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Original Research Article

An Exploration of Factors Associated with Jigger Infestation (Tungiasis) among Residents of Muranga North District, Kenya

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ABSTRACT

Background: Tungiasis is one of neglected health problem in impoverished communities in the affected countries. Tungiasis carry a significant threat to people who live in the Mount Kenya Region, Western Kenya, the Rift Valley and coastal regions of Kenya. This study aimed to explore perceptions of jigger infestation and association between socio-demographic characteristics and economic status and the presence of jigger infestation among the residents of the Muranga North District in Kenya.
Methods: A random sample of 984 respondents was selected from the four divisions of the Muranga North District. Interviews used a structured and open-ended questionnaire to identify factors associated with jigger infestation. Descriptive statistics were used to compute frequencies and percentages for nominal and ordinal variables. Chi-square test and multivariable logistic
regression were used to examine the association between socio-demographic variables and jigger infestation.
Results: A majority of the respondents (65.9%) viewed jiggers as a nuisance rather than a health condition. In the multivariable-adjusted model the presence of jigger infestation was significantly associated with age (aOR 2.02; 95% CI 1.23, 3.30), education (aOR 0.38; 95% CI 0.22, 0.65), employment status (aOR 1.96 95% CI 1.17, 3.30) and place of residence (aOR 0.11 95% CI (0.07 - 0.18))
Conclusions: A multi-sectorial approach to this health condition is suggested. Further longitudinal studies to evaluate the effectiveness of such approaches are recommended.

Keywords: Tungiasis, jigger infestation, ectoparasitosis, Public health.

INTRODUCTION

It is estimated that about 2.6 million (6.5%) of Kenyans suffer from tungiasis resulting from jigger infestation.[1] Tungiasis is also found in several other countries in Africa, in Mexico, Argentina, Brazil and the Caribbean islands [2] Researchers agree that tungiasis is a neglected health problem in impoverished communities in the affected countries.[2,3] In Kenya, tungiasis is a common problem among people who live in the Mount Kenya Region, Western Kenya, the Rift Valley and coastal regions of Kenya.

Tungiasis is defined as an infestation caused by penetration of the skin by the female flea *Tunga penetrans* [4] also known as the sand flea. The tiny female flea—1 mm—burrows deep into the epidermal-dermal junction to feed on blood from dermal capillaries of its host. The first evidence of infestation by the sand flea is a tiny black dot on the skin at the point of penetration. This is followed by a small inflammatory papule with a central black dot forming within the next few weeks. [5] Jigger infestation, ectoparasitosis, has serious health consequences as it is associated with considerable morbidity. [2] A clinico-microbiological study showed that lesions caused by *T. penetrans* are almost constantly infected with pathogenic bacteria. [6] In Brazil, tungiasis causes 10% of tetanus cases with some reported deaths, not to mention other infections that may cause gangrene and amputation of extremities (Feldmeier et al. 2003). [6] In addition, tungiasis may cause difficulties in walking or using the hands. These difficulties prevent the victims from leading productive lives. [7]

Researchers have identified several factors that are associated with the infestation, including environmental, socio-economic, behavioral and cultural factors. [2,8] In Brazil, for example, severe tungiasis has been linked to poor housing in fishing communities.[9] In such areas, fleas breed close to the resting and sleeping places of the host, in dust, dirt, rubbish, cracks in floors or walls and carpets in poor housing. Moreover, individuals who suffer from the infestation are stigmatized as the society tends to blame them for not maintaining personal hygiene.[8]

The purpose of this study was to establish the prevalence of jigger infestation and the factors associated with it in Muranga North District in Kenya. Understanding these factors can significantly contribute to designing effective programs to treat and prevent tungiasis in Muranga North and other nearby regions where people share similar social and environmental factors.

MATERIALS & METHODS

Study design and settings

This study employs a descriptive cross-sectional survey design aimed at uncovering some of the determinants of jigger infestation among the residents of Muranga North District, Kenya. The district's total area is 578 square miles - consisting of four divisions: Githunji, Rwathia, Township and Murandia - with a population density of 374 per square mile.

Participants and data collection

Data were collected from a random sample consisting of 984 respondents drawn from the four divisions of Muranga North District. To be included in the study, a respondent had to be willing to take part in the study, be an adult 18 years and older, be a resident of Muranga North District for at least one year and be able to communicate in either Kikuyu or Kiswahili. Those who had not celebrated their 18th birthday and those in prison were excluded from the study, even if they were residents of the district. Data were collected on demographic characteristics, respondents' perceptions of the determinants of jiggers and on respondents' experience of infestation. Because the research was quasi-qualitative, open-ended questions were asked to capture and uncover respondents' crucial experiences about jigger infestation and to allow the respondents to suggest a range of possibilities not known by the researchers and thus may not have been apprehended by the structured (closed-ended questions) interview. The instruments were pretested on 10 respondents and corrected on the basis of the findings to ensure they were accurate and comprehensible.

Ethical approval and procedures

An approval to conduct research was obtained from the Ministry of Science and Technology and the Ministry of Public Health and Sanitation of Kenya. To ensure anonymity of information collected, no personal identifiers such as names, address, telephone numbers, and other identifying information was collected. Before a respondent was interviewed, informed consent was secured. Respondents were assured of anonymity and of the confidentiality of the study and were informed of their right to decline to take part or to refuse to answer or to complete the entire questionnaire. A respondent was only interviewed after agreeing to participate in the study.

Statistical Methods

Data obtained from qualitative questions were transcribed, line by line, and later categorized and coded into meaningful themes. For the quantitative data, descriptive statistics were used to compute frequencies for nominal and ordinal variables. The chi-square test statistic (χ^2) was used to test the significance of association between various socio-demographic, location and other characteristics of the sample. The outcome variable examined was a dichotomous variable of jigger infestation. Participants were asked, "Ever been infected with jiggers during the time of the study or within one month prior to the study?" Selection of independent variables was based on evidence from the literature. Independent variables included age, gender, marital status, level of education, employment status, number of dependents and number of people residing with the respondent. Variables with a p-value ≤ 0.2 in the bivariate analyses were entered into multivariable logistic regression models to adjust for confounding and to calculate the odds ratio (OR [95% CI]) for the presence of jigger infestation. The multivariable-adjusted model included the following variables: age (18-27, 28-37, > 37), gender (male, female), and education (no education, primary, secondary or above), employment (employed, casual laborer, jobless), number of dependents (0-3, 4 or more), number of people residing with respondent (0-3, 4 or more) and village (Githuji, Rwathia, Township, Murandia). A value of $p < 0.05$ was considered statistically significant. Regression diagnostics were used to assess potential collinearity. All analyses were conducted using Statistical Package for Social Science (SPSS) Version 21.0.

RESULTS

A majority of the respondents were aged 37 years and above (58%), women (60%) and married (67%). Over 60% had either no education or some primary (elementary) school education. Most of them (55%) had 4 or more people residing with them (Table 1). All respondents indicated they knew about jiggers, with the largest group of them (46.9%) having learnt through their own experience. On perception of jiggers, most respondents (65.9%) viewed jiggers as a nuisance rather than a health condition. Less than half (44.6%) of the respondents who were affected with jiggers sought treatment or help. A majority sought assistance through schools (61.5%) with only 8.4% seeking treatment or help from health facilities. Respondents identified poverty, hospitalization, amputation, inability to walk, depression, mental retardation and deformity of the extremities as some of the effects of jigger infestation. A majority identified poor hygiene and poor housing (78.6% and 53.6%) as significant contributors to infestation. To a lesser extent, respondents indicated hot season (37%), negligence (34%) and age (39.3%) as contributors to infestation (Table 2).

The results showed that there is an association between being infested with jiggers and the experience of being rejected.

Among those who were infested with jiggers, 124 respondents indicated that they had faced rejection. The frequencies were significantly different, χ^2 (1, N = 852) = 300.5, p < .001. In addition, respondents infested with jiggers significantly reported low self-esteem (χ^2 (1, N = 838) = 295.9, p < .001) than those without (Table 3).

Table 1. Socio-demographic characteristics of respondents by village						
		Githuji N (%)	Rwathia N (%)	Township N (%)	Murandia N (%)	Total N (%)
Age						
	18-27	32 (14.3)	19 (9.4)	47 (22.6)	55 (24.0)	153 (17.7)
	28-37	61 (27.2)	27 (13.3)	56 (26.9)	66 (28.8)	210 (24.3)
	>37	131 (58.5)	157 (77.3)	105 (50.5)	108 (47.2)	501 (58.0)
Gender						
	Male	91 (40.0)	76 (37.4)	59 (27.7)	117 (50.9)	343 (39.5)
	Female	131 (59.0)	127 (62.6)	154 (72.3)	113 (49.1)	525 (60.5)
Marital status						
	Single	42 (20.0)	18 (10.1)	51 (25.4)	33 (15.4)	144 (17.9)
	Married	147 (70.0)	143 (80.3)	96 (47.8)	157 (73.4)	543 (67.6)
	Divorced/widowed	21 (10.0)	17 (9.6)	54 (26.9)	24 (11.2)	116 (14.4)
Education						
	No education	45 (20.1)	30 (14.9)	33 (15.3)	38 (16.1)	146 (16.6)
	Primary	82 (36.6)	136 (67.7)	61 (28.2)	119 (50.4)	398 (45.4)
	Secondary or above	97 (43.3)	35 (17.4)	122 (56.5)	79 (33.5)	333 (38.0)
Employment						
	Employed	160 (71.7)	172 (84.7)	108 (51.4)	206 (86.9)	646 (74.0)
	Casual laborer	28 (12.6)	17 (8.4)	43 (20.5)	9 (3.8)	97 (11.1)
	Jobless	35 (15.7)	14 (6.9)	59 (28.1)	22 (9.3)	130 (14.9)
Number of dependents						
	0-3	163 (76.5)	129 (66.2)	111 (56.6)	153 (70.2)	556 (67.6)
	4 or more	50 (23.5)	66 (33.8)	85 (43.4)	65 (29.8)	266 (32.4)
People residing with respondent						
	0-3	68 (30.4)	86 (42.6)	82 (40.4)	146 (61.9)	382 (44.2)
	4 or more	156 (69.6)	116 (57.4)	121 (59.6)	90 (38.1)	483 (55.8)

Table 2. Association between characteristics of study sample and the presence of jigger infestation			
		Crude OR (95% CI)	Adjusted OR (95% CI) †
Age			
	18-27 (Referent)	1.00	1.00
	28-37	1.73 (1.13 - 2.65)*	1.59 (0.95 - 2.66)
	>37	1.71 (1.18 - 2.47)**	2.02 (1.23 - 3.30)**
Gender			
	Male	1.00	1.00
	Female	0.79 (0.60 - 1.05)	0.76 (0.55 - 1.06)
Education			
	No education (Referent)	1.00	1.00
	Primary	0.54 (0.36 - 0.81)**	0.62 (0.37 - 1.04)
	Secondary or above	0.51 (0.34 - 0.78)**	0.38 (0.22 - 0.65)***
Employment			
	Employed (Referent)	1.00	1.00
	Casual laborer	1.39 (0.90 - 2.14)	1.15 (0.67 - 1.97)
	Jobless	1.69 (1.14 - 2.50)**	1.96 (1.17 - 3.30)*
Number of dependents			
	0-3 (Referent)	1.00	1.00
	4 or more	1.55 (1.15 - 2.09)**	1.42 (0.94 - 2.15)
People residing with respondent			
	0-3 (Referent)	1.00	1.00
	4 or more	1.34 (1.02 - 1.76)*	0.92 (0.62 - 1.38)
Village			
	Githuji (Referent)	1.00	1.00
	Rwathia	0.15 (0.10 - 0.23)***	0.11 (0.07 - 0.18)***
	Township	0.77 (0.52 - 1.14)	0.81 (0.51 - 1.28)
	Murandia	0.75 (0.51 - 1.10)	0.84 (0.53 - 1.33)
Abbreviations: OR: Odds ratio; CI: Confidence interval * p < 0.05, **p ≤ 0.01, ***p ≤ 0.001 †Model adjusted for all variables listed in Table 3			

An analysis of the relationship between demographic characteristics of the sample and jigger infestation, age, level of education, location and employment were significantly associated with jigger infestation. Older respondents (27 and above) were more likely to report experiences of tungiasis—$\chi 2$ $(2, N = 851) = 9.0$, $p < .05$—than younger respondents. A significant number of respondents without education—$\chi 2$ $(2, N = 867) = 11.1$, $p < .01$—were more likely to report being infested with jiggers than those who had some level of formal education. Similarly, unemployed people were more likely to be infested—$\chi 2$ $(2, N = 865) = 8.1$, $p < .05$—than the employed. Respondents who had more than three dependents were also more likely to report infestation than those who had less than three $\chi 2$ $(3, N = 863) = 99.2$, $p < .001$. Interestingly, residents of Rwathia village were less likely to be infested with jiggers than the residents of Githuji, Township or Murandia.

Table 3. Factors associated with jiggers identified by those who were infested

Factor	Yes N (%)	No N (%)
Age	184 (39.3)	284 (60.7)
Mental inability	106 (22.8)	358 (77.2)
Poor housing	251 (53.5)	218 (46.5)
Poor hygiene	368 (78.6)	100 (21.4)
Negligence	164 (34.8)	307 (65.2)
Hot seasons	173 (37.0)	295 (63.0)
Low education	103 (22.0)	365 (78.0)

Table 4. Societal consequences of jigger infestation among infested respondents

	Yes N (%)	No N (%)	*p
Rejection	124 (26.6)	342 (73.4)	<0.001
Low self-esteem	113 (24.5)	349 (75.5)	<0.001
*P-values are for one sample test of proportions			

In the multivariable-adjusted model (Table 4), participants who were over 37 years of age were twice as likely to experience jigger infestation compared to participants 18-27 years of age (aOR 2.02; 95% CI 1.23, 3.30), while participants with secondary or above education were nearly 60% less likely to experience jigger infestation compared to participants with no education (aOR 0.38; 95% CI 0.22, 0.65). Unemployed participants were nearly twice as likely to experience jigger infestation compared to employed participants (aOR 1.96 95% CI 1.17, 3.30). Residents of Rwathia village were nearly 90% less likely to experience jigger infestation compared to residents of Githuji village (aOR 0.11 95% CI (0.07 - 0.18)) (Table 4).

DISCUSSION

Over the last several decades, epidemiological studies have been enormously successful in identifying risk factors for major diseases. The standard way of thinking is that socio-demographic and economic factors may determine whether an individual is at risk of diseases or conditions, thereby producing patterns of disease in populations. The findings of variability based on demographic characteristics such as age, level of education, employment and number of dependents among respondents in this study underscores the importance of contextualizing risk factors. In this view, social patterns are explained by risk factors, and thus it is the "risk factors" that are of primary importance. The importance of identifying risk factors cannot be overemphasized. As researchers have argued, individualized examination of risk factors is what can enable a healthcare system to craft effective treatment and prevention interventions. [10]

The results showed a strong association between economic status and jigger infestation. Most respondents (60.9%) were found to be living in earthen-floor houses. The type of houses is a measure of economic well-being, and this could be interpreted as most respondents being of low economic status, which is a major determinant of jiggers. It is not surprising

that only 16.5 percent of the respondents were in gainful employment. The latter were mainly those working in their own farms. A majority of the respondents (60.9%) were living in poor housing conditions (earthen floors with mud/timber walls. Jigger prevalence among impoverished communities has been found to be significantly higher than in communities of higher socio-economic status in the Caribbean, Brazil and South Africa. [2,6,11,12] As such, part of the solution to infestation is not merely medical treatment or simple preventative education, but rather interventions aimed at reducing poverty. Poverty alleviation strategies can empower the affected to improve their living conditions, including making solid floors and affording cleaning and other supplies to maintain a healthy environment.

Age was significantly associated with jigger infestation. Older individuals appear to have a higher risk of jigger infestation, and thus, need to be targeted for treatment and prevention. Older people were more likely to report being infested with jiggers than the youth. The reason older people are more often infested by jiggers than younger adults may be attributed to comorbidities that create situations that make it difficult for them to care for themselves. Similarly, children remain vulnerable because they may not have caregivers at home and are unable to take care of themselves due to lack of skills and resources to address the problem. Although this study did not include children, other studies have found children aged 5-14 are vulnerable to the infestation, which means that jigger infestation is common among children as well. [9]

In addition, jigger prevalence was found to be high among residents of rural settings; 48% of jiggers' prevalence was from rural areas, as compared to 21.4% from urban settings. Thus, economic disparities and access to treatment and preventative care may partly explain the differences between urban and rural infestation rates.

Interestingly, prevalence of jiggers was higher in households headed by females than those headed by males, although this difference was not statistically significant. Nevertheless, in two similar studies in Nigeria- and Brazil-based research, gender was not a significant predictor of being infested.[8] This means that environmental factors and acquired characteristics such as age, education and socio-economic status, rather than inherent characteristics such as gender, race and ethnicity or those acquired genetically explain differences in jigger infestation.

As noted, scientific community, policy makers, and healthcare providers have largely neglected tungiasis despite its serious consequences to human health and its interference with several aspects of human development such as education and economic activity. [2-6,8,13] Further research that would increase knowledge on other factors that influence it as well as intervention is needed.

Limitations

As with all studies, this study presented with design issues that affect the generalizability of its findings. Furthermore, no cause and effect can be inferred because the study was not controlled and randomized; therefore, the results do not suggest the direction of influences. It is possible that jigger infestation affect level of education an individual can attain or contribute to low socio-economic status and vice-versa. Additionally, even though all what was possible was done to ensure the sample was representative because informed consent was required or members of household were absent, respondents are considered convenience sample of willing individuals and households who were present at the time of researchers visit. As a

result, this sampling method limits the degree to which the findings can be generalized to other populations in other parts of the country where jigger is a public health issue.

To ensure greater generalizability and applicability of findings, future investigations should utilize a longitudinal study design across diverse regions in Kenya.

CONCLUSION

In conclusion, the problem of jigger infestation is not merely a medical issue. As much as a medical intervention is needed, it is also a public health issue that requires an approach that addresses the underlying factors influencing jigger infestation with the goal of prevention. Clearly, jigger infestation is influenced by socio-demographic characteristics such as age, level of education, geographical location and environment and socio-economic status. We propose that a multi-sectorial approach may be the most appropriate way to address each of the core factors such as poor housing, illiteracy, age and geographical locations.

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