Malaria Prevalence and Risk Factors in University Communities of Eastern Uganda: a case of Islamic University in Uganda

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Research

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Abstract

Background: Malaria remains the world's leading vector-born cause of mortality and morbidity, and Eastern Uganda contains some of the country's highest prevalence rates. Though academic societies, such as universities, may be prone to high malaria transmission, the extent of the burden and risk factors in university communities of Eastern Uganda are poorly understood. The aim in this study was to examine malaria prevalence, preventive strategies, and risk factors, among University communities in Eastern Uganda; to inform targeted malaria eradication efforts in academic settings.

Methods: A mixed methods approach was applied. A case study of Islamic University in Uganda (IUIU), located in Eastern Uganda, was selected. A retrospective approach was used to determine malaria prevalence in IUIU from August to December 2019. Stratified random sampling was used to select IUIU community members; these were subjected to semi-structured questionnaires and Key informant Interviews (KII) to examine the preventive approaches and risk factors. An observational survey was also conducted to identify barriers to malaria prevention. Data was analyzed using descriptive statistics, graphs, Chi-square, and pictures; with STATA version**-15.0**.

Results: The study involved 255 respondents (204, 80% students, 51, 20% staff); 130, 51% were males, 125, 49% were females. Malaria prevalence was; 12.9%, 11.7% and 12.7% for students, staff, and the general study population respectively. Lowest prevalence was registered in November (8.3% for students, 0% for staff), and the highest in December (18.4% for students, 6.7% for staff). Overall malaria prevalence in IUIU was significantly greater than Uganda's national prevalence (χ^2**=**182.009; p<0.0001; 95%CI). The commonest intervention was, sleeping under insecticide-treated mosquito-nets (96%), and the rarest was usage of medicinal herbs (15%). Though 41 (17.5%) of respondents who used mosquito-nets never suffered malaria, usage of mosquito-nets was not significantly associated with absence of malaria infection (p = 0.83). The same applied for other interventions except timely testing and treatment (p = 0.02). Most frequently mentioned risk factors were; improper use of mosquito nets (214, 84%), inappropriate depositing of garbage (196, 77%), and "staying out late" (133, 52%). Key barriers to malaria prevention observed were; usage of damaged bed nets (38, 19% of 198), clogged trenches with liquid wastes, and perforated wire meshes in ventilators.

Conclusion: The overall prevalence of malaria in IUIU community was 12.7%; and was significantly higher than Uganda's national prevalence (7%). Usage of insecticide-treated bed-nets was the commonest intervention, but showed no statistically significant association with malaria non-prevalence. Awareness programs should be enhanced to address inappropriate use of malaria control methods/tools, because the widespread adoption of these interventions alone did not effectively curb the burden.

Background

Malaria, occasionally called "the king of diseases", is the world's oldest and greatest parasitic cause of human illness and death (1–4). Malaria is ranked among the top global medical challenges, causing over 229 million annual cases, and tremendous impacts on the global economy and human welfare (3). Ninety percent of malaria-associated deaths occur in Africa, and the greatest impact is experienced in Sub Saharan Africa (SSA) (3,5). The malaria burden in SSA might escalate in the near future, because the proportion of the population that is at risk of acquiring malaria is increasing each year, partly due to the deterioration of health systems, drug resistance, natural disasters and climate change (6). In some East African countries such as Tanzania and Kenya, 90% and 75% of the population are at risk of contracting malaria respectively (7,8). In Uganda, there is a historical record of high malaria prevalence; for example, the country registered the world's fourth highest malaria prevalence, and third highest in SSA in the year 2015 (9). The disease is endemic in about 95% of the country, incurring tremendous impacts on over 90% of the population (10). At present, clinically diagnosed malaria is the leading cause of death and hospital visits in Uganda, accounting for over 30-50% of outpatient consultations, 15-20% of inpatient admissions, and about 20% of all inpatient deaths annually (Uganda Ministry of Health (UMoH), 2020; World Health Organization (WHO), 2020).

Eastern Uganda is one of the country's regions with the highest malaria burden despite the relative presence of some malaria control efforts, such as the use of insecticide treated mosquito nets (12–14). For example, in Mbale, one of the largest cities in Eastern Uganda, malaria prevalence was put at 21% compared to 7% national prevalence in the year 2019 (Madoi, 2019; UMoH, 2020). In order to roll back this burden, an inter-sectoral approach would potentially be more suitable and cost-effective (16). It is therefore essential that malaria research and interventions in Uganda focus on all key sectors and institutions, such as: infrastructure, environment and education, to establish concerted remedial actions. The factors that underpin limited success of malaria control strategies in education institutions, more so, universities in Eastern Uganda are poorly understood.

Most malaria research and interventions in Uganda have been mostly focusing on pregnant mothers, infants, drugs, and transmission dynamics in the non-academic settings (17–19). This hinders the design of risk-based preventive interventions in academic institutions such as universities. University students and staff commonly engage in late evening/night-time activities that may be academic or otherwise, posing a risk of plasmodium-infected mosquito bites, hence malaria infection. The consequences, besides death, can be disruption of school attendance and performance, absenteeism of the students, and inefficiency of staff, among others. In this research, a case study of Islamic University in Uganda (IUIU), Mbale campus (in Eastern Uganda), was adopted. In IUIU Mbale campus, malaria is perceived to be a major cause of ill health and economic burdens; surpassing other diseases such as urinary tract infections, ulcers, and pneumonia which were leading in the recent past (12). Scientific evidence about the malaria prevalence rates and mitigation challenges in this University is scarce. In this research; the malaria prevalence from November to December 2019, risk factors, and the approaches used for controlling malaria in IUIU were examined. The rationale was to inform targeted malaria eradication efforts for academic settings, to improve malaria control and public health protection in Uganda.

Methods

Study setting

The study was conducted from Islamic University in Uganda (IUIU) Mbale campus. The university is located in Mbale City, Eastern Uganda. The IUIU is approximately 2 kilometers north of Mbale city's central business area, on the Mbale-Soroti road. It is approximately 225 kilometers northeast of Uganda's capital and major commercial city, Kampala (Fig. 1). Mbale city lies at an average elevation of 1,156 meters (3,793 ft) above sea level. The coordinates of the city are 1°04'50.0"N, 34°10'30.0"E (Latitude: 1.080556; Longitude: 34.175000). The city also lies on the railway from Tororo to Pakwach. Mount Elgon, one of the highest peaks in East Africa, is approximately 57 kilometers (35 miles) north-east of Mbale, by road.

Theoretical basis to inform this University based study

In order to design this study, concepts drawn from two public health theories or models were combined and applied; *viz*; the Social Ecological Model (SEM), and the Health Belief Model (HBM). The SEM explains the linkages among several factors affecting health (disease prevention and treatment, malaria in this case), from individual level to the larger socio network and the environment (20). In this regard, the data collection instruments were designed not only to examine the factors related to human practices and perceptions alone, but also the general surroundings, such as; vegetation, infrastructure, drainage systems, and hospital facilities. According to the HBM, one's intention to protect him/her self or family against dangerous conditions (i.e., malaria in this case), depends on four factors; (i) the perceived *severity* of the dangerous event (for example malaria attack); (ii) perceived *vulnerability* (such as perceived vulnerability of the individual to malarial attacks); (iii) perceived *efficacy of the recommended preventive intervention* (for example, the perceived effectiveness of recommended actions that prevent or cure malaria, i.e. proper use of antimalarial medicines, Insecticide Treated Bed-nets (ITNs), prompt medical care-seeking behavior, among others); and (iv) the *perceived self-efficacy* (one's degree of confidence in his ability to undertake the recommend interventions, such as proper use of medicines, Indoor Residual Spraying (IRS) among other) (21). To this end, items in the research instruments were designed based on the framework and assumptions of both the HBM and SEM.

Study design

A mixed methods approach was adopted. A case study design was used, whereby IUIU main campus, Mbale; was selected based on its perceived record of high malaria burden (15). A retrospective cross-sectional survey was conducted, whereby by medical records were reviewed to determine the prevalence of malaria among patients who had received treatment at IUIU health center III (IUIU-HC III) from August to December 2019. Also, a descriptive cross sectional study approach was used to examine the risk factors for malaria spread and methods used for controlling malaria among the IUIU community.

Study population and sample size

The target population included all the members of IUIU community. This comprised of students, teaching staff, and non-teaching staff, such as; Library staff, administrators, medical and security personnel, among others.

The sample size was determined using the formula published by Fischer et al 1998 (22).

$$n = \frac{[Z^2 Pq]}{d^2}$$

Were; n = required sample size, Z = confidence level at 95% (standard value of 1.96), P = estimated prevalence of malaria in Mbale ≈ 21% (0.21) (Madoi, 2019; UMoH, 2020), q = 1-P (expected non-prevalence ≈ 0.79), d = accepted error of 5% (standard value of 0.05). $n = \frac{[(1.96)^2 \ x \ (0.21)x(0.79)]}{(0.05)^2} \approx 255$. Hence, the sample size (n) = 255 was adopted in this study.

Inclusion and exclusion criteria

Only the respondents that had attained the age of 18 years (consent age according to the Ugandan laws), at the time of data collection, and regularly sought medical attention at the IUIU HC III were included in this study. Potential clients that did not give written voluntary informed consent to participate in the study, and those that did not belong to the IUIU community were excluded.

Sampling techniques

The stratified random sampling approach was used to select the respondents. The study sample was divided into two strata, *viz*; (i) Students and (ii) Staff. In each stratum, simple random sampling (picking a chit out of a bowl), was used to select the respondents who were subjected to interviews and/or questionnaires. Purposive sampling was used during determination of malaria prevalence through medical records reviews.

Data collection methods and tools

Data were collected from both primary and secondary sources. Malaria prevalence among the IUIU community was determined retrospectively, by reviewing the medical record-registers at IUIU HC III, for client belonging to IUIU, who were diagnosed with malaria across a period of five months (1st August - 31st December 2019). A data abstraction tool was used. The prevalence was expressed as the percentage of members of IUIU community who tested positive for malaria infection, out of the total clients belonging to the target population, that visited IUIU HC III for treatment. Primary data, pertaining to the risk factors of malaria disease, and the approaches used for controlling malaria were collected by subjecting selected members of IUIU community to pretested, semi structured questionnaires, originally developed for this study. The questionnaires covered socio-demographic factors (such as gender and age), behavioral factors (such as staying out long), malaria prevention and treatment-seeking behaviors (such as self-medication, prompt seeking of medical care, home

keeping of medicines as a way of being ready for malaria attacks, use of ITNs), among others. An observation guide, and a camera were used to collect qualitative data related to the visible barriers to malaria spread in the IUIU premises.

Results

Socio-demographic characteristics of respondents

Out of 255 respondents who participated in this study, 130 (51%) were male, while the females were 125 (49%). Of these, 204 (80%) were students while 51 (20%) were staff. Majority, 194 (76%) were in the age category of 18-25 years while the minority, 23 (9%) were above 35 years. The respondents belonged to 11 nationalities namely; Ugandans 140 (55%), Nigerians 43 (16%), Somalis 18 (7%), Malawians 15 (6%), Kenyans 13 (5%), Sudanese 13 (5%), Rwandese 2 (1%), Tanzanians 2 (1%), Arabs 2 (1%), Indians 2 (1%), Comoros 5 (2%). The highest level of education attained by the respondents was PhD, 8 (3%), while the lowest was Uganda Certificate of Education (UCE) (6%). The results are summarized in Table 1 below.

Malaria prevalence in IUIU community from August to December 2019

Out of the 4396 clients who attended IUIU HC III to seek treatment between August and December-2019; 559 (12.7%), were diagnosed with malaria, hence a prevalence of 12.7%. Among the malaria positive cases, 472 were students, in the age group of 20 to 40 years; Of these; 300 (63%) were females while 172 (37%) were males. The Staff contributed 87 (2%) of the malaria positive cases, belonging to the age category of 23-73; 55 (63.2%) were females and 32 (36.8%) were males. The highest prevalence (17.6%) was reported in the month of December while the lowest (7.5%) was reported in November (Table 2).

Prevalence trends of malaria in the IUIU community

Figure 2 below indicates that the malaria prevalence among students (Fig. 2a) and staff (Fig. 2b) kept on fluctuating in the study period from August to November 2019, with a sharp increase in December. However, the general forecast trend (represented by dotted straight lines) shows that on average, the malaria prevalence across the period of study was fairly constant in each group. Among staff, the malaria prevalence first dropped to zero in November before sharply increasing to 18% in December (Fig. 2b).

Combined prevalence of malaria among students and staff of IUIU

Like in the case of group specific prevalence rates for students and staff (Fig. 2a and Fig. 2b), the combined prevalence rate showed a generally fluctuating trend from August to November, followed by a sharp increase in December. However, the forecast trend of the combined prevalence showed a slightly clear upward rise across the study period of August to December, as shown by the dotted line (Fig. 3).

Comparison of malaria prevalence rates among students and staff in the IUIU community

Figure 4, displays the malaria prevalence among students as compared to that of the staff in the IUIU community. Though the prevalence rates for the two groups followed a generally similar trend across the study period, the malaria prevalence rates among the staff were slightly lower than those of the students, with the exception of December, where it rose to 18 % among staff as compared to 17.6% among the students.

Comparison of malaria prevalence rates of IUIU community with the national prevalence rate in Uganda

The overall prevalence of malaria in IUIU community from August to December 2019, (12.7%) (Table. 2), was found to be higher than the 7% national malaria prevalence for Uganda, recently reported among the 41,034,354 registered population of Ugandans (15,24); the statistical significancy of the difference between the two prevalence values was evaluated (Table 3).

Consequently, the group specific malaria prevalence, as well as the combined prevalence rates were higher than the national prevalence rate throughout the study period, except for the staff whose prevalence dropped to 0.0% in November (Fig. 5).

Practices and methods used for malaria prevention and control in the IUIU Community

The practices and methods used for controlling malaria among members of the IUIU community were examined in order to gauge if they paused safety concerns in regards to escalation of malaria.

As shown in Figure 6, sleeping under insecticide treated bed nets and timely closing of windows and doors were the most reported practices undertaken by the community of Islamic university in Uganda; these were reported by 245, 96% and 242, 95% respectively. Timely testing and treatment of malaria were other practices reported frequently by the respondents at 209, 82%, followed by spraying using insecticides 176, 70%. The latter was majorly practiced by the males as it was reported at 140, 55% and it was highly undertaken by the single respondents at 196, 77% compared to the 59, 23% among the married clients. The use of herbs and herbal products was the least used (38, 15%), approach in the prevention and control of malaria among the IUIU community (Fig. 6).

Association between malaria control methods and/or practices, and the malaria status of the members of IUIU community

It was hypothesized that the practices and methods mentioned by respondents in this study (Fig. 6), did not have a statistically significant effect on control and prevention of malaria among the IUIU Community. Cross tabulations of each malaria control and prevention practice were done with a Chi-square statistic to test the statistical significance of the possible associations. The Chi-square results reported at a 5% significance level revealed that most practices did not help in preventing or controlling malaria in IUIU community (P-values > 0.05); except timely testing and treatment ($\chi^2 = 5.562$, P-value = 0.02), as shown in table 4.

Malaria diagnosis and treatment practices among members of IUIU community

Only 122, 48% of the respondents reported that they strictly utilize laboratory diagnosis to confirm malaria infection, and that they only take medicines prescribed by physicians. Other respondents reported not to seek prior medical consultation when they develop malaria symptoms; for instance, 41, 16% reported that they buy and consume antimalarial drugs from pharmacies/drug shops, while 20, 8% consume herbal medicine. About 89 (35%) of the respondents were aware of the names of common antimalarial drugs, and 15 (6%) were aware of the drugs which are no longer effective in treating malaria. Less than half, 83 (32%) reported that they buy and keep antimalarial medicines as a way of being prepared for malaria episodes, while 107 (42%) reported stopping to consume the prescribed anti-malaria drugs immediately when the symptoms get disappear or start to cease. One hundred and seventy-three (173, 68%), respondents reported that they commonly receive malaria treatment from the IUIU health center III; 26, 10% get treatment from other health centers outside IUIU; while 56, 22% of the respondents receive medical treatment from both IUIU health center III and other health centers outside IUIU (Table. 5).

Interventions regularly implemented by IUIU to prevent malaria

Waste management and disposal within IUIU, was the most frequently reported activity that most respondents (120, 47%), observed being undertaken by the university to promote malaria prevention. The least reported intervention was leveling of potholes around IUIU premises, 20, 8% (Fig. 7).

Risk Factors for Malaria spread in IUIU Mbale campus

Risk factors for malaria spread in the community of IUIU Mbale campus were investigated by, (i) subjecting the respondents to questionnaires and (ii) conduction an observational survey around the IUIU premises.

Awareness of the community about risk factors for malaria spread in IUIU

When examined about their knowledge of the factors that potentially predispose individuals to the risk of contracting malaria in IUIU, the majority, 214, 84% of respondents agreed that low/poor utilization of insecticide treated bed nets was a major factor. This was followed by the dumping of garbage, 196, 77% around residences; while the fact that malaria is a transmissible disease was the least reported risk factor among the respondents, 71, 28% (Table. 6).

Exploration of possible association between Risk factors and ever suffered from Malaria within the study period in IUIU community

To establish the plausible risk factors that could potentially increase malaria spread in IUIU among those in table 6 above, a bivariable analysis was conducted using cross tabulations with a chi-square test. The variable “Ever suffered from malaria while in IUIU” was taken as a proxy response variable. The variable that registers a significant relationship at the bivariable analysis could further be tested at the multivariable level to arrive at the independent effect of each significant factor on the potential spread of malaria. Results of the bivariable analysis are reported in Table 8 below.

The Chi-square test was performed against the hypothesis that each of the stated risk factors had no statistically significant relationship with one’s suffering from malaria in IUIU community. The research results reported in Table 8, do not give evidence for possible statistical associations between each of the plausible risk factors and the proxy outcome variable since all the computed probability values (P- values) were greater than 0.05, the chi-Square test significance level at 95% confidence interval. The multivariable analysis was therefore not conducted.

Awareness about malaria diseases management among members of IUIU community

Misdiagnosis was the most widely known cause of high malaria burden, 216, 85%; while self-medication was the least known, 23, 9% (Fig. 8).

Challenges affecting malaria treatment, prevention and control in IUIU community

The most frequently reported challenges encountered in the undertaking of malaria control approaches were those linked to the use of mosquito nets, viz; difficulty in hanging the bed nets since such provisions are not considered when designing the students’ beds and/or bed rooms, 255 (100%), mosquito nets were reported to be too expensive to be owned by some of the students 156 (61%), getting mosquito bites before entering bed 171 (67%), and bed nets get damaged very fast 224 (88%). Other challenges mentioned by the respondents were; high cost of medicines and insecticides 105 (41%), limited mandate to manipulated the IUIU environment by the students 87 (34%), allergic reactions to some common antimalarial drugs 10 (4%), limited access to authentic health information 8 (3%), and the inability to recognize whether the commercial bed nets are treated with genuine insecticides 8 (3%).

Factors that potentially influence malaria spread in IUIU that were revealed through observational survey

From the observational survey conducted by the research staff in this study, the following were found to potentially influence malaria spread in the IUIU community.

Malaria prevention resources observed in the on-campus residences

Among the 198, 78% respondents that allowed the research staff to examine their mosquito nets, 38 (19%), possessed bed nets with damages that were big enough to permit potential entry of mosquitos (Fig. 9.1); all the respondents affected by this anomaly were students.

Further, one of the students’ on-campus hostels was found to possess damaged wire meshes, which potentially provide a porous route for entry of mosquitoes Fig. (9.2).

All the resident staff (n = 6), declined to allow the research team to examine their malaria prevention equipment and housing facilities. In the University guest house, all the beds were found covered with appropriate mosquito nets and the facilities were regularly cleaned.

Waste management and disposal

Though daily collection of garbage and general cleaning of the University premises were observed throughout the entire study period, the garbage was deposited in large masses at open sites, close to selected residences, near IUIU HC III (Fig. 9.3).

Stagnant water and liquid wastes

Thought the potholes in the university compound were repaired regularly to eliminate mosquito breeding spots, stagnant water in the swamp close to some students' hostels, as well as stationary liquid wastes in trenches were observed (Fig. 9.4a and Fig. 9.4b).

4.6.4 Vegetation

Richness of vegetation cover was observed at IUIU main campus, ranging from trees and shrubs to herbs (Fig. 9.5). Regular pruning of some vegetation was observed across the study period.

Malaria management and control in IUIU lecture rooms

Though the University offers some evening courses, with lectures occurring beyond 8:30pm, there were no any observable measures established to prevent entry of mosquitoes into the lecture rooms, and prevention of malaria in general.

Malaria management and control within IUIU HC III

The diagnostic laboratory at IUIU HC III was found to contain functional equipment that were routinely used for malaria diagnosis through microscopy-based approaches. These included; electric microscopes, microscope slides, Giemsa stains, laboratory staff, and well written standard operating procedures (SOPs).

Copies of Uganda's Ministry of Health (UMoH) treatment guidelines, as well as the recommended antimalarial drug**s** such as; Coartem (Tabs), Duocotoxin (Tabs), Quinine (injection and Tabs), Artesunate (Injection), and Fansidar (Tabs), were found to be available for use during prescription and treatment of malaria. All the hospital beds 8 (100%), in this health center contained insect treated mosquito nets that were found not to possess any damages. The medical records were well kept using the format availed by the UMoH, incorporated in the University's database called IUIU-Electronic Resource Planning (ERP). The facility was relatively clean, and all windows and ventilators contained appropriate wires meshes to safeguards patients and staff against mosquito bites.

Discussion

Socio-Demographic characteristics of respondents

Two hundred fifty-five (255), members of the IUIU community participated in this study; 204 (80%), were students while the staff were 51 (20%), and 30 (51%) were males, while 125 (49%) were females. Majority, 194 (76%) were in the age category of 18-25 years and the minority, 23 (9%) were above 35 years. This is a true reflection of university communities whereby most students commonly belong to the ages above 18 years but below 26 years, as reported earlier in South Africa, Britain, Canada and United States of America (25–27).

Malaria prevalence in IUIU community from August to December 2019

According to the data collected from IUIU HC III medical records captured from August to December of 2019, the malaria prevalence rates were 12.9%, 11.7% and 12.7% for the students, staff and general study population respectively. The difference in the malaria prevalence rates among students and the staff was marginal. Though the overall malaria prevalence (12.7%), reported in the IUIU community in this study was less than that recently observed in university hospitals in other countries such as Colombia (15.2%); the burden in IUIU was found to be significantly higher than the 7% national malaria prevalence in Uganda ($p< 0.0001$) (Carreño-Almánzar et al., 2020; Madoi, 2019; UMoH, 2020). The lowest malaria prevalence rates in IUIU were registered in the month of November; 0% for staff and 8.3% for the students; while the highest prevalence, 18.4% and 6.7% among staff and students respectively were registered in the month of December. This might be partly explained by the fact that in December 2019, the IUIU community was reported to have engaged in end of semester examinations. Examination periods in Universities are associated with prolonged night reading, hence lengthy stays outside the beds on the side of side of students, posing a risk of mosquito bites and hence potential malaria episodes.

Practices and Methods used for malaria prevention and controlling in the IUIU Community

Sleeping under insecticide treated bed nets and closing windows and doors promptly were the most reported practices undertaken by the community of Islamic university in Uganda; the interventions were reported at 96% and 95% respectively. These findings conform to the malaria report published by WHO, which indicated that the use of long-lasting insecticidal nets (LLINs) is one of the most effective and commonest ways of preventing malaria (9). The LLINs confer protection against malaria by killing and/or repelling mosquitoes, hence limiting the transmission of plasmodium spp parasites. The use of herbs and herbal products was the least used (15%), approach in the prevention and control of malaria among the IUIU community. These findings are in agreement with a study conducted by John R.S. Tabuti, 2008, in Budiope district in Eastern Uganda. The study in Budiope district revealed that majority of the communities preferred treating and preventing malaria disease using allopathic medicines instead of plants, for reasons such as; the belief that synthetic medicines are more superior and effective, and the lack of adequate indigenous traditional knowledge necessary to exploit medicinal plants (29).

The scarce use of herbal medicine for the management and control of malaria in IUIU could be partly attributed to the population structure and the policy environment in this University. In this regard, the IUIU community comprises of a multinational population of relatively educated individuals. Accordingly, an earlier study has revealed that fewer people (44.4%), among those who are educated up to university level prefer using herbal medicine than individual

(83.3%), who have no education (30). Regarding the policy environment, the conduct of business in IUIU is closely regulated by the university administration, and access of the general public to the university is restricted. Herbal medicine (HM) vendors are therefore uncommon in the premises; yet HM are unavailable in the IUIU HC III, potentially limiting herbal medicine use.

Though 41 out of the 234 (17.5%), respondents that used insect treated bed nets (ITNs), did not suffer from malaria, the association between usage of ITNs and absence of malaria was not statistically significant (p = 0.83). Similarly, all other malaria control practices and/or methods employed by the respondents did not exhibit statistically significant association with malaria non-prevalence (Table 4), except timely testing and treatment of malaria (p = 0.02). This may partly explain why malaria prevalence in IUIU community was found to be significantly higher than Uganda's national prevalence rate (p< 0.0001). Therefore, though the recommended malaria control methods/tools are widespread among the IUIU community, there is need to address the appropriate utilization of these interventions.

One hundred and twenty-two (122, 48%), of the respondents reported to strictly depend on laboratory diagnosis to confirm malaria disease, followed by consumption of medicines that are only prescribed by physicians. This implies that more than 126 (50%), of the respondents potentially confirmed malaria disease by their personal judgement and treated the disease by self-medication. The use of antimalarial medicines without prescription is hazardous practice previously reported in several public health studies elsewhere (31–33). This practice has been associated with treatment challenges such as the evolution of antimalarial drug resistance and consequent escalation of the malaria burden (31,34). Less than half, 83 (32%) reported that they buy and keep antimalarial medicines as a way of being prepared for malaria episodes. Still, this poses treatment challenges since the medicines, during prolonged home storage conditions, may lose potency.

The commonest intervention implemented by the university, as reported by the respondents was garbage collection and regular cleaning of the university premises 120, (47%). This intervention is in agreement with other studies which implicated domestic waste as an escalator of malaria transmission, commonly necessitating prompt management (Castro, et al., 2009; Griffing, et al., 2015). The least reported intervention implemented by the university was leveling of potholes around IUIU premises, 20, 8%. This may contribute towards reduction of the malaria burden by elimination the existence of stagnant water in which mosquito vectors may breed.

Risk Factors for Malaria spread in IUIU Mbale campus

Among the risk factors mentioned by the respondents, low/improper use of mosquito nets was the most dominant (214, 84%), followed by the inappropriate depositing of garbage, 196, 77% around some residences. This was further confirmed through an observational survey (Fig. 9.3). Liquid wastes and solid garbage, such as wasted papers, plastics, food remains, plant materials have been reported to support mosquito breeding, cause clogging of drainage, and to have significant association with high malaria prevalence in some communities elsewhere (4,37). Other key factors suggested by the respondents, to potentially promote malaria spread in IUIU were; low/poor utilization of indoor residual spray (IRS), (163, 64%), and prolonged stay outdoors, (133, 52%). Similarly, "staying out late", has been severally implicated in escalating malaria in Africa and beyond (38–40). On the contrary, a chi-square test, at 95% confidence interval, revealed that all the risk factors stated by the respondents had no statistically significant relationship with one's suffering from malaria in IUIU community, because all the p- values were greater than 0.05 (Table 8).

Largely, our findings from the observational were in agreement with the views of the respondents. The observational survey revealed that, the mosquito nets for 38 (19%) among the 198 respondents who allowed inspection of their bed nets, possessed grave damages. This partly explains why the use of insecticide treated bed nets did not exhibit a statistically significant association with one's not suffering from malaria. Likewise, severe damages were observed on the wire meshes, fixed in the ventilation outlets of some students' hostels, potentially enabling mosquito passage (Fig 7.2). Also observed were the garbage hips (Fig. 7.3), and clogged trenches with stagnant liquid wastes (Fig. 7.4); these may promote abundancy of mosquito vectors, heightening the malaria burden (36). On the other hand, the situation in IUIU's staff guest house was safer, since all the beds were found covered with appropriate mosquito nets and the facilities were regularly cleaned. Similarly, no substantial visible risk factors were observed at the IUIU HC III in all the aspects of disease management, including diagnosis, treatment, record keeping, and protection of inpatients against mosquito bites. This may prevent the potential cases of nosocomial malaria which have been reported elsewhere (41).

Conclusion

The overall prevalence of malaria among the IUIU community from August to December 2019 was 12.7%; and was higher than Uganda's national prevalence (7%). Sleeping under insecticide treated bed nets, closing windows and doors promptly, and spraying using insecticides were the commonest interventions undertaken by the students and staff of IUIU. However, there was no statistically significant association of these interventions with the possibility of not suffering from malaria. Inappropriate utilization of insecticide treated bed nets, staying out late, dumping of garbage at open sites around residences, abundancy of vegetation and stagnant liquid wastes in trenches; were the most considerable risk factors that potentially increase the risk of malaria in the IUIU community. Interventions such as awareness programs should be prioritized to address the inappropriate usage of malaria control measures. Additional to pruning, the university should consider other methods such as fumigation, to safeguard against mosquito breeding on vegetation resources. Garbage collected from the university premises should be deposited in a closed structure. Innovations to support malaria prevention in the evening lecture rooms are warranted.

List Of Abbreviations

WHO; World Health Organization, IUIU; Islamic University in Uganda, UNCST; Uganda National Council for Science and Technology, UMoH; Uganda's Ministry of Health, IUIU HC III; Islamic University in Uganda Health Center Three, LLINs; Long-lasting insecticidal Nets, IRS; Indoor Residual Spray.

Declarations

Ethical approval and consent

The study sought approval from the institutional review board of the Islamic University in Uganda. Informed consent to participate in this study was obtained in writing from the study participants. Respondents' identifiers were recorded in form of assigned codes instead of names to ensure anonymity. All information from the participants were kept confidential & stored under lock and key; and password protected electronic files were stored during data analysis. The research was conducted in conformity to national guidelines for the conduct of research in the COVID-19 era established by the Uganda National Council for Science and Technology (UNCST) and UMoH (23).

Consent for publication

Not applicable

Availability of data and materials

Data sets generated and analyzed during this study are available from the corresponding author on reasonable request.

Competing interests

There were no competing interests in this study.

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Authors' contributions

"Abdishakur E. Warsame (AEW), Joweria Nakizito (JN), Shaban A. Okurut (SAO), Iramiot **J. Stanley (IJS), and** Ali Kudamba (AK) conceived the research idea, participated in data collection & analysis, and writing of the primary draft of the manuscript.

"Jamilu E. Ssenku (JES), Joseph Mpagi (JM), Mujibu Nkambo (MN), Aidah Namuli (AN), George **Gidudu (GG),** Hawa Nabuuma (HN), and Hussein M. Kafeero (HMK), participated in data analysis and were major contributors in writing the manuscript.

"Sarah Nachuha (SN), and Abdul Walusansa (AW) were advisors and supervisors in the study, they were major contributors in writing the manuscript and performed final editing of the manuscript.

"All authors read and approved the final manuscript."

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Tables

Variable	Frequency (n)	Percent (%)
sex of respondent		
Female	125	49
Male	130	51
Age category		
18-25 years	194	76
26-34 years	38	15
35 years above	23	9
Marital Status		
Single	194	76
Married	61	24
Highest level of education		
UCE	15	6
UACE/Remedial	94	37
Diploma	48	19
Bachelor's Degree	77	30
Master's Degree	13	5
PhD	8	3
Duration of stay in IUIU (yrs.)		
1-4 years	215	84
5-9 years	20	8
10 years above	20	8
Category of respondent		
Student	204	80
Staff (Teaching & Non-Teaching)	51	20

Table 1: Socio-demographic characteristics of the respondents

Month	Malaria status	Students	Staff	Total
August	Malaria positive	101	26	127
	Malaria negative	556	181	737
	Total Cases	657	207	864
	Prevalence (%)	15.4	12.6	14.6
September	Malaria positive	180	20	200
	Malaria negative	1314	182	1516
	Total Cases	1494	202	1696
	Prevalence (%)	12	9.9	11.8
October	Malaria positive	163	22	185
	Malaria negative	1151	202	1353
	Total Cases	1314	224	1538
	Prevalence (%)	12.4	9.8	12
November	Malaria positive	4	0	4
	Malaria negative	44	5	49
	Total Cases	48	5	53
	Prevalence (%)	8.3	0	7.5
December	Malaria positive	24	19	43
	Malaria negative	118	84	202
	Total Cases	142	103	245
	Prevalence (%)	16.9	18.4	17.6
Aug to Dec	Malaria positive	472	87	559
	Total Cases	3655	741	4396
	Prevalence (%)	12.91	11.74	12.72

Table 2: Malaria prevalence in IUIU community from August to December 2019

Place/ institution	Total of clients	Malaria Positive		Malaria Negative		χ^2	p-value at 95% CI
		Cases	Prevalence (%)	Frequency	Proportion (%)		
IUIU	4396	559	12.7	3837	87.3	182.009	< 0.0001*
Uganda	41,034,354	2,872,405	7	38,161,949	93		

CI=Confidence Interval, χ^2 = Chi-square

Table 3: Malaria prevalence in IUIU community from August to December 2019 versus the national prevalence

Malaria control practices/methods	Total respondents (N)	Never suffered from malaria while in IUIU, N (%)	Test for correlational significance at 5% CI	
			χ^2	P-value
leeping under insecticide treated bed ets	234	41	0.046	0.83
/earing Long-sleeved clothes	237	113	1.299	0.25
laking fire and smoke to control ıalaria	15	9	2.868	0.09
praying using insecticides	157	41	0.225	0.64
sing synthetic mosquito repellants	116	36	0.479	0.49
sing herbs and herbal products	33	15	1.853	0.17
losing windows and doors promptly	211	56	0.006	0.938
utting wire meshes in windows	113	27	0.592	0.44
nsuring proper disposal of waste	136	33	0.759	0.38
egularly cleans dark corners in the ouse	157	41	0.354	0.55
imely tests and treats malaria	178	39	5.562	**0.02***
sually attends malaria awareness rograms	107	21	2.258	0.13

Table 4: Significance of Correlation between Malaria control practices/methods and never suffered from Malaria, among the members of IUIU community from August to December 2019

Indicator Variable	Frequency (n)	Percentage (%)
What do you do when you develop malaria symptoms		
Going to a physician for assessment and prescription	189	74
Procuring antimalarial drugs from a pharmacy/drug shop	41	16
Consuming herbal medicine	20	8
Other actions*	23	9
How do you confirm that you have malaria infection		
When I take a laboratory test	122	48
Whenever I feel fever	36	14
Whenever I feel headache	26	10
Whenever I feel both headache and fever	71	28
Other signs and symptoms**	03	1.2
Do you know any names of antimalarial drugs; (Yes)	166	65
Do you knowing any anti- malaria drugs that are no longer effective in treating malaria; (Yes)	15	6
Do you keep antimalarial drugs as a way of being prepared for malaria; (Yes)	82	32
Where do you get Medical treatment while in IUIU		
IUIU Health Center	173	68
Other health centers	26	10
Both IUIU and Other Health center	56	22
Do you stop taking anti-malaria drugs when symptoms are improving	107	42

*Consulting spirits, praying to God; ** muscle pains, nausea, chills, sweats, vomiting, tiredness

Table 5: Malaria Diagnosis and Treatment practices

Variable	Number (n) of respondents in agreement	Percentage (%)
The following factors potentially increase malaria spread in IUIU; (a) Low/poor utilization of Insecticide treated bed nets (ITNs) potentially increase malaria	214	84
(b) The fact that malaria is a communicable disease	71	28
(c) Inadequate malaria awareness programs	153	60
(d) Low/poor utilization of indoor residual spray (IRS)	163	64
(e) Dumping garbage around residences	196	77
(f) Prolonged stay outdoors overnight	133	52
(g) High malaria prevalence in the community	89	35
(h) Shortage of antimalarial drugs	125	49
(i) Abundance of mosquito breeding sites such as stagnant water	186	73
(j) Poor management of solid and liquid wastes	176	69

Table 6: Perception of risk factors for malaria spread among members of IUIU community

Risk factors	Agree, N (%)	Ever suffered from malaria while in IUIU		Test for correlational significance	
		Yes (N)	%	χ^2	P-value
w/poor utilization of Insecticide treated bed nets (ITNs) potentially rease malaria in IUIU	214 (84)	158	62	0.872	0.35
ility of malaria to spread from one person to another potentially reases malaria spread in IUIU	56 (28)	59	23	1.418	0.23
dequate awareness programs potentially increase malaria spread in IU	153 (60)	107	42	0.493	0.48
w utilization of indoor residual spray (IRS) potentially increase malaria read	163 (64)	115	45	0.258	0.61
aying outdoors overnight potentially increase malaria spread in IUIU	135 (52)	115	45	1.880	0.17
evalence of Malaria in IUIU potentially increase malaria spread in IUIU	89 (35)	56	22	2.147	0.14
ortage of antimalarial drugs potentially increase malaria spread in IUIU	125 (49)	84	33	0.816	0.37
istence of mosquito breeding sites such as stagnant water near hostels tentially increase malaria spread in IUIU	186 (73)	143	56	0.668	0.41
or management of solid and liquid wastes potentially increase malaria read	176 (69)	130	51	0.369	0.54
mping garbage around IUIU hostels potentially increase malaria spread IUIU	196 (77)	143	56	0.261	0.61

ble 8: Cross Tabulations of Risk factors for malaria spread with Ever Suffered from malaria Status while in IUIU

Figures

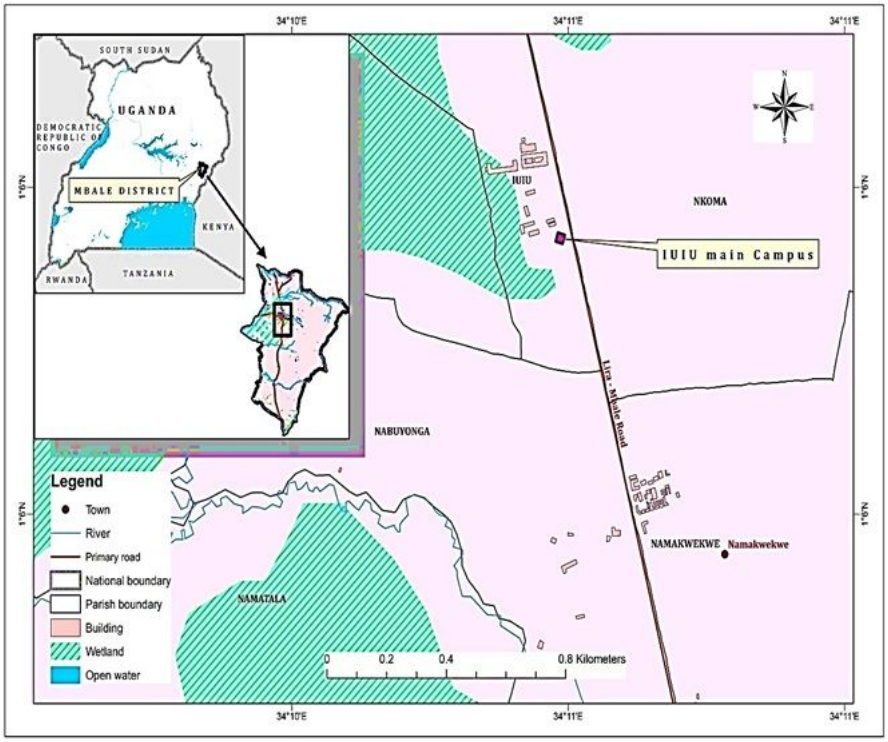

Figure 1

Map showing the study site

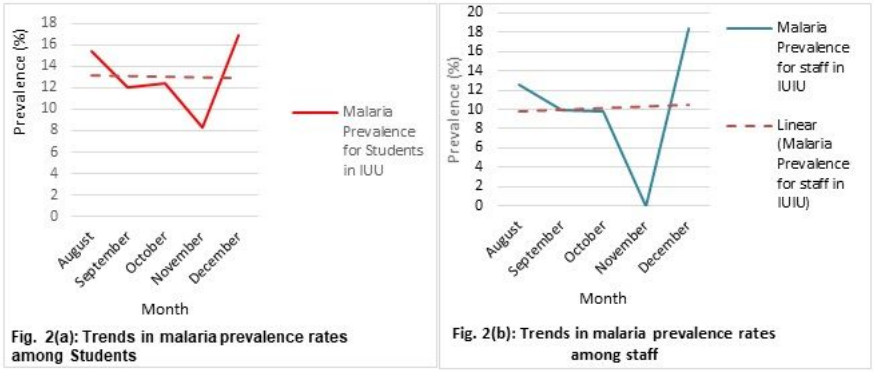

Figure 2

Trends in malaria prevalence rates in the IUIU community from August to December 2019

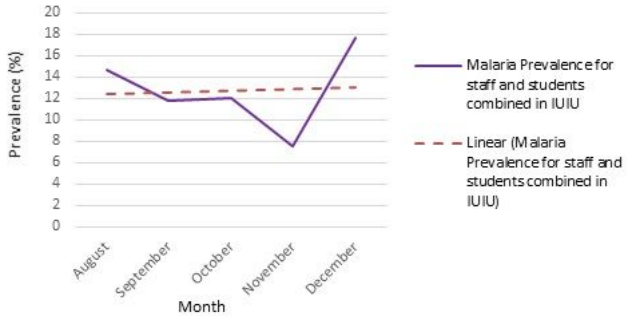

Figure 3

Combined malaria prevalence for students and staff from November to December 2019 in IUIU

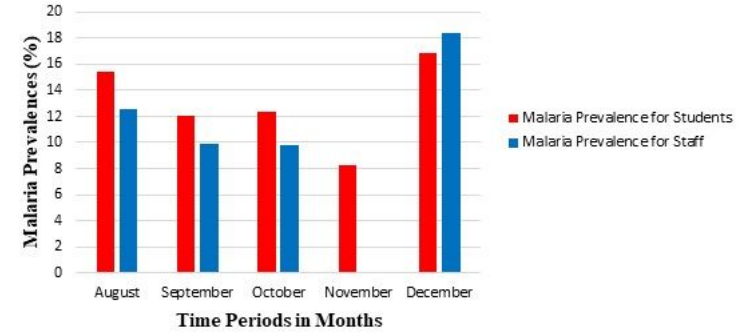

Figure 4

Comparison of malaria prevalence rates among students and staff of IUU from August to December 2019

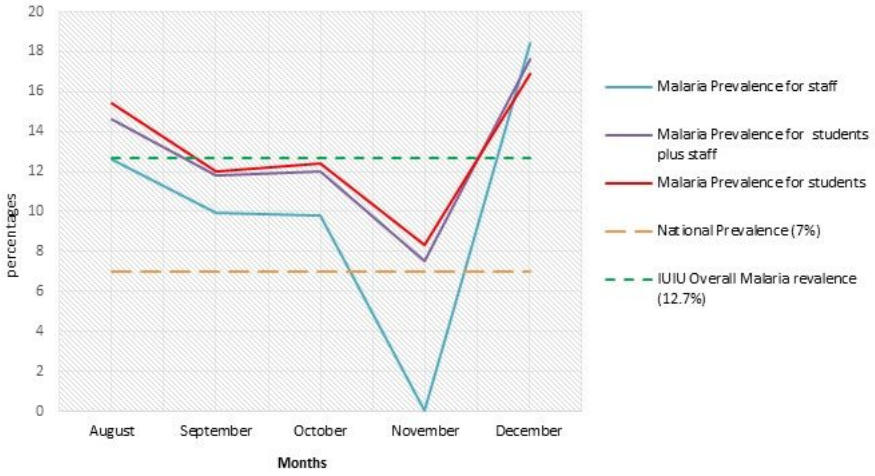

Figure 5

Malaria prevalence for staff, students and staff-students combined in IUIU, August-December 2019

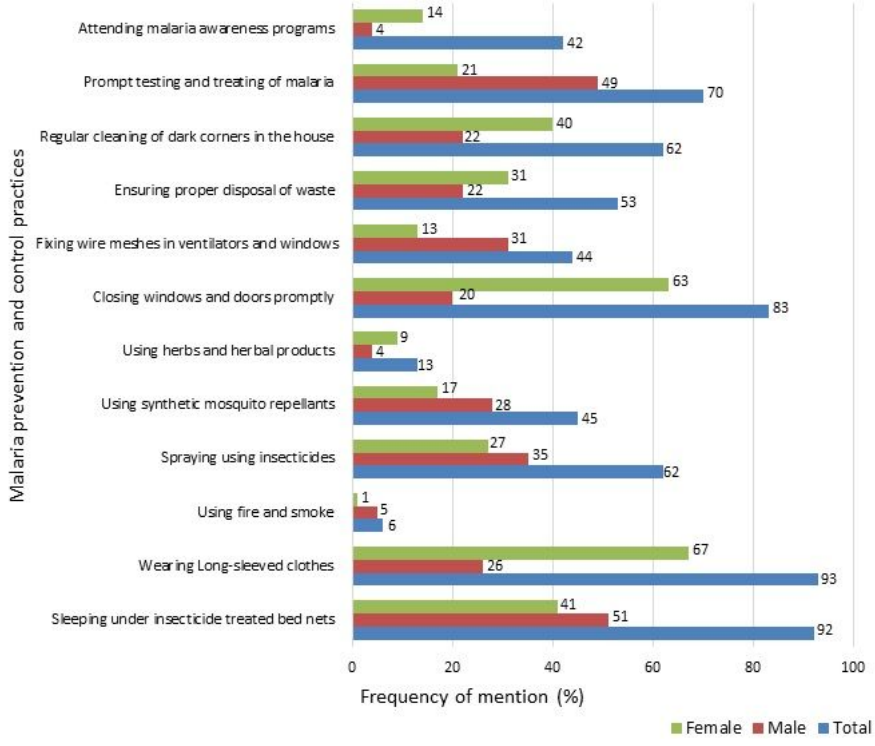

Figure 6

Methods and practices used in controlling malaria among the IUIU community

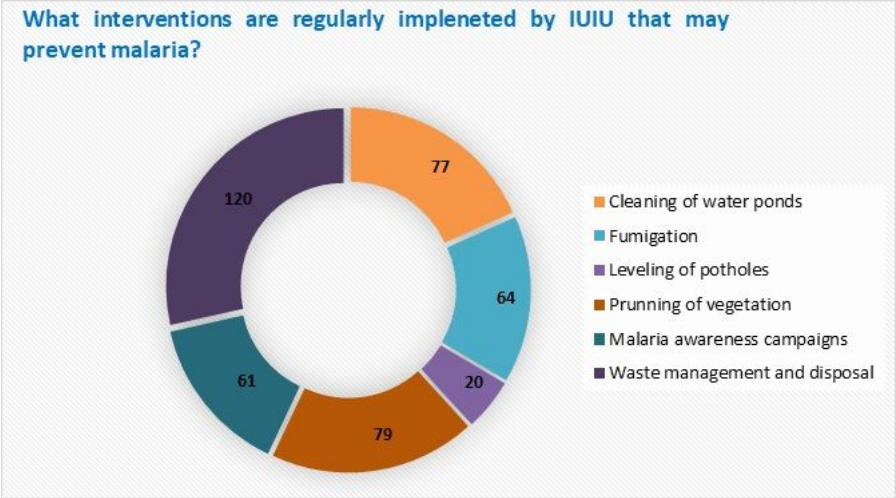

Figure 7

Number of respondents that reported the interventions regularly implemented by the university / IUIU which may prevent malaria

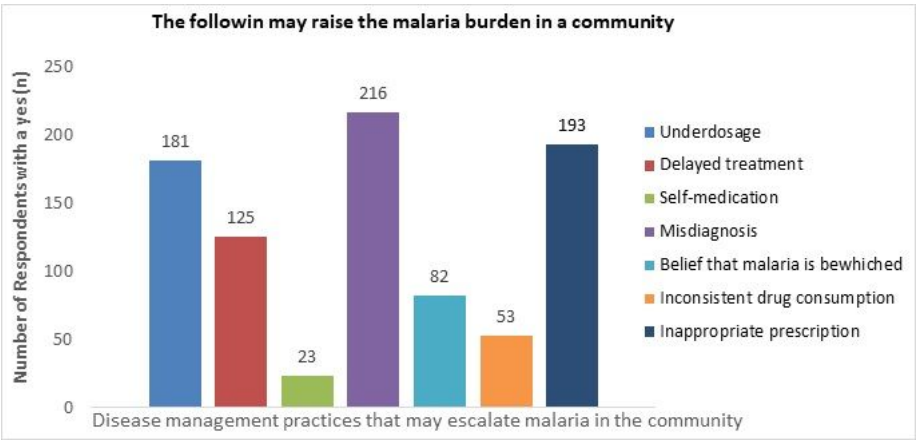

Figure 8

Awareness about disease management practices that may escalate malaria in the community

Figure 9

9.1: Representative image for damaged mosquito nets possessed by some members of the IUIU community, posing a potential risk of malaria spread. 9.2: Representative image for damaged ventilation wire meshes found in one of the students' on-campus residences at IUIU. 9.3: Representative image for garbage at a deposit site close to one of the female students' residences at IUIU. 9.4: Representative image for stagnant water that may serve as potential breeding spots for mosquitoes at IUIU. 9.5: Representative image for vegetation cover at IUIU premises

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Warsameetal2021.pdf