggers Extraction methods		
Thorns	7.31(1.76 – 36.13)	0.01
Living with domestic animal under one roof		
Yes	3.43(1.03 - 12.81)	< 0.05
Nature of school's classrooms floor		
Earthen and Dusty	35.00 (9.15 – 113.8)	< 0.05

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

Discussion

School going children were the most affected by tungiasis in our study. This is in agreement with a study, which was conducted in Western Nigeria where majority of those affected by tungiasis were children aged 5 to 14 years old and the elderly (Ugbomoiko *et al.,* 2007). Children may be highly exposed in schools where classroom floors are earthen and dusty hence giving room for jiggers to multiply and ample time to invade their limbs (Mwangi, 2015). The finding of this study shows statistical significance in children learning in earthen dusty floored classroom presenting with high infestation. *Tunga penetrans* usually develops in dry, cracked and sandy soil further supporting our observations. The infestation leads to these children being unable to participate in learning activities to the same level as their un-infected peers. Severe itching, pain, difficulty in walking to school and stigma makes it hard for pupils to concentrate in class, or remain in school which leads to high rate of school dropout and poor performance (Muehlen *et al.,* 2006). Despite this poor performance in school being associated with reduced economic opportunities in later life, lack of proper medical care sometimes results in irreversible limb damage leading to increased dependency in the future and exposing the affected individuals to more health hazards. Enhanced efforts to further understand the infection and other routes of potential elimination would greatly consolidate government efforts for universal basic education in the country in line with the SDGs.

Living with domestic animal like poultry, calves, goats, sheep and cats under one roof and living in mud walled houses which are common in our setting predisposes hosts to high jigger infestation, (Feldmeier *et al.,* 2004). Both of the two factors were statistically significant in participants presenting with a high level of jigger infestation. This could be attributed to domestic animals acting as a reservoir host of jigger fleas that breed in cracks on walls and

dust. Locally available neem trees leaves extract can also be utilized to build separate animal shelters some few meters away from the respondent's premises.

Extracting jiggers with unsterile thorns and sharpened wooden sticks was the major contributing factor to both high tungiasis infestation and bacterial super-infection. The presence of bacterial super infection secondary to tungiasis may lead to have septic lesions that are easily penetrated by another *Tunga penetrans*. Such unsterile extraction also exposes victims to the risk of transmission of diseases like Hepatitis B, C and even HIV (Thielecke *et al.*, 2013). We suspect participants were using thorns as a cheap and available method probably because they are not aware of the associated risk factors. Long distances (> 7kms) to the hospital (especially in Ganze), lack of resources and stigma could be some reasons why most of the respondents do not seek hospital care where they could have educated and enlightened on the risk factors to tungiasis. The Public Health Department should embrace community outreaches and discourage the use of unsterile thorns and sharp wooden sticks and encourage hygiene at individual and environmental level.

Conclusion

The study concludes that schooling in earthen and dusty classrooms is the major contributing factor to tungiasis in children living in Kilifi, coastal Kenya. Other factors associated with tungiasis rate of jigger infestation are, living with domestic animal under one roof and living in mud walled and dusty floored houses. Jigger extraction using thorns also leads to high jigger infestation.

Recommendations

1. Personal hygiene should also be encouraged and the residents should be discouraged to stay with the domestic animals under one roof and also use of thorn in extracting jiggers.
2. Use of local trees extract like Neem tree (leaves extracts) should be encouraged to the community in an effort of preventing and treatment of tungiasis
3. A study should be done in an effort to see whether use of local available material like cow dung to smear their living house or school walls and floors in order to minimize dust and cracks in the house should can be an effective measure in preventing tungiasis.

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