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Efficacy of Coconut Oil in The Control of Acute Tungiasis

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***Abstract*— Tungiasis is a disease caused by a jigger flea (Tunga penetrans). The flea turns into an ectoparasite once embedded on the host. It is a public health problem in Kenya, particularly in poor rural communities. There is therefore a need to explore the possibilities of developing local, innovative solutions to this problem. The efficacy of coconut oil in controlling tungiasis in a rural setting in Kenya was, evaluated with a view of developing a solution based on scientific data. A baseline survey was, carried out to assess infestation and severity of the disease. A severity score for acute disease was, used in the study. A cohort of 39 individuals, with varying degrees of infestation was, recruited for treatment and follow up. The recruited study participants were first examined for a period of 30 days followed by an intervention treatment with coconut oil applied twice daily for a period of ten weeks to prevent re-infestation.**

The spearman rank correlation coefficient was, calculated to assess the significance of the association between the severity scores and infestation rate. The correlation coefficient was strong (r = 0.6). To compare findings before and after the intervention, the mean of each variable was determined for each patient during baseline assessment and during the intervention. The difference between baseline and after intervention results was, assessed using Wilcoxon matched pairs signed rank test and found to be significant. These results indicated that coconut oil could provide a reliable, simple and inexpensive means of controlling the disease.

***Index Terms*— Acute tungiasis, Coconut oil, Infestation rate, Morbidity.**

I. INTRODUCTION

Tungiasis is a disease caused by penetration of the female sand flea, *Tunga penetrans*, into the epidermis and the subsequent hypertrophy of the parasite [18, 22].

The flea originally occurred in South America and Caribbean islands but was inadvertently, introduced into sub-Saharan Africa in late 19th century [22]. Tungiasis is today endemic in Latin America, Caribbean and sub-Saharan Africa. It has, also been reported in Asia and Oceania [17, 31, 28, 23]. In Kenya, tungiasis is endemic in Central, Western, Nyanza, Coastal and Western regions. The prevalence in these endemic areas ranges between 15 to 40% [19]. Data relating to the effects of tungiasis is very limited [7]. The ectoparasitosis has, also been reported in individuals with diseases like epilepsy and mental disabilities [7]. Tungiasis inhibit progress and development due to associated morbidity including difficulties in walking, persistent itching and insomnia [7]. A population highly infested with jiggers is not able to participate in the democratic processes of the country and general economic activities. Infested children are unable to walk to school, write properly or even participate in learning activities [7].

Tungiasis is a zoonosis, which affects domestic and peridomestic animals. Where human live in close contact with these animals, and where environmental factors and human behavior favor exposure, the risk of getting the disease is high [22]. Tunga penetrans invades the unprotected parts of the skin, mostly in the feet [5, 14, 3]. The inter-digital skin and subungual region (area under the nail) are highly infested [22]. Both the male and female jigger fleas are hematophagous. The male does not burrow into the host and dies after copulation [2]. There are no significant morphological differences between male and female. The female is, however, generally smaller than the male [30]. Without appropriate treatment, secondary infections are common [16, 38, 5]. Diagnosis of tungiasis is by macroscopic inspection of the lesion. The total control and prevention of tungiasis must entail measures that would interrupt the lifecycle. These measures include environmental and personal hygiene, traditional methods, chemical control, and biological control, mechanical and physical control [21].

Chemotherapy (hydrogen peroxide and potassium permanganate) used by the government in Muruka ward, where the study was conducted, is expensive for the victims who happen to be poor. There is also a drawback in that these chemicals are corrosive and are poisonous if ingested accidentally, especially by children. Coconut oil is not expensive and has no side effects. It has been, used in repelling other ectoparasites like ticks from domestic animals [38]. Tungiasis by itself is a threat to realization of vision 2030 and the national goals of accessible education and health for all citizens in Kenya. The objective of this study was to determine efficacy of coconut oil in the control of acute tungiasis.

II. MATERIALS AND METHODS

A. Study area and settings

Muranga County where Muruka ward is located is about 60 km driving from Nairobi city. The county has temperature ranging between 21 and 35 °c .The variation in temperature is due to the differences in altitude as the area is hilly. The area has a volcanic loam soil. The large Muranga County is among those leading in tungiasis. This study was, conducted in Muruka ward in Kandara constituency to serve as a typical representation of all the wards in the county. Kandara is located at latitude 0 ° 54’ 0 S and longitude 37° 0’0 E. It is at

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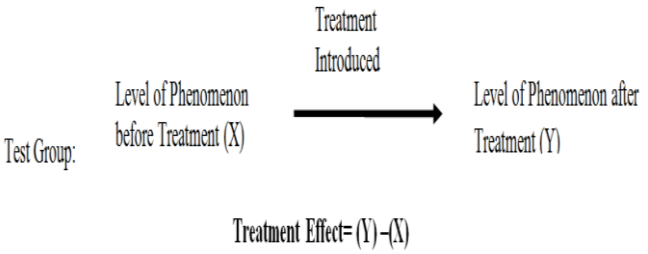
altitude 5308 feet above the sea level. Muruka ward has an area of approximately 38.50 sq km and a population of about 23,535 people. The local community is, characterized by poor housing mostly of mud walls. Overcrowding, poor hygienic conditions, illiteracy and unemployment are rampant. Only few houses have concrete floor.

B. Research design

This study entailed comparing the tungiasis phenomenon before intervention to the same after treatment with coconut oil. A control group was not included in the study due to ethical considerations. An informal experimental design, below, adopted from Kothari [26] was thus appropriate for the study.



C. Sampling design

In this study, snowball-sampling technique, a non-probability sampling design was, used. The concept "snowball" is following the way a snowball picks on more snow and enlarges as it rolls down the hill [4]. It involved identifying a few participants with tungiasis who in turn assisted in bringing the others with the same disease on, board. This design was appropriate as tungiasis is associated with some stigma and thus not everyone infested was willing to participate. Sample size in this study was not important, as any size would yield the desired results. Using this sampling design, a cohort group of 39 individuals, who included both gender was, formed.

D. Ethical clearance and consideration

Permission to conduct this study was, granted by KNH/UON ethics committee. The ministry of health also cleared the study through Public Health Officer Kandara sub-county. Permission was, obtained from relevant local leaders before meeting their subjects

E. Clinical examination of the flea stage

The whole body was, examined as the flea can attack any topographic site. Lesions were, classified according to the Fortaleza classification [9], a recently elaborated staging system outlined as follows;

Stage I: a dark and itching spot in the epidermis with a diameter of 1-2 mm with or without local pain. It is an adult flea in the process of penetration (*status penetradi).*

Stage II: called early lesion or a lesion, which is whitish with a central black dot, and having a diameter of between 3 and 10 mm.

Stage III: a mature lesion, which is a brown-blackish circular crust with or without necrosis of the surrounding epidermis.

Stage IV: a dead lesion defined as a dark central crust surrounded by necrotic tissues.

Stage V: a lesion altered through manipulation by patient. This stage also includes suppurated lesions mainly caused by using non-sterile perforating instruments such as needles or thorns.

F. Determination of severity score

The scoring system for this study was, adopted from [20], for acute disease manifestations. Symptoms and signs used to determine severity score for acute tungiasis (SSAT) were, divided into two categories as summarized in table I below. The first category comprised variables that could be associated with individual sand flea lesion or with a group of them in a defined topographical area. Since more than 90% of sand flea lesions were, found on feet, ectopic localizations were, not recorded. The surface of each foot was, divided into nine topographic areas in which sand fleas mainly penetrate. The areas included toes one to five, sole, lateral and medial foot rim and heel, giving a total, of 18 topographic areas for both feet. According to topographic area affected, 0 to 3 points were, awarded to the above variables. The other category involved symptoms and signs which could not be, localized precisely or which affected the patient in general manner.

G. Study cohort

A group of 39 individuals with varying degrees of tungiasis was, identified using the sampling design earlier stated and recruited for the study. On accepting to take part in the study, the participants were requested to sign a consent form, incase adult or assent form for the children. For very young children, the mentally hand caped, the illiterate and those unable to write, their consent forms were signed by their guardians. Selection of the participants was, based on inclusion and exclusion criteria. One had to be 2yrs and above to qualify for the study. The individual had also to have at least ten lesions and above to be included in the cohort group. Children below two years with tungiasis were not included in the study, but were, referred to Kandara hospital for treatment. Persons with extreme tungiasis incidences like ulcerated lesions were not eligible for the study but were also, treated in the hospital. Those with tungiasis but with other diseases like elephantiasis were, equally referred to the hospital for treatment. Individuals were eligible for the study provided they resided in their present dwelling places for the whole study duration (14 weeks).

H. Baseline survey

Cohort members were, visited twice a week for a period of 30 days during the baseline survey. During this period, the severity scores and infestation rate were, assessed and recorded. Demographic and parasitological information were, also recorded. This was, done through macroscopic examination of the patient with the aid of magnifying glasses. Baseline survey was, followed by a 10 weeks period of intervention with coconut oil.

I. Intervention

After 30 days of baseline observation, an intervention was, carried out using coconut oil. Pure coconut oil without a preservative or additives was, applied twice a day on the infested areas by, community health workers under the supervision of public health officer of Muruka ward. The mode of application was direct by simply smearing about

Table I. SSAT (severity score for acute tungiasis)

Signs and Symptoms		Points Attributed
According to the number of topographic areas affected;		
-Edema, Erythema, warmness [a]	0	0
	1-6	0.5
	7-12	1
	13-18	2
-Ulcer	0	0
	1-6	1
	7-12	2
	13-18	3
-Fissure	0	0
	1-6	1
	7-12	2
	13-18	3
-Pustule, abscess [a]	0	0
	1-6	1
	7-12	2
	13-18	3
-Supuration	0	0
	1-6	1
	7-12	2
	13-18	3
-Lesions in clusters [b]	0	0
	1-6	1
	7-12	2
	13-18	3
-Above 18 for any of the above symptoms		4
Irrespective of the number of topographic areas affected;		
-if negative for any of the symptoms below		0
	- itching	0.5
	-Sleeping disturbances due to itching	0.5
	-pain upon pressure	1
	-pain while walking	1
	-persistent pain	1
	-Difficulty walking [c]	3

a Sign alone or in combination
b Dense accumulation of embedded sand fleas, also described as “honeycomb-like lesion”[35].
c Difficulty walking was defined as an altered gait pattern, caused by the attempt to alleviate the pain while walking.

2mls of the oil on the palms and spreading it over the infested areas. Before applying the oil, the nails were, trimmed in order to enable the oil reach all the areas. Before application, washing was, done with water to remove dirt. The community health workers had protective gloves on. Symptoms, signs and infestation rate were, monitored during the intervention to see how their scores changed. Through direct observation method of data collection, the findings of each visit were, recorded in data sheets until the end of the study.

J. Statistical analysis

The concept of spearman correlation coefficient was, applied. This correlation coefficient helped to determine whether the two variables (infestation rate and severity scores) correlated in a monotonic function, that is, when one variable increased, so did the other, or vice-versa. The mean of each variable was determined for each patient during the baseline and intervention period. The Wilcoxon matched pairs signed rank test was, used to determine the significance of the difference between the two sets of scores that came from the same participants (in baseline and after intervention). The data was, presented using the column graphs. Statistical software, IBM 20 SPSS was, used in this analysis.

III. RESULTS

Table II. Demographic and parasitological characteristics of the study cohort

Variables	N	Median	Range
Age in years	39	48	94
Female/Male ratio	39		16/23
Total no of lesions per patient	39	56	41
Viable Lesions (stage i-iii)	39	41	63
Dead Lesions (Stage iv)	39	9	26
Manipulated Lesions	39	12	27
Lesions in Clusters	39	6	7

[a] Erythema, edema, warmness
[b] **Suppuration, pustule or abscess**

Table III. Clinical pathology in the 39 individuals

Type of Clinical Pathology	N	%
Difficulty walking	39	100
Fissure	20	51
Signs of acute inflammation [a]	20	51
Signs of super infection [b]	30	77
Ulcer	20	51

[a] Erythema, edema, warmness
[b] Suppuration, pustule or abscess

Table IV. Various variables at baseline and after intervention

Variables	Mean at Baseline	Mean after Intervention
Number of embedded fleas	4	1
Infestation rate	2.1	0.02
SSAT	3.2	1.03

A. Tungiasis cases

The figures below show photographs of acute cases at baseline and after intervention.

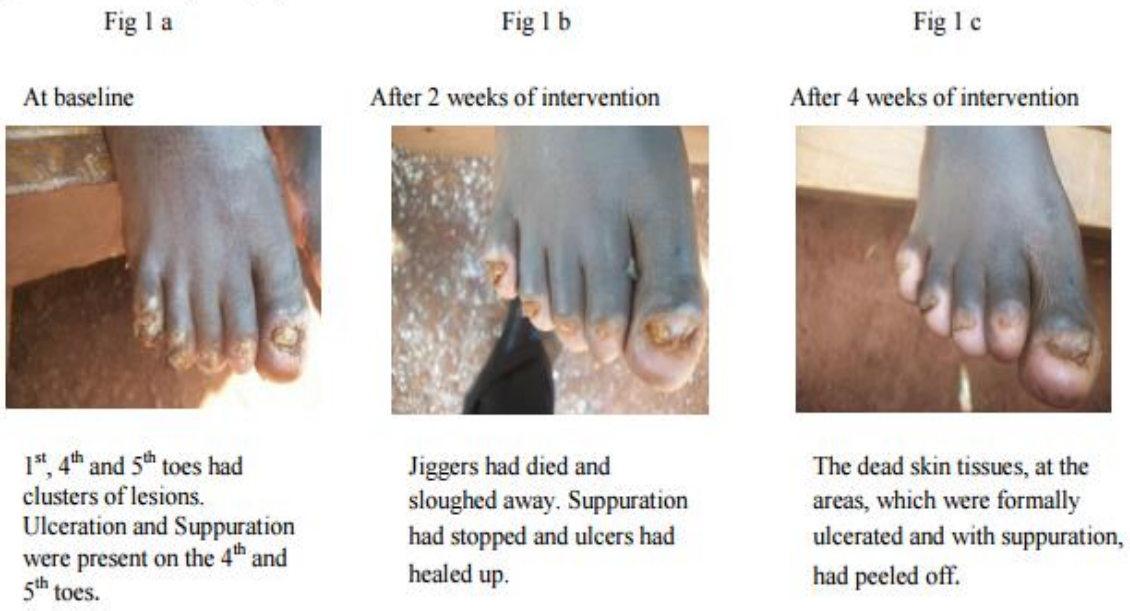


Figure 1: An acute case of 8-year-old boy

Fig 2 a

At baseline

Each toe had developed edema to some degree. This made the skin around the nails shine.

Fig 2 b

After 2 weeks of intervention

After the death of jiggers, edema had greatly reduced.

Fig 2 c

After 4 weeks of intervention

No jiggers observed and edema had cleared away.

Figure 2: An acute case of 12 years old boy

In this study, acute cases occurred in individuals aged 60 years and below. Infestation rate along age classes and gender was as shown in figures 3 and 4 respectively.

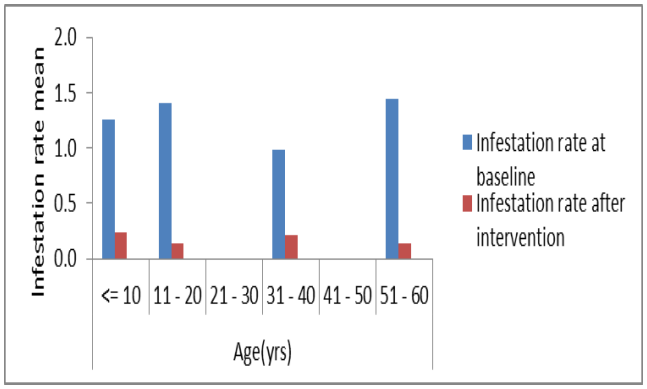


Figure 3: Infestation rate for acute tungiasis along age at baseline and after intervention.

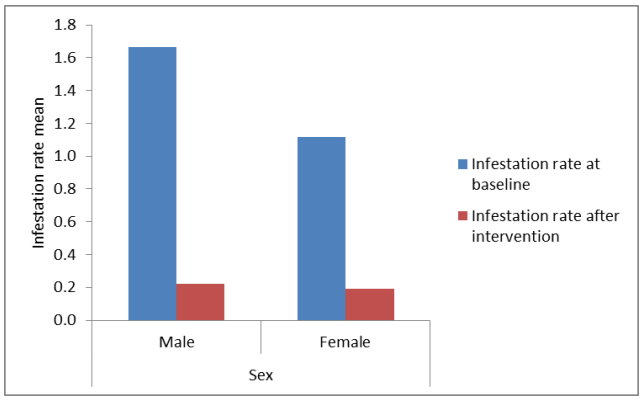


Figure 4: Infestation rate for acute tungiasis along gender at baseline and after intervention

The signs and symptoms of acute tungiasis were assessed along age classes and gender. The results were as presented in figures 5 and 6 respectively.

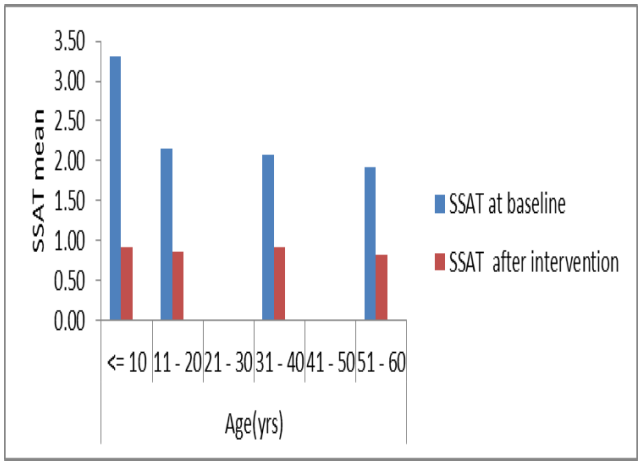


Figure 5: Severity scores for acute tungiasis (SSAT) along age at baseline and after intervention

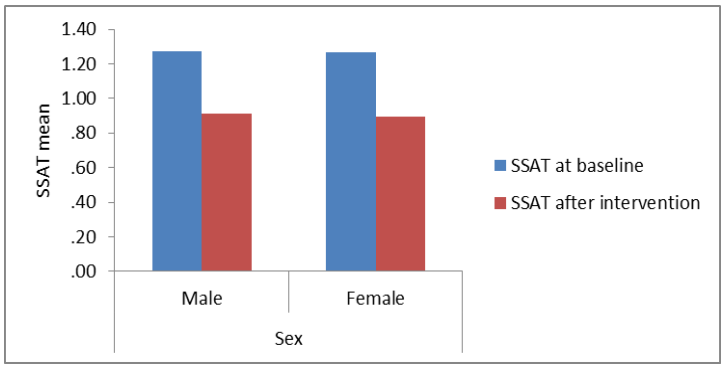


Figure 6: Severity scores for acute tungiasis (SSAT) along gender at baseline and after intervention

In fig 7 below, five acute parameters were, analyzed and their means at baseline compared to the same after intervention, to show how they changed. Their p- values were as shown in table V

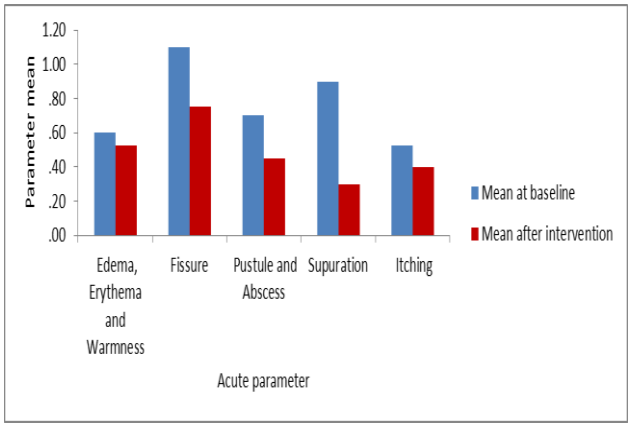


Figure 7: Various acute parameters at baseline and after intervention

Table V. P- values of various acute parameters

Signs and symptoms	N	Mean at baseline	Mean after intervention	P-value
Edema, Erythema and Warmness	20	0.6	0.33	0.03
Fissure	20	1.10	0.75	0.02
Pustule and Abscess	20	0.70	0.35	0.02
Suppuration	20	0.90	0.30	0.01
Itching	20	0.53	0.24	0.02

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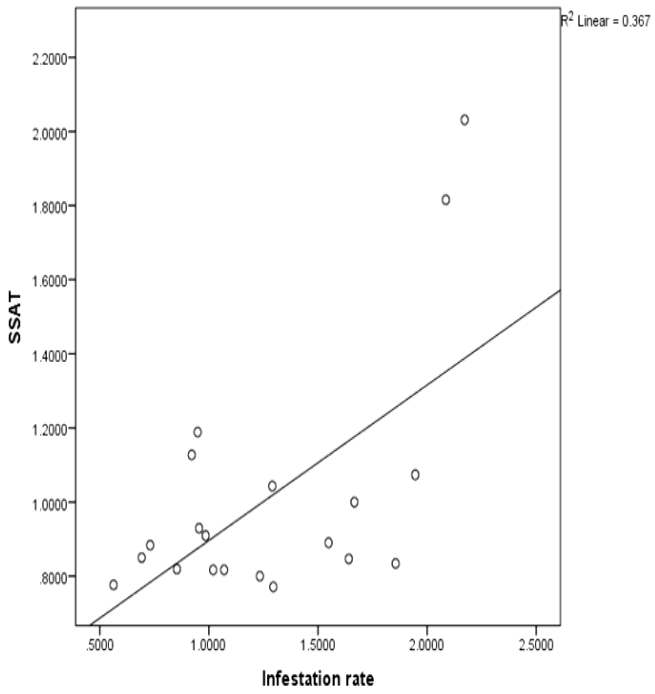

Spearman correlation between severity score for acute tungiasis and infestation rate indicated a strong correlation coefficient *(R)* of 0.6. *R* is significant when it occurs below 1.0 i.e *R*<1.00.

Figure 8: Correlation between SSAT and infestation rate

B. *Wilcoxon matched pairs signed rank test* Wilcoxon signed rank test showed that a four weeks, twice daily treatment course with coconut oil elicited a statistically significant change in lowering the acute severity scores *(Z=-3.946,p=0.001).*The test also showed that the same treatment elicited a significant change in lowering the infestation rate *(Z=-3.971,p=0.001)*

IV. DISCUSSION

The demographic and parasitological characteristics of this study were as summarized in table II. In the study, only the age and gender of the participants were important and thus reflected in the results. Among the 39 cohort members, 16 were females while 23 were males, including both children and adults. Their ages ranged from 3 to 60 years. There was an assumption that age and gender would not have any effect (negative or positive) on the performance of coconut oil. This assumption was, adopted from a study conducted in Fortaleza, a town in Northeast Brazil, by [13]. In this study, manipulated lesions were more than, those encountered by [24]. The lesions occurring in clusters were not as many as those encountered by [24] in their study. Viable lesions (stages I-III) were many with a median of 41. Only a few lesions were found dead (Stage IV) with a median of 9. The median of the total number of lesions (dead or viable) in the cohort members was 56. The parasitological characteristics of this study were unique to itself. This is because, as observed by other researchers, there is no parasitological pattern in tungiasis. The parasitological characteristic of a cohort group depends on the risk factors surrounding it, and this varies from place to place and from season to season [24, 12, 11].

As this study depicted, tungiasis presents in various kinds of clinical pathologies. Each of the pathologies was, analyzed and the percentage of the individuals in the cohort afflicted by it calculated as shown in table III. In this study, a number of clinical pathologies were present in the same person. Signs of acute inflammation included erythema, edema, and warmness. Suppuration, pustule and abscess were signs of super infection. Signs of super infection were present in 77% of the group. In this study, every member of the cohort had difficulties while walking. Acute inflammation, ulcers and fissures afflicted the group in equal proportions of 51% each. The clinical pathologies reported in this study were characteristic findings in different stages of the disease, just as confirmed by [9] and [11]. According to this study, the ectoparasitosis presents with intense clinical pathology depending on the status (whether chronic or acute), and that the disease morbidity is directly proportional to infestation rate, confirming the findings of [24] and [11]. These results, on clinical pathologies, disputes the observation made by [32]. [32], having studied 14 cases of tungiasis imported to United States reported that patients showed only one or two lesions and that except for itching and local pain, no clinical pathology was, observed [32].

At baseline, acute signs and symptoms presented in almost equal degrees in both males and females (fig 6). As observed in this study, acute tungiasis is characterized by symptoms and signs like pustules, abscess, suppuration, lesions in clusters, persistent pain and pain upon pressure, erythema, ulcers and edema among others. This is in line with the findings of [10]. Acute inflammation in the victims was, characterized by erythema, edema, itching and pain.

Suppuration observed among the acute victims was an indication of infection by bacteria, which may have been on the flea surface or within its body. The bacteria may also, have entered into the victims as they scratched themselves, as most of them complained of pruritus. Inflammatory response among the victims could also have, been caused by proteolytic enzymes released by the flea during penetration, or by the immune response of the individuals, as [10] concluded in their findings.

As [15] explained in their study, honey comb like lesions (clusters) encountered in this study were thought to be related to reproductive biology of *Tunga penetrans* , enabling a single male to fertilize several embedded females within a short period of time. Most acute victims confessed that often they attempted to extract the embedded fleas using thorns and unsterilized needles, which might create avenues for bacterial infections. As [10] observed in their study, the bacteria might have aggravated the case as the jigger decomposed. Every acute victim in this study had difficulty in walking due to persistent pain, which is a known fact among tungiasis victims since the first description of the ectoparasitosis [8, 18, 25, 27].

In this study, there was a strong positive correlation between acute severity scores and infestation rate at baseline, with a correlation coefficient (*R*) of 0.6 (fig 8). Thus once the infestation is eliminated, the disease severity comes under control. This confirms prior findings by [13] and [9] that acute morbidity and infestation rate strongly correlates. This study also supports their diagnosis that the signs and symptoms highlighted in table I characterize acute tungiasis. After intervention with coconut oil, there was a big decline in the rate of acute infestation as depicted in figures 3 and 4. The acute severity scores also reduced tremendously (figures 5, 6 and 7). This was evident in the specific acute cases highlighted in figures 1 and 2. Both acute infestation rate and severity scores reduced to levels below the mean of 1.0. Statistically, the reduction in signs and symptoms in acute victims was very significant as epitomized by their p-values in table V.

In this study, acute infestation rate was higher in males than in females at baseline (fig 5). After intervention with coconut oil, infestation in acute victims reduced to levels below the mean of 1.0 as depicted in table IV. Acute morbidity occurred in almost equal proportions in males and females (fig 6). After intervention, acute morbidity declined below the mean of 1.0 (figures 5, 6 and 7). This is similar to observations made by [1], [2] and [6]. According to these authors, preponderance of males over females occurs in jigger infestation. In other studies in south Brazil, higher prevalence was, observed in females than in males [5]. Studies in Trinidad, Brazil and Nigeria have found no significant differences along gender [1, 2, 6, 36, 37]. Data on tungiasis distribution along gender has not been consistent. It appears to vary from one population to the other.

In this study, acute cases were present in participants of age 60 years and below. Among these cases, children were the most (fig 5). Infestation was very high in participants of age 20 years and below. For unknown reasons, the cohort did not have victims in age classes of 21-30 and 41-50 years. Infestation was not high in participants of middle ages (fig 5). In this study, acute morbidity was highest in children. Participants of middle ages did not present with very severe morbidity among the acute cases (fig 5). Just like observed by [34], an S-shaped prevalence pattern along age occurred in acute cases, with the highest prevalence in participants of age 20 years and below, and 51-60 years age class (fig 5). This S-shaped prevalence pattern in acute tungiasis also reflected in a study conducted in a rural community in Brazil [29]. According to this author, marked increase in infestation among the old people is due to different exposure. Middle-aged people spend most of the time working outside their respective endemic communities. They also remove the embedded flea more rigorously. In contrast, children and the old people, as confirmed in this study, spend most of the time in endemic areas, as they do not go out to work [29].

According to [33], coconut oil contains a triglyceride called lauric acid, which is a powerful anti-microbial agent. It also contains caproic, caprylic and capric acids, which have some anti-bacterial properties and work synergistically with lauric acid, making coconut oil so healing to the skin.

A. *Conclusion*

Wilcoxon signed rank test showed that, a four weeks, twice daily treatment course with coconut oil elicited a statistically significant change in lowering the acute severity scores *(Z=-3.946,p=0.001).*The test also showed that the same treatment elicited a significant change in lowering acute infestation rate *(Z=-3.971,p=0.001).* According to these statistical results, coconut oil is highly efficacious in controlling acute tungiasis.

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