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PREVALENCE AND FACTORS ASSOCIATED WITH THE MANAGEMENT OF TUNGIASIS IN IKOLOMANI SUB-COUNTY, KAKAMEGA COUNTY, WESTERN KENYA
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ABSTRACT

***Background*: Tungiasis is a neglected tropical disease caused by skin penetration by female jigger fleas, predominantly *Tunga penetrans*, most commonly in resource-limited settings with sub-optimal basic hygiene standards, mainly in developing countries.**

***Objective*: We investigated the factors associated with tungiasis management in Ikolomani Sub County, Kakamega County in Western Kenya.**

***Design*: Descriptive study using mixed-methods approach, involving clinical observation, questionnaire, and environmental observation.**

***Setting*: Ikolomani Sub-County, Kakamega County, western Kenya**

Participants: Tungiasis patients identified at community.

***Outcome measures*: Quantitative data underwent descriptive and inferential analysis ($\alpha = 0.05$) using SPSS v.23, qualitative data was analyzed thematically.**

***Results*: Overall tungiasis prevalence was 65% (95% CI: 60–70%), Idakho South and Idakho North recording the highest prevalence. Toes and soles were the most common sites of infestation. Only 91(34.5%) respondents sought medical treatment. Thorns (13.9%) and hydrogen peroxide (15.2%) were the common methods for jigger extraction. Residents from Idakho Central (aOR 0.44, 95%CI (0.23-0.83)) and Idakho East (aOR 0.43, 95%CI (0.22-0.85)) were less likely to suffer from tungiasis than those from Idakho North. Those with previous tungiasis were 7.24 times (aOR 7.24, CI (4.54-13.9)) more likely to be infested. Good/ hospitable healthcare staff was the major reason for choice of treatment. Sleeping on the floor was the main cause of tungiasis and its manifestation presents as a painful**

swelling. The major intervention of tungiasis was to remove them as mentioned by the participants. Spraying of animals was the preventive measure for Tungiasis.
***Conclusion*: Residence and previous jigger infestation were independently associated with tungiasis infestation. Stigma, discrimination, and difficulty wearing shoes were some of the major challenges faced by tungiasis patients.**
***Recommendation*: There is need for enhanced intervention and health education in Ikolomani Sub County community on risk factors and management of tungiasis.**

INTRODUCTION

Tungiasis (sand flea disease), caused by skin penetration by the female flea, *Tunga penetrans* or, less commonly, *Tunga trimamillata*[1,2], is one of the neglected tropical diseases (NTDs), and is mainly prevalent in the tropics, especially in South America, the Caribbean, and sub-Saharan Africa[3]. It predominantly affects remote communities living in resource-poor areas, both in urban and rural settings [4-6]. In endemic communities, the presence of dogs around the home and proximity to animal parks have been associated with an increased risk for tungiasis[6-8].

Despite efforts by different governments and entities, tungiasis control remains without a strategic roadmap [9]. In vast areas of Africa, South America, and the Caribbean, human tungiasis has been reported as a considerable health problem, often requiring operative, safe, and simple treatment [5,10,11]. In high-risk individuals living in extremely stressful conditions, tungiasis has caused severe disease and deformation[1,12-14].

Various common factors that increase human vulnerability to tungiasis have been observed in high-risk communities, including poverty, poor housing and inadequate healthcare, having domestic animals, nearness to game reserves or parks, and lack of footwear, which enhance potential for transmission, high parasite burden on infested persons[1,4,7,15-17].

Tungiasis afflicts over 2.6 million in Kenya [2,14], the most vulnerable being children, who experience different effects[18-20]. In Kilifi, coastal Kenya, high tungiasis prevalence of 48% has been reported, with children aged below 15 years being predominantly affected, and boys being twice more likely than girls to be infected[15]. In Idakho South in Kakamega, a 45.2% tungiasis prevalence was reported, peaking among those aged 5-14 years[21].

This study therefore sought to establish the prevalence of tungiasis, assess the existing management practices, and identify the factors associated with tungiasis in Ikolomani Sub-county.

Study Objectives

This study determined the prevalence of tungiasis, associated factors, and management practices in Ikolomani Sub County, Kakamega County, Western Kenya

METHODOLOGY

Study setting

This cross-sectional study obtained data from 30 tungiasis patients identified by Community Health Volunteers (CHVs) from each of 4 administrative wards of Ikolomani Sub-county, who were visited for clinical examination and environmental assessment. For each, the household, homestead, or neighboring homesteads were visited to identify six to seven tungiasis patients, until 381 patients were seen.

Data collection

A semi-structured questionnaire was used to collect data from the community, and

homestead and classroom floors were examined for both the presence and suitability for flea habitation using a checklist. Participants were examined for tungiasis related morbidities and pathologies, and the location, and number of lesions identified were noted. Infestation was classified as mild (<5 lesions), moderate (6–30 lesions), or heavy (>30 lesions) as per Muehlen *et al.* [22].

Data analysis

Descriptive statistics was used to describe prevalence and management practices for tungiasis. Using SPSS ver.23, frequency counts were compared using the Pearson Chi-square test. Bivariate logistic regression was used to identify factors associated with tungiasis. Odds ratios (COR and aOR) were used to test for association (P<0.05). Qualitative data underwent thematic analysis whereby causes, prevention and interventions were explored.

Ethical issues

Ethical approval was sought from Jaramogi Oginga Odinga University of Science and Technology. (JOOUST), research permit from the National Council of Science, Technology and Innovation (NACOSTI/P/22/18106), and permission from the Ministry of Health, Kakamega County, and Chiefs of the 4 wards was obtained. Participants provided a written informed consent, and confidentiality was ensured.

RESULTS

Prevalence of tungiasis

A total of 381 respondents participated in this study, where tungiasis prevalence (65%; 95%CI: 60–70%) varied across the wards, with Idakho South (80%) and North (74%) recording the highest prevalence (Table 1).

Table 1

Prevalence of Tungiasis among residents of Ikolomani Sub County

Residence	**Examined, n (%)**	**Positive Cases**	**Prevalence, n(%)**	**95% CI**	
				Lower	Upper
Idakho North	94(24.7)	70	74	64.0	82.0
Idakho South	70(18.4)	56	80	68.0	88.6
Idakho Central	120(31.5)	70	58	48.0	67.2
Idakho East	97(25.5)	53	54	44.0	64.7
Total	381	249	65	60.0	70.0

This study found that two sites (*toes*, and, *toes and soles*) were the most infested (25, 42.4%) each, followed by infestation of toes, soles and fingers, 4(6.8%) as shown on Table 2.

Table 2

Severity and degree of infestation

Site of infestation	Total observed, n(%)	Mild, n(%)	Moderate, n(%)	Severe, n(%)
Toes	25(42.4)	24(96.0)	1(4.0)	0
Toes and soles	25(42.4)	10(40)	15(60)	0
Toes and fingers	3(5.1)	0	3(100)	0
Toes, soles and fingers	4(6.8)	0	1(25)	3(75)
Toes, soles, fingers, elbow	1(1.7)	0	0	1(100)
Soles only	1(1.7)	1(100)	0	0

Key: Mild (< 5 lesions), moderate (6-30 lesions), severe (> 30 lesions)

Of the 381-study participated, 253 (66.4%) had previous tungiasis, and 208(83.5%) respondents with current infestation had been infested by jiggers before. Having a current infestation was significantly associated with a previous infestation (P<0.0001).

From observation of selected 100 households, 59 individuals said they had jiggers, although only 33(56%) had jiggers detected on examination. Floor type was significantly associated with jigger infestation (P<0.0001), whereas means of communication, house type, source of water, and wearing closed shoes were not associated with jigger infestation (Table 3).

Table 3

Observation checklist of selected households

Factor		Total(N) 100	Infested 41(41%) 59(59%)		P value
			No (%)	Yes (%)	
Floor Type	Earthen	48(48)	9(18.8)	39(81.3)	0.0001
	Suspended	6(6)	3(50)	3(50)	
	Cemented	46(46)	29(63)	17(37)	
Means of communication	Mobile phone	35(42.2)	10(28.6)	25(71.4)	0.167
	Radio	15(18.1)	6(40)	9(40)	
	Television	9(10.8)	2(22.2)	7(77.8)	
	Chief's baraza	12(14.5)	7(58.3)	5(41.7)	
	Health talk	12(14.5)	7(58.3)	5(41.7)	
Closed Shoe	worn, good	38(38)	15(39.5)	23(60.5)	0.33
	worn, torn, old	21(21)	12(57.1)	9(42.9)	
	not worn, only slippers	26(26)	8(30.8)	18(69.2)	
	Not worn	15(15)	6(40)	9(60)	
House type	Mud	43(43)	15(34.9)	28(65.1)	0.467
	Block/brick	44(44)	21(47.7)	23(52.3)	
	Timber	13(13)	5(28.5)	8(61.5)	
Means of transport	Walking	51(51)	21(41.2)	30(58.8)	0.978
	Bicycle	18(18)	7(38.9)	11(61.1)	

	Public transport	31(31)	13(41.9)	18(58.1)	
Source of water	River/stream	34(34)	15(44.1)	19(55.9)	0.712
	Well	19(19)	6(31.6)	13(68.4)	
	Tap	9(9)	3(33.3)	6(66.7)	
	Pond	17(17)	9(52.9)	8(47.1)	
	Rain	21(21)	8(38.1)	13(61.9)	

Health management practices for tungiasis

Of the 295 who had ever been infested, 254(86.1%) acknowledged seeking treatment; 91(34.5%) were treated in the hospital while 145(54.9%) at home. Up to 230(92%) said their preferred treatment worked. To reach a health facility for treatment, 123(41.7%) participants walked, while 49(16.6%) used public transport. On preference of a type of treatment, 82(30.6%) participants mentioned proximity of services, while 102(38.5%) cited good or hospitable healthcare staff as their reasons. Other reasons given included good services (48, 17.9%), having been advised (12, 4.5%), were treated with respect (12, 4.5%), and got professional treatment (12, 4.5%). On why they thought their preferred treatment worked, 109(38.9%) stated that they recovered well while 60(21.4%) said treatment was done once. Another 57(20.4%) reported the pain ended, as 54(19.3%) affirmed that the pain ended, and wounds healed following treatment.

Sleeping on the floor, sharing rooms with infected people, walking barefoot, and contact with animals were the most common causes of tungiasis mentioned by the respondents as supported by their sentiments, although some also held incorrect beliefs like drinking water having jigger fleas:

"Sleeping on the floor" (23-year-old female, Idakho North)

"Sharing room with infected people" (37-year-old male Idakho Central)

"Contact with animals" (40-year-old male, Idakho South)

"Being in a place with dusty ground without shoes" (45-year-old male Idakho North)

"Drinking water with jigger flea" (40-year-old female, Idakho East)

On tungiasis manifestation, 167(43.7%) respondents cited painful swelling, 86(22.5%) foot irritation, 56(14.7%) difficulty walking, 19(5%) total inability to walk, 28(7.3%) whitish painful swelling, 25(6.5%) painful wounds on feet, soles, or fingers, and 1(0.3%) itching.

Up to 147(38.5%) respondents stated that those with jiggers should be helped to remove them, while 113(29.6%) felt they should be taken to hospital, 32(8.4%) believed they should be given some herbal remedies, 21(5.5%) wanted them well fed, while 69(18.1%) felt nothing should be done to them.

Proximity to the hospital and proper treatment at the hospital were the reasons given for those who felt the infested should be taken to the hospital, while the others preferred they be treated at home, or not attended to, as reported below from the different wards:

"Take them to hospital, there is proper treatment given" (33-year-old female, Idakho North"

"*Take to hospital, hospital is nearby"* (26-year-old female, Idakho Central)

"Help them remove the jiggers, this is how we grew up doing" (46-year-old female, Idakho East)

"Give some herbs, this is how we grew up doing it" (49-year-old female, Idakho South)

"Nothing should be done to them, they can handle it" (34-year-old female, Idakho Central)

On tungiasis prevention measures, 101(26.5%) respondents mentioned spraying animals, 77(20.2%) insecticide use, 51(13.4%) smearing/cementing floors, 42(11%) wearing

shoes, 35(9.2%) personal hygiene, and *others* (75, 19.7%), including avoiding contact with infested people. Thorns (53, 13.9%) and hydrogen peroxide (58, 15.2%) were the most commonly used approaches to extract jiggers (Figure 1).

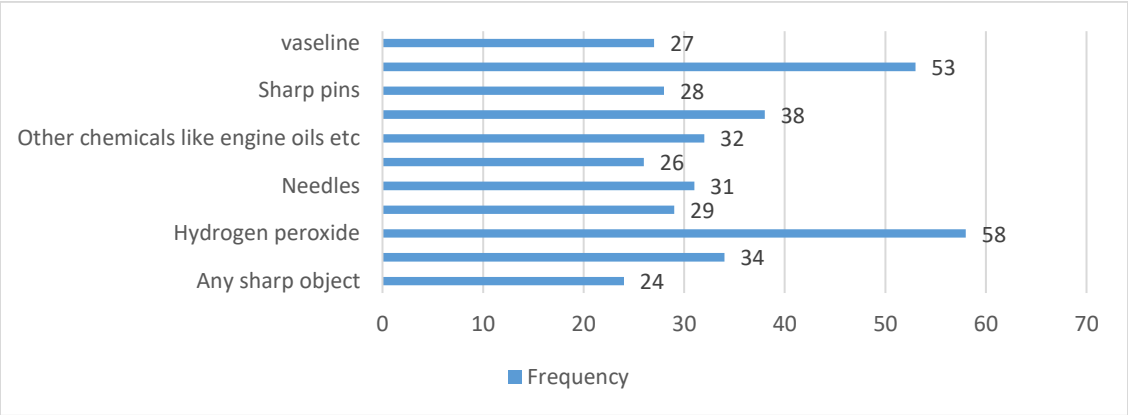

Figure 1: Methods of tungiasis extraction

Discrimination (103, 27%), stigma (139, 36.5%), and difficulty wearing shoes (73, 19.2%) were mentioned as some of the major challenges for tungiasis patients. Others were school absenteeism (47, 12.3%), use of crude home remedies (13, 3.1%) and lack of prompt treatment at home (7, 1.8%).

Factors associated with Tungiasis

Table 4 shows respondent residence, previous jigger infestation, and waiting time for service at the health facility were significantly associated with jigger infestation ($p<0.05$). The residents from Idakho Central (OR 0.48, 95%CI (0.26-0.86)) and Idakho East (OR 0.41, 95%CI (0.22-0.76)) were less likely to suffer from tungiasis compared to Idakho North. However, age, gender, marital status, monthly income, type of house, and number of daily occupants was not associated with tungiasis.

Table 4

Bivariate analysis of factors associated with tungiasis

Factors		**Total Examined**	**% Positive**	**OR (95% CI)**	**P Value**
Residence	Idakho North	94	74.5	Reference	
	Idakho South	70	80	1.371(0.64-2.89)	0.407
	Idakho Central	120	58.3	0.48(0.26-0.86)	0.015
	Idakho East	97	54.6	0.412(0.22-0.76)	0.005
Duration lived (years)	< 1	81	65.40	Reference	
	1-5	113	60.20	0.79(0.44-1.44)	0.457
	> 5	187	68.40	1.14(0.65-1.99)	0.628
Age-Category (years)	18-24	20	60	Reference	
	25-34	98	58.2	0.92(0.34-2.47)	0.879
	35-44	142	73.2	1.82(0.69-4.80)	0.224
	45-54	79	62	1.08(0.39-2.96)	0.868

	55-64	33	63.6	1.16(0.37-3.65)	0.791
	≥ 65	9	66.7	1.33(0.25-6.93)	0.732
Infested before	No	128	33.6	Reference	
	Yes	253	83.5	9.05(5.92-15.85)	0.0001
Gender	Female	245	64.5	Reference	
	Male	136	66.9	1.11(0.71-1.73)	0.634
Marital Status	Married	265	67.5	Reference	
	Widowed	55	61.8	0.77(0.42-1.41)	0.413
	Divorced	13	76.9	1.60(0.42-5.96)	0.483
	Single	48	54.2	0.56(0.30-1.05)	0.075
Education level	None	5	40	Reference	
	Primary	255	66.3	2.94(0.48-17.97)	0.241
	Secondary	86	64	2.66(0.42-16.79)	0.298
	Post-Secondary	35	65.7	2.87(0.42-19.62)	0.281
Monthly income Kenyan Shillings (KSh)	< 5000	323	65.9	Reference	
	50001-10000	9	88.9	4.13(0.51-33.45)	0.184
	10001-20000	42	54.8	0.62(0.32-1.19)	0.156
	> 40000	4	50	0.51(0.07-3.71)	0.512
Type of house	Temporary	46	65.2	Reference	
	Semi-permanent	224	70.5	1.27(0.65-2.49)	0.476
	Permanent	110	55.5	0.66(0.32-1.35)	0.261
House cleaning frequency	Daily	257	66.5	Reference	
	3-5 times/week	101	61.4	0.79(0.49-1.28)	0.358
	Once/week	14	71.4	1.25(0.38-4.12)	0.706
	Occasionally	9	66.7	1(0.24-4.11)	0.994
Daily house occupancy	0-2	100	71	Reference	
	3-5	230	64.8	0.75(0.45-1.25)	0.272
	6+	48	60.4	0.62(0.30-1.28)	0.2
Duration to health facility (minutes)	5-10	72	61.1	Reference	
	20-45	255	66.7	1.27(0.74-2.18)1	0.382
	About 60	54	64.8	1.17(0.56-2.43)	0.671
Duration served (minutes)	<10	125	56	Reference	
	15-45	200	68.5	1.7(1.07-2.71)	0.023
	About 60	37	81.1	3.36(1.37-8.24)	0.008

Multivariate analysis confirmed that respondent residence and previous jigger infestation were associated with current tungiasis. Residents from Idakho Central (aOR 0.44, 95% CI (0.23-0.83)) and Idakho East (aOR 0.43, 95% CI (0.22-0.85)) were less likely to suffer from tungiasis compared to residents from Idakho North. Those with previous jigger infestation were 7.24 times (aOR 7.24,95% CI (4.54-13.9)) more likely to be infested by jiggers compared to those who had no previous infestation (Table 5).

Table 5
Multivariate analysis of potential risk factors of tungiasis

Factors		Total Examined	% Positive	a OR (95% CI)	P Value
Residence	Idakho North	94	74.5	Reference	
	Idakho South	70	80	1.49(0.62-3.55)	0.361
	Idakho Central	120	58.3	0.44(0.23-0.83)	0.012
	Idakho East	97	54.6	0.43(0.22-0.85)	0.015
Duration served (minutes)	<10	125	56	Reference	
	15-45	200	68.5	1.6(0.98-2.62)	0.057
	About 60	37	81.1	1.56(0.57-4.27)	0.384
Infested before	No	128	33.6	Reference	
	Yes	253	83.5	7.24(4.54-13.9)	0.0001

DISCUSSION

We investigated the factors associated with tungiasis management in Ikolomani Sub-County in rural western Kenya. The prevalence of tungiasis was 65%, much higher than that reported in an earlier review of 27 studies in 7 Sub Saharan Africa ,SSA countries, that showed a 33.4% pooled prevalence of tungiasis in SSA, and 37.2% for Kenya[23]. In support of our findings, this meta-analysis reported a varying prevalence of tungiasis between countries and regions in SSA, here reflected in prevalence variation between the wards. A school-based study by Elson *et al.* [15] showed an overall tungiasis prevalence of 48%, which though high is still lower than our finding. However, the earlier study population was school-going children aged 2-21 years in contrast to the population in the current study. Differences in exposure, environmental conditions, and population characteristics such as sociodemographic factors could account for these differences in prevalence[2].

Two sites (*toes*, and *toes and soles*), were most infested, similar to several previous findings[1,12,19,24]. Individuals with infestations distributed at several body sites like infection of toes, soles and fingers, recorded a severe manifestation of tungiasis, relative to those infested only at one site of the body, who presented a less severe (mild) infestation, as previously reported elsewhere[13,19,25]. About 66% of the study participants had a history of jigger infestation, with 83.5% of those currently infested having a previous infestation, and these were significantly associated. As tungiasis remains largely ignored[3], a very severe disease which if not treated may end in a fatal disease course occurs in settings without access to healthcare, complicated by poverty, pre-existing illness, and neglect [13]. The current study was in resource limited settings with restricted access to basic needs like conducive housing, and closed footwear, aggravating jigger infestation.

Only 56% of individuals who stated they had tungiasis were actually diagnosed with infestation, shedding light on misreported cases. Still, this is higher than the 45.2% prevalence reported in Idakho South[21], which also revealed the prevalence was highest between the ages of 5-14 years, declined in adults and increased in the elderly. The difference could be explained by differences in population characteristics, geographic expanse and timelines, given a twelve-year gap between the two studies.

Floor-type was significantly associated with jigger infestation (P<0.05), consistent with findings by Elson *et al.* [15], where having sleeping places of children with hardened floors reduced mild to moderate tungiasis by 33%, and severe tungiasis by 50%. In our study, means of communication, house type, source of water, and closed shoes were not associated with jigger infestation (P >0.05), although these are among common factors previously reported to intensify tungiasis infestation[19].

Residency within the study area and previous jigger infestation were associated with tungiasis infestation, living in Idakho Central and Idakho East being protective from tungiasis compared to Idakho North. Previous tungiasis raised chances of infection 7-fold. However, age, gender, marital status, monthly income, and number of daily occupants for more than one year were not significantly associated with tungiasis infestation among the respondents in this study (P>0.05). Comparatively, a review of 27 studies on SSA revealed the risk for tungiasis was associated with gender and age, earthen floor, non-regular use of footwear, contact with animals, and residence in rural areas[23].

Only 86% of those who had been infested with jiggers (current or previous) received treatment; 35% at the hospital and 55% at home. Up to 92% believed their treatment of choice worked, the reasons cited included having got well, and, that treatment was only done once. Generally, tungiasis management is complex, with surgical removal being the most common method of extracting the flea [10,23]. However, local communities have different remedies, like in coastal Kenya where tungiasis has been successfully controlled using a locally produced mixture of neem and coconut oils[26].

In this study, 37% of the participants mentioned stigma, 27% discrimination and 19% difficulty wearing shoes, as some of the major challenges. Such challenges reflect numerous similar ones that have been reported among tungiasis-infested populations in Ondo State, Nigeria[12].

CONCLUSION

Tungiasis prevalence was 65%, varying across the four wards of Ikolomani, with only one-third of infested persons seeking hospital treatment. Living in Idakho North and having a previous jigger infestation independently posed the greatest risk of infestation, with thorns and hydrogen peroxide being the predominant techniques used to extract jiggers. Stigma, discrimination, and difficulty wearing shoes are among the major challenges faced by tungiasis patients.

RECOMMENDATION

There is need to enhance measures like jigger extraction, regular fumigation of infected households, and health education on control of tungiasis to improve health-seeking in hospitals and to curb the stigma and discrimination, to reduce tungiasis prevalence.

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