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ABSTRACT

Background: Tungiasis is a parasitic tropical disease caused by female *Tunga penetrans* which causes different health disabilities hence the need for behavior change. Main objective of the study was to determine the association of WASH on tungiasis occurrence among pupils in schools implementing Home Grown School Meals Programme.

Methods: A school-based cross-sectional study design was employed in which data from a control and intervention sites were compared. 24 schools (12 as control and 12 as intervention) were included. 10 pupils aged 5-15yrs were targeted from each school, totaling to 240 participants. Guardians of the 240 pupils in the selected schools were also interviewed. Quantitative data was collected through a pretested structured questionnaire. The data was keyed-into the SPSS version 23 and analysed.

Results: Study findings indicate that majority of the pupils aged between 10 – 14 years were 69.7%, while those aged between 15-18years were 25.5% and the least was aged between 5-9 years old at 5.0%. Majority of the pupils were in class 5-6 forming 48.7% of the responses, followed by classes 7-8 at 46.7% while classes 3-4 at 4.6 %. The study results indicate that 54% of the pupils were female and 46% male. It was noted that there is statistical significance among pupils and infested by tungiasis (χ^2=6.00, df = 1, P<0.005) within the past 3 months. Gender (χ^2= , df = 1, P<0.005), training on health related issues at school (χ^2= 3.938, df = 1, P<0.005), as well implementation of Home Grown School Meals Programme (HGSMP) (χ^2= 1.455, df = 1, P<0.005) had a significance association with tungiasis infestation occurrence. Toilet usage (χ^2= 2.088, df = 1, P>0.005), availability of water (χ^2= 0.836, df = 2, P>0.005), availability of handwashing facilities (χ^2= 0.141, df = 1, P>0.005) had no significant association with occurrence of tungiasis. Further significance was noted on demographic (β = 0.867, P=.000) behavioural (β = 0.924, P=.000), environmental factors (β = 0.689, P=.000) and tungiasis infestation.

Conclusions: Study indicates that environmental, demographic and behavioral factors significantly predict tungiasis infestation. WASH related diseases, Trainings on WASH and implementation of HGSMP have a positive relationship with tungiasis infestation. Control programs need to adopt a more comprehensive approach at the school level. Health education is also imperative to significantly reduce the spread and morbidity from tungiasis. From the study environmental, demographic and behavioral factors significantly predict tungiasis.

Key words: Practice, Tungiasis, Water, Sanitation, Hygiene, Prevention, Control, Ganze

Background

Tungiasis is a parasitic tropical disease caused by female *Tunga penetrans* also known as sand flea or jigger flea. The disease is coded as B88.1 under International Classification of Diseases 10th Edition [1]. Tungiasis morbidity often lead to loss of health due to various disabilities which include pain and itching, lack of sleep, difficulty in walking and grasping [2]. The disease is prevalent among children in Latin America, Caribbean and sub-Saharan Africa [3]. In the affected countries, millions of people are at risk of infection especially in stable endemic foci [3]. The resulting morbidity has been shown to reduce the children's ability to acquire basic education due to absenteeism, repetition and dropout from school [4].

School health and nutrition programmes (SHN), which include Homegrown School Meals (HGSM), are now widely recognized as significant contributors to the attainment of the Millennium Development Goals in regard to food security, Health and Education for All [5]. Homegrown School Meals (HGSM) programme generally aims at providing school meals to children in schools located in food insecure areas like Ganze. Such meals may act as an incentive and mechanism for increased child attendance and attainment in school. Its primary objective is to promote school attendance including gender parity while enhancing cognitive abilities. These effects are more effective when combined with other complementary actions such as water and sanitation programmes, deworming, providing food and/or micronutrients [6]. Impaired cognitive development and low learning performance are long-term outcomes of persistent jigger infestations which are largely attributed to water stress, poor sanitation, and hygiene [7]. Thus, estimating the burden of sanitation related illnesses like jiggers among school going children and their guardians is an important prerequisite for the development of both quick-win and long term solutions. This will help guide outreach programs and improve understanding of other correlates of early childhood development [8].

Locally, approximately 2.7 million cases of Tungiasis were reported in 2009 among all age groups by Africa Health and Development International (AHADI) Trust cited in [9]. Another source indicated 1.4 million cases of Tungiasis and 25% of the children in Kenya were at risk of suffering from the disease in the country [10]. In a period of a few years it was also estimated by AHADI that 275 people had died of Tungiasis related co morbidities and complications cited in Ngunjiri and Keiyoro (2011). Although the number of persons suffering from Tungiasis in these reports differed it is evident that this disease is of health concern in Kenya where 17 million of the country's 40 million inhabitants do not have access to clean drinking water. The most official estimates of access from the Government of Kenya put water supply coverage at 42 percent and sanitation coverage at 31 percent in 2006 (urban and rural areas combined) [11]. Most of the burden of tungiasis infestation can be preventable with improvements in sanitation, water quality such as point of use disinfection. Proper sanitation infrastructure and behaviors at schools can improve attendance and improve educational outcomes, leading to societal impacts on human productivity and dignity. Activities at schools also model sanitation technologies and behaviors that are transferred from schools and school children to households and community. Similarly, School Feeding Programmes have been shown to impact positively on enrollment, nutritional status and cognition of school children as well as reduce hunger and improve poverty indicators [12].

While the HGSMP is seen as a crucial element for; supporting equitable access to education, including supporting learning outcomes and securing healthy behaviours, there is however, dearth of information regarding water sanitation and hygiene in schools benefiting from these programmes, in as much as WASH is an important aspect of any school feeding programme. This study also provides critical information on the effect of HGSM programme in relation to water sanitation and hygiene and further assist the line ministries in implementing the Programme. The results of this study will be useful to the District health managers and other public health practitioners in the area of sanitation and hygiene, particularly in formulating appropriate policies and strategies to address the problem of poor sanitation and hygiene. The County Government of Kilifi will also be able to benefit from the study by applying concerted efforts towards prevention and control of tungiasis among its population towards a healthier county

Methods

Study Area

The study was conducted in the 4 divisions of Ganze Sub County, Kilifi County, namely; Bamba, Ganze, Vitengeni and Jaribuni. The geographical coordinates are 3° 32' 0" South, 39° 41' 0" East. It is located in the North-West Coast of Kenya, and has semiarid vegetation with very little rainfall in the months of May and August. Ganze has a population of close to 140,000 Citizens and stretches on a 3,000 km^2 surface. Ganze is classified among the poorest of areas in Kenya. It is estimated that more than 90%, 85% and 80% of the population living in Bamba, Ganze and Vitengeni Division live below the poverty line, respectively. Poverty in the area manifests itself in the inability of the majority of the people to access basic needs such as food, shelter, clothing, health, water and education. Factors influencing this include climate and low levels of education. The main economic activity in Ganze is agriculture Cashew nut is the major cash crop produced since 1930 [13]. The price of cashew nut has declined substantially in recent years translating into extremely poor remuneration for farmers. The area has a total of 125 primary schools, with 48 primary schools implementing the government led Home Grown School feeding Programme though it has low primary and secondary school enrolment rates

Study Design

This was a cross sectional study adopting quantitative approach. It entailed surveying schools implementing Home Grown School Meals Program and comparing the same variables with schools not implementing Home Grown School Meals Program. Data from the households was also collected around the schools implementing HGSM Programme and those not implementing HGSMP. Data was compared from both arms of the study for children aged between 5-15 years and that from their guardians.

Study population

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The study targeted pupils aged 5-15 years in primary schools in Ganze, Kilifi County. A total of 12 control schools and 12 intervention schools were included. Ten pupils were targeted from each school, totaling to 240 participants. Parents/guardians were paired with the pupils giving rise to a total of 480 study participants. Once enrolled, pupils were followed home for the household survey involving their parents/guardians

Sample size determination

The sample size calculation was based on formula as described by Demidemko 2008 for comparative study [14]. Assuming that the school feeding program would result in a 10% change in all outcomes (Cohen, 1998 for small effect size), 80% power to detect the change, 5% level of precision, 80% response rates, the formula below would result in a sample size of 470.

$$n = \frac{r+1}{\mathrm{r}} \frac{(\overline{p})(1-\overline{p})(Z_{\beta} + Z_{\alpha/2})^2}{(\mathrm{p}_1 - p_2)^2}$$

Where r is the ratio of number of pupils required between the control and intervention sites, assumed to be 1:1. P will be average rates of outcomes set at 50% which is the maximum variation in proportion, Za is the Z score of a normal distribution (1.96) at 0.05 level of precision and Z score at 80% (0.84). P1- p2 is the effect size expected as a result of intervention. An additional 10% accounted for non response, hence the minimum sample size was 480. Estimated sample size for both control (120) and intervention (120) was 240. Parents (240) were paired with the each pupils giving rise to 480 participants.

Sampling Procedure

Twelve feeding schools under HGSMP were surveyed. The same number was allocated for the non feeding schools. A list of schools implementing the HGSMP were obtained and stratified per division and random sampling was used to select 12 out of 48 schools as a representative number of schools. The same technique was used for non implementing schools. For ease of data collection, attempt was made to organize the schools randomly until the required sample size was reached. The school pupils (240) were then stratified according to their grade that is standard 1-8. Thereafter random sampling was done using class registers as the sampling frame and random numbers generator.

Description of WASH Intervention in schools implementing feeding program

Water, sanitation and hygiene practices was implemented in 12 schools already participating in the feeding program. This involved setting up of WASH clubs in schools, providing training on

WASH to pupils and teachers. Encouraging development of low cost technologies to water provision after visiting toilets and encouraging creating school competitions on WASH amongst schools. Further, community awareness meetings were held to encourage proper WASH practices. These were conducted at the catchment villages of the intervention schools. A free zone buffer was created such that communities close to both an intervention and controls were avoided to avoid contamination of intervention. The WASH intervention went hand in hand with already existing school feeding program in the same schools. Schools not participating in the schools (n=12) program acted as control arms of this study and did not receive WASH interventions. Comparative cross sectional surveys were conducted in both interventions and controls schools and households. The data collected included individual, school, environmental and behavioral factors. Additionally, data on tungiasis occurrences in schools was also collected.

Questionnaire

Before administration, approximately 10% of the 480 questionnaires (48 questionnaires) were pretested in schools from an area neighboring the survey site. For the school based survey; interviewer administered semi-structured questionnaires were developed and used as one of the data collection tools to elicit information on the demographic data including; age, gender and education level, behavioral, personal hygiene at facility and individual levels as well as prevalence.

Quality Assurance

Quality assurance measures included training enumerators and data entry clerks on the survey instruments, field testing with a special focus on a ‘real-life’ situation, as much as possible so as to improve the process and to enhance the understanding of the study team. Field supervisors were also engaged to immediately review questionnaires on a daily basis and to rectify any inconsistencies that may arise. Data Cleaning was a multi-stage process. The data was cleaned immediately after data entry in MS Access, data was continually exported to excel and fed into SPSS during analysis until the final report was completed.

Data Management and Analysis

Once collected, quantitative data was coded and keyed-in in MS-Access which acted as the database Code-books were available for reference. Data security was ensured by creation of back-ups in removable discs and in servers. Access of the data was limited through robust pass-words to only those involved in the survey. Data was exported to Epidata Version 3.1 (EpiData Association) and Statistical Package for Social Sciences (SPSS version 23.0) for analysis. Summary/descriptive statistics was used to describe the data and generate summary tables for each level-factor. Frequencies and proportions were computed for categorical variables. For univariate comparisons of changes between the intervention and control groups, mixed-effects regression models with a random intercept (to account for within-subject correlation) was used. Covariates was included in the analysis to adjust for baseline differences between the intervention and control groups. Regression method for clustered data or multilevel models was used to adjust for confounding pupil variables such as age, gender and existing health conditions. Multiple regression model was used to assess the effect of intervention controlling for confounding factors. Results were presented in frequency distribution tables, charts and graphs. Differences between the parameters of estimate were deemed statistically significant at $p < 0.05$.

Results

Demographic characteristics of the respondents

Findings of the study indicated that majority of the pupils aged between 10 – 14 years were 69.7%, while those aged between 15-18years were 25.5% and the least was aged between 5-9 years old at 5.0%. Majority of the pupils were in class 5-6 forming 48.7% of the responses, followed by classes 7-8 at 46.7% while classes 3-4 at 4.6 %. The study results indicate that 54% of the pupils were female while 46% were male(Table 1). The findings indicate that prevalence of tungiasis was (23.3%). Male pupils had a prevalence of 15.8% while female pupils had a prevalence of 7.5% (Table 2).

WASH Related Practices and Tungiasis Occurrence in Schools

Gender and tungiasis occurrence were statistically associated at (χ^2= 7.979, df = 1, P<0.05). Hand washing was not related to tungiasis occurrence in which 218 (94.0%) indicated they wash hands, while 14 (6.0%) did not wash hands at (χ^2 = 0.556, df = 1, P>0.05). Frequency for handwashing in which 68 (30.1%) washed before feeding, 156 (69.0%) after visiting toilet and 2 (0.9%) for others did not also indicate statistical significance at (χ^2= 2.098, df = 2, P>0.05).

Further analysis for handwashing (χ^2= 0.027, df = 2, P>0.05), friends at school washing hands after visiting the toilet (χ^2 = 0.184, df = 1, P>0.05), latrine/toilet usage (χ^2=2.088, df = 1, P>0.05), availability of soap (χ^2= 0.401, df = 2, P>0.05) and handwashing with soap (χ^2= 2.219, df = 2, P>0.05) revealed no significant relationship with tungiasis occurrence. The results on availability of drinking water was 106 (45.7%), for drinking water always being available, 104 (44.8%), sometimes and 22 (9.5%) for water not being available at all, no significance relationship was revealed for availability of water (χ^2= 0.836, df = 2, P>0.05) as well as schools' source of drinking water at (χ^2= 3.022, df = 2, P>0.05), while training on health related issues had a significance influence at (χ^2= 3.938, df = 1, P<0.05).

The proportion of Schools without Home Grown School Meals Program were 17 (33.3%), with pupils aged 5-15yrs and 34 (66.7%) for those aged above 15 years. There was however no significant association between schools without HGSMP and tungiasis occurrence at $\chi2$= 0.046, df = 1, P>0.05. Schools with Home Grown School Meals Program were 67 (35.4%) with pupils aged 5-15yrs and 122 (64.6%) for those aged above 15 years. Study findings revealed a significant relationship between schools with HGSMP and tungiasis occurrence at ($\chi2$= 1.455, df = 1, P<0.05) (Table 3).

Tungiasis Infestation in School

The number of pupils affected by tungiasis in the last 3 months was at 1 (16.7%) school and in 5 (83.3%) schools. There was a notable significant dependency between pupils affected by tungiasis in the past 3 months and disease occurrence at (χ^2= 6.000, df = 1, P<0.05) (Table 4). The relationship between the number of pupils suffering from jiggers in schools was 1 (100%) out of a total number of 21 pupils in one stream with jiggers, while the other 9 streams did not have any pupil suffering from jiggers. The cross tabulation of pupils suffering from jiggers in schools was 1 (100%) out of a total number of 30 pupils wearing shoes per class with jiggers, while the other 9 classes did not have any pupil suffering from jiggers. Study findings revealed no significant association between pupils with jiggers (χ^2= 10.000, df = 9, P>0.05) as well as pupils wearing shoes and had jiggers (χ^2= 10.000, df = 9, P>0.05) (Table 4).

Inferential analysis

Relationship between Environmental Factors and Tungiasis

The study also found that environmental factors explained a significant proportion of variance in tungiasis occurrence, R^2= 0.800. This implies that 80% of the proportion in tungiasis occurrence can be explained by environmental factors in primary schools in Ganze within Kilifi County. Other factors not covered by this study therefore contribute to 20%. The study found that environmental factors significantly predicted tungiasis occurrence, (β = 0.894, P < 0.000). The study therefore concluded that environmental factors significantly influenced tungiasis in primary schools in Ganze within Kilifi County (Table 5).

Relationship between Demographic Characteristics and Tungiasis

The study also found that demographic characteristics explained a significant proportion of variance in tungiasis occurrence, R^2= 0.725. This implies that 72.5% of the proportion in occurrence in tungiasis can be explained by demographic characteristics in primary schools in Ganze within Kilifi County. Other factors not covered by this study therefore contribute to 27.5%. The study found that demographic characteristics significantly predicted tungiasis occurrence, (β =0.159, p =0.002). The study therefore concluded that demographic characteristics significantly influenced tungiasis occurrence in primary schools in Ganze within Kilifi County (Table 6).

Relationship between Behavioural Factors and Tungiasis

The study also found that behavioural factors explained a significant proportion of variance in tungiasis occurrence, R^2= .722. This implies that 72.2% of the proportion in tungiasis occurrence can be explained by behavioural factors in primary schools in Ganze within Kilifi County. Other factors not covered by this study therefore contribute to 27.5%. The study found that behavioural factors significantly predicted tungiasis occurrence, (β = 0.249, p = 0.011). The study therefore concluded that behavioural factors significantly influenced tungiasis occurrence in primary schools in Ganze (Table 7).

Multiple Regression

The estimates of the regression coefficients and the p-values for the relationship between the variables of the study are as shown in Table 8. From the findings, water had a coefficient (β = .521, $p < .05$). Sanitation had coefficients (β = .299, $p < .05$) while hygiene had coefficients (β = .364, $p < .05$). From the findings on the moderated model, water had a coefficient (β = .544, $p < .05$). Sanitation had coefficients (β = .342, $p < .05$) while hygiene had coefficients (β= .449, $p < .05$). Testing the influence of the confounding factors, weather and climatic conditions had coefficients (β = .226, $p < .05$) while household factors had coefficients (β = .229, $p < .05$).

Discussion

The current study findings indicate that there was significant relationship between the use of a latrine by pupils and their gender (p = .005), this concurs with a study by Joshua *et al.,* 2014 which revealed some evidence suggesting facility dirtiness may deter girls from use (p = 0.06), but not boys (p = 0.98), these relationships provide insight into the complexity of factors affecting pupil toilet use patterns, potentially leading to a better allocation of resources for school sanitation, and to improved health and educational outcomes for children. Studies by Mathew *et al.,* 2009; Njuguna *et al.,* (2008) indicate that usage of school toilets is associated with their level of cleanliness.

This study indicates no significant relationship between place of hand washing at school (p= 0.798), availability of soap (p= 0.818) and tungiasis occurrence. These findings contradict with a study by Jae-Hyun Park *et al.,* (2010) on hand washing practice conducted in Korea that noted out of the 942 students who participated there was a 30.3% increase in hand washing an improvement of one carried out one year earlier (Jae-Hyun Park *et al.,* 2010). Targeted interventions aimed at increasing hand washing practice should be encouraged across all communities including schools.

Beyond improvements in access to food, school feeding programs also have a positive impact on nutritional status, gender equity, and educational status, each of which contributes to improving overall levels of country and human development (UN, 2013),this concurs with study findings which indicated a positive relationship between schools implementing Home Grown School Meals Programme and tungiasis occurrence at (χ^2= 1.455, df = 1, P<0.005),thus schools without HGSMP programme tended to suffer more from sanitation related diseases as compared to schools implementing HGSM.

Current study findings indicate a significant relationship between training on health related issues at school and suffering from tungiasis (χ^2= 3.938, df = 1, P<0.005). The study further revealed a significant relationship between participation in water, sanitation and hygiene programs and tungiasis occurrence (χ^2= 2.339, df = 2, P<0.005). There is evidence that health message-based hygiene promotion efforts alone are not always sufficient to motivate behavior change among adults in developing countries, but it is not known whether this strategy improves hygiene practices among children (Curtis *et al.,* 2011; Biran *et al.,* 2009); an evaluation of an intervention in Kenyan schools found no evidence that teacher trainings and school health club activities improved handwashing behavior (Njuguna *et al.,* 2008).

In this study, the overall prevalence of Tungiasis was found to be at 23.3% among children aged 15years and below with lesions mostly at the feet. In other studies, higher prevalence rates had been reported inclusive of other age groups during the dry season in poor rural communities and urban slums in Brazil, (Muehlen *et al.,* 2003, and Carvalho *et al.,* 2003). Njeumi *et al.,* (2002) reported a prevalence of about 50% among school children from different communities in the West Province of Cameroon neighboring Nigeria. In the year 2009, the prevalence was found to be the highest among children in the same country (Collins *et al.,* 2009). The most prevalent sequel was lesions which were observed among all the children diagnosed with the disease, most of the lesions were localized on the feet thus making pupils to have difficulty in walking and deformation of the toenails. This has also been observed among children in Tanzania (Mazigo *et al.,* 2011).

Study findings indicates a significant association between pupils affected by tungiasis ((χ^2= 6.000, df = 1, P<0.005) in the past 3 months. Further significance found that environmental factors significantly predicted tungiasis occurrence (p = .000). This concurs with a study by Ugbomoiko *et al., (*2006) which indicates that School-aged children may have a longer duration of exposure to an environment contaminated with T. penetrans without adopting appropriate protective behavior. It was observed that most of the children walked barefooted or, at best, wore slippers or open shoes. The high prevalence among children is probably a result of their greater exposure. In endemic areas closed foot wear has been described to reduce T. penetrans infestations which may reduce severity of the disease (Ugbomoiko *et al.,* 2006). Though the rate of Tungiasis prevalence varied across different age groups, the study found that demographic characteristics significantly predicted tungiasis occurrence (p = .000). Results showed that age of the pupils (p=0.028) influenced infestation of Tungiasis especially in schools with HGSMP, contrary to those pupils in schools without HGSMP and of the same age set (p=0.831). The different prevalence may be influenced to large extent by the different exposure behavior and age.

The current study revealed that behavioural factors significantly predicted tungiasis occurrence, (p = .000). This could also be attributed to sanitation related trainings in schools. One possible reason why older children had a lesser prevalence of Tungiasis than younger ones was because most of them were able to take care of their personal hygiene. Current study noted no significance between pupils with shoes and had jiggers (p = 0.350). Ugbomoiko *et al.,* 2008 noted that older children above fifteen years were likely to observe their personal hygiene. Also skillful older children carry out flea extraction for their friends and younger children at school (Ugbomoiko, 2007). The pupils who were very young had high concentration of Tungiasis' infestation than older pupils. This may also be due to limited knowledge about the parasites, inability to care for themselves or playing in dirty, dusty environment where the parasite thrives best. Secondly they may have just been enrolled to school translating into less contact with the parent thus less physical examination. It was also noted that younger sibling competed for care with their older siblings or left to be taken care of by grandparents, aunts or even left on their own. Thirdly, their ability to remove embedded female T. penetrans is limited and they exhibited less tolerance of the pain experienced during the process of physical removal.

These findings are in agreement with Muehlen *et al.* (2003) and Ugbomoiko *et al. (*2008) who found out that S-shaped prevalence pattern has been reported previously from a rural community in Brazil and Nigeria. The highest prevalence being among the children aged below 5years. The disease affected both gender (male and female) none discriminatively. Though the rate of Tungiasis varied among both sexes, the test results shows that there was statistically significant relationship between gender and infestation (P= 0.005). Data on sex distribution are inconsistent and, similar to age, are probably related to different exposure and disease-related behavior. For example, in some studies it has been observed more females than males to be affected in south Brazil, whereas other studies from Brazil, and Nigeria found more males to be affected, or no significant difference between the sexes (Carvalho *et al.*, 2003; AdeSerrano *et al.*, 1981; Arene FO, 1984; Muehlen *et al.*, 2003). In Cameroon, males were found to have high prevalence than females in Cameroon (Mazigo *et al.*, 2011).

Conclusions

The study concluded that there was a positive and significant relationship between the variables of the study and tungiasis infestation includes; Occurrences of WASH related diseases, Trainings on WASH, Implementation of HGSMP and tungiasis infestation. Schools without HGSMP, availability of handwashing facility with soap, availability of drinking water, gender, and toilet usage revealed no level of significance.

Tungiasis is prevalent among the children aged between 5-15 years in endemic areas. Acquisition of basic education can be improved by addressing and managing tungiasis which would promote school attendance and retention. In order to reduce burden of disease caused by tungiasis the health care providers should adopt effective and sustainable disease management measures. School and community-based health education is also imperative among these communities to significantly reduce the infestation and morbidity from tungiasis. This study recommends a focus on change in practices in the community and in schools to complement existing efforts aimed at controlling tungiasis. The study findings indicated that tungiasis occurrence is significantly influenced by environmental, demographic characteristics and behavioral factors.

Recommendations

1) Schools could be the most effective points of managing and controlling sanitation related diseases like tungiasis among the children in collaboration with community health workers who should do follow ups at household levels. This could also help reduce stigmatization if integrated with other routines such as deworming.
2) Interventions aimed at improving sanitation and hygiene in communities should always include targeted behaviour change interventions -adopt and upscale community and school based participatory approaches to overcome sanitation and hygiene barriers in resource constrained communities by application of relevant participatory approaches such as CLTS and PHAST.
3) This study found that acquisition of basic education could be improved by addressing and managing tungiasis in endemic areas. This would improve school attendance, retention and dropout which were found to be low among children who were suffering from Tungiasis.
4) The study also found that severe Tungiasis among the children was likely to cause continued absenteeism from school and stigmatization. School absenteeism on the other hand in most cases may result in low performance in standardized score tests.
5) There is need to develop capacity to improve Tungiasis management by providing adequate training and infrastructure to community health workers and teachers in charge of health care and hygiene of children in schools to enable then focus on management and treatment of sanitation related illnesses.
6) Finally, there should be continued and sustained research and surveillance on burden of disease caused by sanitation related illnesses like tungiasis.

List of abbreviations

CLTS: Community Led Total Sanitation

ESACIPAC: Eastern and Southern Africa Centre of International Parasite Control

KEMRI: Kenya Medical Research Institute

HGSM: Home Grown School Meal Programme

MDG: Millennium Development Goals

PHAST Participatory Hygiene and Sanitation Transformation

SERU: Scientific Ethical Review Committee

SHNP: School health and nutrition programmes

SPSS: Statistical Package for Social Sciences

STLS: School total led sanitation

UN: United Nations

WASH: Water Sanitation and Hygiene

DECLARATIONS

Ethics approval and consent to participate

This study was approved by the KEMRI Ethical Review Committee (SSC/ERC protocol No. (3029). The study used questionnaires uniquely coded with results of each questionnaire being kept in strict confidence. Participating in the study was voluntary and one could withdraw at any point. The purpose of the study and its objectives were explained to local authorities, opinion leaders, headteachers, and community members. Informed consent and assent was obtained from the participating respondents in writing. Parental consent was obtained for participants under 16. Subjects were assured about confidentiality of information obtained from them and personal identifiers were removed from the data set before analysis.

Consent for publish

Not applicable

Availability of data and materials

That all data used in the manuscript is available for sharing; including all relevant raw data, will be freely available to any scientist wishing to use them for non-commercial purposes, without breaching participant confidentiality.

Competing Interests

The authors declare that they have no competing interests.

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This study was self-funded and the author is a PhD student

Authors' contributions

JM- conceived of the study, participated in its design coordination, and helped to draft the manuscript.

SK-participated in the design, coordination and helped to draft the manuscript.

JM- participated in the design of the study and helped to draft the manuscript.

GK-participated in the design, coordination and helped to draft the manuscript. All authors read and approved the final manuscript.

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Tables

Table 1 Socio-Demographic Characteristics of Pupils

Distribution by Age (years)		**Frequency**	**Percentage**
5-9		12	5.0
10 -14		167	69.7
15-18		61	25.3
Distribution by Class			
3-4		11	4.6
5-6		117	48.7
7-8		112	46.7
Respondents			
	Male	113	46%
Pupils	Female	126	54%

Table 2 Prevalence of tungiasis

Disease	**No of Children Affected**	**Prev of Both Male and Female**	**Male**	**Prev of Male pupils**	**Female**	**Prev of Female pupils**
Jiggers	56	23.3%	38	15.8%	18	7.5%

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Table 3: Cross Tabulations on WASH practices in schools

	Occurrence of disease in the school	Gender: Male Yes Frequency (%)	Gender: Female No Frequency (%)	χ^2	df	P-value
	Yes	68(47.9)	74 (52.1)	7.979	1	0.005
	No	65 (66.3)	33(33.7)			
		Washing Hands				
	Yes	131 (94.)	7 (5.1)	0.556	1	0.456
	No	87 (92.6)	7 (27.4)			
		Place of washing hands at school				
	Yes	Tap water 82 (66.7)	Handwash Basin 16 (13.0) Leaky Tins 25(20.3)	0.027	2	0.986
	No	54 (66.7	10 (12.3) 17(21.0)			
		Use of Latrine/Toilet				
	Yes	131 (94.2)	8(5.8)	2.088	1	0.148
	No	81(89.0)	10(11.0)			
		Washing of hands with soap and water after visiting the toilet				
	Yes	Always 15 (10.6)	Sometime 20(14.2) Never 106(75.2)	2.219	2	0.330
	No	9(9.3)	8(8.2) 80(82.5)			
		Availability of drinking water in school				
	Yes	Always 64 (46.7)	Sometime 62(45.3) Never 11(8.0)	0.836	2	0.658
	No	42(44.2)	42(44.2) 11 (11.6)			
		Training on health related issues				
	Yes	Yes 120 (86.3)	No 19(13.7)	3.938	1	0.047
	No	74(76.3)	23(23.7)			
		Number of pupils affected with tungiasis in the last 3 months				
	Yes	1 1(100.0)	2 0(0.0)	6.000	1	0.014
	No	0(0.0)	5(100.0)			
		Age of Pupil suffering from tungiasis				
		5-15years	Above 15 years			
NO HGSMP	Yes	Yes 12(34.3)	No 23(65.7)	0.046	1	0.831
	No	5(31.3)	11(68.8)			
Have HGSMP	Yes	34(31.8)	73(68.2)	1.455	1	0.028
	No	33(40.2)	49(59.8)			

Table 4: Cross Tabulations on occurrences of tungiasis infestation

Tungiasis Occurrence	**No. of pupils with jiggers per stream**										**X2**	**df**	**P-Value**
Yes **No**	10 0(0.0) 1(11.1)	11 0(0.0) 1(11.1)	17 0(0.0) 1(11.1)	18 0(0.0) 1(11.1)	19 0(0.0) 1(11.1)	20 1(100.0) 0(0.0)	20 0(0.0) 1(11.1)	21 0(0.0) 1(11.1)	23 0(0.0) 1(11.1)	40 0(0.0) 1(11.1)	**10.000**	**9**	**0.350**
	Number of pupils with jiggers per class												
Yes **No**		Class 1 0(0.0) 1(12.5)	Class 2 0(0.0) 1(12.5)	Class 3 0(0.0) 1(12.5)	Class 4 0(0.0) 1(12.5)	Class 5 0(0.0) 2(12.5)	Class 6 1(100.0) 1(12.5)	Class 7 0(0.0) 1(12.5)			**3.937**	**6**	**0.685**
	No. of pupils wearing shoes per class												
Yes **No**	252 0(0.0) 1(11.1)	257 0(0.0) 1(11.1)	269 0(0.0) 1(11.1)	289 0(0.0) 1(11.1)	294 0(0.0) 1(11.1)	362 1(100.0) 0(0.0)	371 0(0.0) 0(0.0)	377 0(0.0) 1(11.1)	390 0(0.0) 1(11.1)	626 0(0.0) 1(11.1)	**10.000**	**9**	**0.350**

Table 5: Model Summary and Coefficients for Environmental Factors and Tungiasis

Model Summary for Environmental Factors and Tungiasis	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.894[a]	.800	.798	.259

a. Predictors: (Constant), Environmental Factors

Coefficients Table for Environmental Factors and Tungiasis		**Unstandardized Coefficients**		**Standardized Coefficients**	**Sig.**
		B	**Std. Error**	**Beta**	
1	(Constant)	1.716	.115		.000
	Environmental Factors	.590	.028	.894	.000

a. Dependent Variable: Tungiasis

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Table 6: Model Summary and Coefficients for Demographic Characteristics and Tungiasis

Model summary for Demographic Characteristics	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.859[a]	.725	.717	.572

a. Predictors: (Constant), Demographic Characteristics

Coefficients Table for Demographic Characteristics		Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	3.352	.429		.000
	Demographic Characteristics	.170	.100	.159	.002

a. Dependent Variable: Tungiasis

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Table 7: Model Summary and Coefficients for Behavioural Factors and Tungiasis

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.749[a]	.722	.715	.449

a. Predictors: (Constant), Behavioural Factors

Model		Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	2.313	.640		.000
	Behavioural Factors	.370	.154	.249	.011

a. Dependent Variable: Tungiasis

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Table 8: Coefficients for the Multiple and Moderated Model

Model		Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	.363	.087		.003
	Water	.532	.040	.521	.011
	Sanitation	.322	.064	.299	.009
	Hygiene	.323	.054	.364	.000

a. Dependent Variable: Disease Condition

Model		Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	.363	.087		.003
	Water	.532	.040	.521	.011
	Sanitation	.322	.064	.299	.009
	Hygiene	.323	.054	.364	.000
2	(Constant)	.376	.089		.000
	Water	.576	.065	.554	.001
	Sanitation	.356	.064	.342	.003
	Hygiene	.452	.057	.449	.000
	Weather and climatic conditions	.275	.034	.226	.001
	Household Factors	.223	.080	.229	.007

a. Dependent Variable: Disease Condition