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Community education training to optimize the use of artemisinin-based combination therapy in Kamuli District, Uganda

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Abstract

Background Community health education improves members health-seeking and utilization behaviours. To enhance the community knowledge and optimize the use of Artemisinin-based combination therapy (ACT), we carried out a community training in Kamuli District, Uganda.

Methods The Analysis, Design, Development, Implementation and Evaluation (ADDIE) model was adopted. A total of 3420 community members were trained, 384 sampled to participate in pre-post-test assessment, with 76 healthcare workers (HCW). Community members were sampled by simple random sampling while the HCW were purposively selected. Community trainings occurred for two days at each of 42 public health facilities and one day at 27 parishes. A paired sample t-test and effect size was computed to establish effect with statistical significance tested at $p < 0.05$.

Results Overall, a total of 3496 participants, majority 2705 (77.4%) females were trained. A total of 3420 community members, majority 2659 (77.7%) females trained, and 76 HCW, majority 46 (60.5%) females trained. The median age of community participants was 32 years, and interquartile range (IQR) = 17 years. The median age of HCW was 32 years, and IQR = 8 years. The training had a positive and significant effect on the community members knowledge: malaria transmission (T-test = 9.359; $p < 0.0001$) causes of malaria (T-test = 6.738; $p < 0.0001$), malaria symptoms (T-test = 5.403; $p < 0.0001$), dangerous malaria species (T-test = 12.088; $p < 0.0001$), *Plasmodium vivax* malaria cycle and occurrence every 48 h (T-test = 7.470; $p < 0.0001$), assessing whether a patient with malaria may suffer from jaundice (T-test = 7.228; $p < 0.0001$), organs affected by *Plasmodium falciparum* (T-test = 12.214; $p < 0.0001$), malaria diagnosis (T-test = 9.765; $p < 0.0001$), Plasmodium associated with malaria relapse (T-test = 10.250; $p < 0.0001$), and malaria prevention and control (T-test = 9.278; $p < 0.0001$). The intervention also had a significant and positive effect on HCW knowledge on all domains except on malaria transmission (T-test = 1.217; $p = 0.228$) where it didn't have any statistically significant increase on their knowledge.

Conclusion The education intervention improved the knowledge of participants significantly. There is need to adopt and scale-up the current intervention at all levels of care to enhance proper use of medicines.

Keywords Community training, Malaria, Uganda

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Background

Malaria is an old infectious disease that has inflicted mankind for decades caused by infection with Plasmodium parasites and transmitted by an infected female anopheles mosquito [1]. Globally, there was an estimated 247 million malaria cases in 2021 an increase from 245 in 2020, and up from 230 million malaria cases in 2015, the baseline year of the Global Technical Strategy for malaria (GTS), with the World Health Organization (WHO) African region accounting for 95% of the burden [2]. Uganda contributes 5% of the global malaria burden, ranking third on the African continent [2], and the disease is endemic (30–50%) where most outpatients' department (OPD) care in facilities are due to malaria [3]. The successful implementation of the 10 programmatic elements of the national malaria policy [4] hinges on the best by-in of individuals and community at large. Continuous health education both at facilities and community are key in improving community knowledge and subsequently their adherence to health providers advise [5], and adherence to Artemisinin-based combination therapy (ACT) prescriptions in particular. Importantly, patient adherence to antimalarial prescription is a major determinant of the drug efficacy as most times, most disease treatments are done at home without professional supervision [5]. Studies done elsewhere have shown that patient and community education on use of medicines improves their adherence to prescriptions and use of medicines [6–11]. However, a baseline study done in Kamuli District showed a knowledge gap exists among community members on malaria and proper use of ACT [12]. If one is properly educated on proper use of antimalarial treatment, common misconceptions may be dispelled, and behaviour may subsequently be improved. Therefore, we sought to establish the community members' knowledge scores following participation in a community health education, designed to address identified gaps, so as to optimize the use of ACT in Kamuli District, Uganda.

Methods

Model

The Analysis, Design, Development, Implementation and Evaluation (ADDIE) instructional model [13], was adopted to conduct a malaria community training. At baseline, data on patients' adherence level and factors influencing their adherence to ACT was collected and analyzed [12]. We then customized/designed on appropriate training intervention, developed the materials for instruction, conducted the training, and evaluated the participant's knowledge gain through pre-post-test assessment. The developed training materials were continuously revised during the implementation phase. The community education trainings were done in the month of May 2023. The training method was both didactic and participatory. The training targeted the community members specifically, with healthcare workers (HCW) trained to aid sustainability of trainings at health facilities and within the community during facility outreach campaigns.

Content

The training was divided into four modules; (1) Uganda national malaria policy (policy goal, objectives and elements), (2) parasitology and entomology (causes, transmission, distribution, life cycle, vector habitation, and malaria prevention and control), (3) clinical features (clinical features of malaria, common signs and symptoms of uncomplicated and complicated malaria, and (4) malaria management [treatment using ACT - important instructions to follow when taking ACT, what to do if you take more medicines than you should and what to do if you forget to take the medicine, things you need to know before use of ACT, possible side effects of ACT, medicine storage, myths about malaria, advantages of completing treatment and disadvantages of non-completion, things to do and never to do at home and role of healthcare workers (HCW)].

Strategy

The trainings were conducted through the following channels; (1) at the outpatient departments of the 42 public health facilities within Kamuli district for two days targeting patients seeking services at these facilities on pre-announced days – lasting 30 min (15–20 min for presentation and 10–15 min for question and answer sessions, (2) 27 parish community trainings each training lasting 1 h (40 presentation and 20 min question and answer session) on pre-communicated days using the village health teams (VHT) model [6, 14, 15], and (3) facility-based training/mentorship of HCW at the 42 public health facilities lasting one hour (45 training and 15 min question and answer) (Additional file 1). The customized guide was shared with the participants during such engagements for continual referral after training. Using a participant paper-based self-filling questionnaire, a brief assessment before (pre-test) and after (post-test) each training of the participants was performed to assess change in their knowledge. Furthermore, use of visuals on the blister packs and displayed posters was done. The training was both didactic and participatory. This helped in assessing the knowledge level of the participants and immediate contribution of the training to the participants.

Study area

The study area was Kamuli District, located in South-Eastern Uganda, and which was originally known as Bugabula District and started in 1974. The district is

rural, economically poor and lies in the region that ranks third in having the highest malaria burden in the country [16]. Malaria is highly prevalent, and accounts for 33% of outpatient department cases and 21% of inpatients admissions [17]. Malaria is holoendemic with peak transmissions occurring from March to May and September to December [18]. The district is served with one public hospital, 2 public health center (HC) IV facilities at county level, 12 public HC III's at sub-county level, and 27 public HC II's at parish level, with numerous privately-owned clinic and dispensaries offering malaria-related services to the locals [19]. The education was based at public facilities as they manage more patients compared to private facilities [20, 21], and within the community at parishes.

Sample

Study population and eligibility criteria

All patients and caregivers/ guardians of minors who were at OPD waiting for services were eligible for participation irrespective of age, gender and their medical history. In the community trainings, all members residing in the area were eligible and invited through their VHT member. The target population also included HCW.

Sample size

The intervention was set to optimize the appropriate use of ACT by the community. The community participants sample size was calculated based on the formula $n = Z^2 * P(1-P)/e^2$ [22], assuming a 95% confidence interval (CI), with an allowable error of 5% and a 50% appropriate use. The final sample size was calculated as follows: $n = (1.96^2 * 0.5 * 0.5)/0.05^2$, $n = 384$. All accessed health providers found managing patients at the public facilities during the training were requested to be included in the study leading to a total of 76 HCW being enrolled.

Sampling procedures

Community members involved in the evaluation exercise were enrolled by simple random sampling method. Since trainings occurred at 42 public health facilities for 2 days at OPD plus one day at 28 parishes, final number of community participants involved in the pre-post-test evaluation was 384 / 112=4 participants. Numbers say 1, 2, 3, ……., n, were written on small pieces of paper, folded, and put in an empty box. The box was shaken and members asked to pick out a paper. Participants who picked out papers with the first four even numbers say, 2, 4, 6, and 8 were asked to participate in the pre-post evaluation activity. In case one declined, the immediate person with the next even member was enrolled hence simple random sampling.

Data collection procedures

Seven trained research assistants (RA) led by the principal investigator (PI) constituted the training and data collection team. The RA had at least a certificate in a medical course, with 1–2 years' working experience in the community. These were trained further in pedagogical methods, on the customized community training guide and use of the various study tools by the PI. The PI provided oversight for the team and obtained all the necessary administrative clearances from the parish chiefs and facility in-charges before proceeding with the trainings. Once permission was granted, trainings were conducted. At the start of the training, four participants were sampled to complete the pre-test evaluation. The training was then delivered, participants asked questions and these were answered by the team, and then a post-test assessment done on the same four participants who had done the pre-test. For HCW, all those present were asked to complete the pre- and post-test assessment. At the end of each training, team evaluation was done and plan for the next training drawn. The PI checked all data at the end of the day for completeness. Primary data was elucidated from the field using pre-post evaluation tool.

Data Analysis

Data capture screens were designed in Epi-data version 3.1 with inbuilt checks and double entry command to minimize data entry errors. Data were entered and secured on a protected computer. Data were transferred from Epi-data to IBM SPSS version 20 software for statistical analyses. Exploratory analyses were done to check for cleanliness and any outliers or erroneous looking data were cross-checked and cleaned where errors were identified. The indicators for measuring effectiveness in this study were knowing: (1) malaria transmission, (2) causes of malaria, (3) symptoms of malaria, (4) most dangerous malaria type, (5) fever in *Plasmodium vivax* malaria seen every 48 h, (6) a patient with malaria with jaundice, (7) organ(s) affected by *Plasmodium falciparum*, (8) diagnosis of malaria, (9) type of Plasmodium causing malaria relapse, and (10) precaution(s) of preventing malaria (Additional file 2). To measure the effectiveness of health education intervention on participants knowledge, a paired samples t-test [23, 24] was done and the magnitude of the intervention's effect obtained by calculating the effect size statistic using the formula; Eta squared $= t^2/(t^2+N-1)$ [23], and interpreted according to Cohen (0.01 – small effect, 0.06 – moderate effect and 0.14 – large effect) [25]. Statistical significance was established at $p<0.05$.

Ethical considerations

Before study implementation, we obtained protocol approval from the Maseno University Scientific and

Ethics Review Committee (MUSERC/01122/22), the Mengo Hospital Research Ethics Committee (MH/REC/144/10-2022) and the Uganda National Council for Science and Technology (HS2576ES). Kamuli District Local Government and Kamuli Municipal Council provided administrative clearances for the teams to visit the facilities and communities. The training objectives, its benefits and potential risks and its procedures were explained to all study participants. Informed consent was obtained from all participants and/or legal guardian(s) for minors before participation in the study. Further informed consent was obtained from all subjects and/or their legal guardians for publication of identifying information/ images in an online open-access publication. Subject names were removed from all text/figures/tables/images for anonymization.

Results

Baseline characteristics

Eight four community trainings were conducted at the OPD of 42 public health facilities for 2 days at each facility, and 27 community trainings conducted at the parish level (Additional file 1). Overall, a total of 3496 participants were trained, majority 2705 (77.4%) females. During the facility sessions, 76 healthcare workers were trained, majority 46 (60.5%) being females. Additionally, total of 3420 community members were trained, majority 2659 (77.7%) females. A total of 2160 community members, majority 1650 (76.4%) were females trained at parishes, and 1260, predominantly 1009 (80.1%) females trained at OPD of the public facilities. Among those participating in the assessment, majority 343 (89.3%) were females. A total of 272/384 (70.8%) were assessed at OPD. The median age of community members was 32 years, with the youngest at 18 years and oldest 71 years, and with an interquartile range of 17 years. A total of 76 HCW were trained and assessed. Majority of the HCW 46 (60.5%) were females. The median age of HCW was 32 years, with the youngest at 23 years and oldest at 54 years, and with an interquartile range of 8 years (Table 1).

Effect of community malaria training on community members' knowledge

The results in Table 2 demonstrate the effect of community malaria training on the knowledge of community members. It shows that the training significantly increased their knowledge on various aspects. On **malaria transmission**, there was a statistically significant increase in the knowledge scores from pre-test time (mean=0.70, SD=0.457) to post-test time (mean=0.95, SD=0.228), T-test=9.359, $p<0.0001$, fairly adequate mean increase of 0.242, and a large effect size (0.19). Regarding **causes of malaria**, the training significantly increased their knowledge scores from pre-test time (mean=0.39, SD=0.487) to post-test time (mean=0.63, SD=0.485), T-test=6.738, $p<0.0001$, fairly adequate mean increase of 0.24, and a moderate effect size (0.11). On the **symptoms of malaria**, like fever and chills and what happens when the parasite enters the liver, the community education significantly increased their knowledge from pre-test time (mean=0.32, SD=0.465) to post-test time (mean=0.49, SD=0.501), T-test=5.403, $p<0.0001$, very inadequate mean increase of 0.177, and a moderate effect size (0.07). In regards to the **most dangerous malaria type**, the community training significantly increased the participants knowledge from pre-test time (mean=0.24, SD=0.429) to post-test time (mean=0.60, SD=0.491), T-test=12.088, $p<0.0001$, fairly adequate mean increase of 0.357, and a large effect size (0.28). Also, on whether ***P. vivax*malaria cycle and occurrence every 48 h**, there was a significant increase in participant knowledge from a pre-test time (mean=0.52, SD=0.5) to post-test time (mean=0.74, SD=0.438), T-test=7.470, $p<0.0001$, fairly adequate mean increase of 0.227, and

Table 1 Background information of participants trained

Training venue	Gender		Total *n* (%)
	Female, *n* (%)	Male, *n* (%)	
Community members trained			
Outpatient department of public health facilities	1009 (80.1)	251 (19.9)	1260 (100)
Community trainings at parishes	1650 (76.4)	510 (23.6)	2160 (100)
Community members participating in the assessment			
Sex	343 (89.3)	41 (10.7)	384 (100)
Age	Median = 32, Min = 18, Max = 71, IQR = 17		
Training group	OPD = 272, parish = 112		
Sub Total	**2659 (77.7)**	**761 (22.3)**	**3420 (100)**
Healthcare workers			
Sex	46 (60.5)	30 (39.5)	76 (100)
Age	Median = 32, min = 23, Max = 54, IQR = 8		
Overall total	**2705 (77.4)**	**791 (22.6)**	**3496 (100)**

n – frequency, % - percentage, Min = Minimum, Max = Maximum, IQR = Interquartile range

Table 2 Effect of community malaria training on community members' knowledge ($n = 384$)

Characteristic		Paired samples statistics			Paired differences					t-test	*P* value	Eta squared
		Mean	SD	Std Error Mean	Mean	SD	Std Error Mean	95% CI of the Difference				
								Lower	Upper			
Malaria transmission	Post	0.95	0.228	0.012	0.242	0.507	0.026	0.191	0.293	9.359	0.000	0.19
	Pre	0.70	0.457	0.023								
Causes of malaria	Post	0.63	0.485	0.025	0.240	0.697	0.036	0.170	0.309	6.738	0.000	0.11
	Pre	0.39	0.487	0.025								
Symptoms of malaria like fever, chills, and sweating are seen when the parasite enters the liver	Post	0.49	0.501	0.026	0.177	0.642	0.033	0.113	0.242	5.403	0.000	0.07
	Pre	0.32	0.465	0.024								
Most dangerous malaria type	Post	0.60	0.491	0.025	0.357	0.578	0.030	0.299	0.415	12.088	0.000	0.28
	Pre	0.24	0.429	0.022								
Fever in Plasmodium vivax malaria is seen every 48 h	Post	0.74	0.438	0.022	0.227	0.594	0.030	0.167	0.286	7.470	0.000	0.13
	Pre	0.52	0.500	0.026								
A patient with malaria may suffer from jaundice	Post	0.75	0.432	0.022	0.229	0.621	0.032	0.167	0.292	7.228	0.000	0.12
	Pre	0.52	0.500	0.026								
Organ(s) affected by Plasmodium falciparum	Post	0.74	0.439	0.022	0.409	0.656	0.033	0.343	0.475	12.214	0.000	0.28
	Pre	0.33	0.471	0.024								
Diagnosis of malaria?	Post	0.56	0.497	0.025	0.310	0.622	0.032	0.247	0.372	9.765	0.000	0.20
	Pre	0.25	0.432	0.022								
Type of Plasmodium causing malaria relapse	Post	0.52	0.500	0.026	0.323	0.617	0.032	0.261	0.385	10.250	0.000	0.22
	Pre	0.20	0.401	0.020								
Precaution(s) of preventing malaria	Post	0.68	0.465	0.024	0.292	0.616	0.031	0.230	0.353	9.278	0.000	0.18
	Pre	0.39	0.489	0.025								

n = sample size, SD = standard deviation, std = standard, CI = confidence interval, Mean Scale: 0.00–0.20 = very low mean (very inadequate), 0.21–0.40 = low mean (fairly adequate), 0.41–0.60 = moderate mean (somehow adequate), 0.61–0.80 = high mean (adequate), 0.81–1.00 = very high mean (very adequate)

a moderate effect size (0.13). On assessing knowledge whether a **patient with malaria may suffer from jaundice**, there was a statistically significant increase on the knowledge scores from pre-test time (mean=0.52, SD=0.5) to post-test time (mean=0.75, SD=0.432), T-test=7.228, $p<0.0001$, fairly adequate mean increase of 0.229, and a moderate effect size (0.12). On further understanding of which **organ(s) are affected by*P. falciparum***, there was a statistically significant increase on the knowledge scores from pre-test time (mean=0.33, SD=0.471) to post-test time (mean=0.74, SD=0.439), T-test=12.214, $p<0.0001$, somehow adequate mean increase of 0.409, and a large effect size (0.28). Regarding **malaria diagnosis**, the community training had a significant increase on the knowledge of the participants from pre-test time (mean=0.25, SD=0.432) to post-test time (mean=0.56, SD=0.497), T-test=9.765, $p<0.0001$, fairly adequate mean increase of 0.31, and a large effect size (0.2). Also, on understanding the **type of plasmodium responsible for malaria relapse**, the community training had a statistically significant increase on their knowledge from pre-test time (mean=0.2, SD=0.401) to post-test time (mean=0.52, SD=0.5), T-test=10.250, $p<0.0001$, fairly adequate mean increase of 0.323, and a large effect size (0.22). On assessment of the various **precautions/ways of preventing malaria**, the community training significantly increased their knowledge from a pre-test time (mean=0.39, SD=0.489) to post-test time (mean=0.68, SD=0.465), T-test=9.278, $p<0.0001$, fairly adequate mean increase of 0.292 and a large effect size (0.18).

Community members perspectives on the community malaria training

Community members (administrators, politicians and local people) *were very positive with attending the trainings both at public health facilities and parishes* (Additional file 3). However, *a section decried the long distance traveled to reach parishes and wanted these organized per village/ zone throughout the district*. Another community member said that "*the training opened his eyes to know more about malaria and why it is very important to follow the "Musawo" (healthcare worker) advise when taking antimalaria medicines if one is to get cured*".

Effect of malaria training on healthcare workers knowledge

Table 3 results show the effect of the education malaria training on healthcare workers knowledge. On **malaria transmission**, the current training did not significantly increase their knowledge from pre-test time (mean=0.84, SD=0.367) to post-test time (mean=0.91, SD=0.291), T-test=1.217, $p=0.228$, very inadequate mean increase of 0.066 and small effect size (0.02). On **causes of malaria**, the training significantly increased their knowledge from pre-test time (mean=0.3, SD=0.462), to post-test time (mean=0.93, SD=0.25), T-test=10.240, $p<0.0001$, adequate mean increase of 0.632, and large effect size (0.58). Regarding the various **symptoms of malaria** being observed in a patient once malaria parasite(s) enter the liver, the training had a statistically significant increase on HCW knowledge from pre-test time (mean=0.47, SD=0.503) to post-test time (mean=0.96, SD=0.196), T-test=7.666, $p<0.0001$, moderate mean increase of 0.487, and large effect size (0.44). On the most **dangerous malaria type**, the training had a statistically significant increase on their knowledge from pre-test time (mean=0.51, SD=0.503) to post-test time (mean=0.89, SD=0.309), T-test=6.151, $p<0.0001$, fairly adequate mean increase of 0.382 and large effect size (0.34). Also, regarding **fever in*P. vivax*being seen every 48 h**, the training significantly increased their knowledge from pre-test time (mean=0.57, SD=0.499) to post-test time (mean=0.79, SD=0.41), T-test=2.847, $p=0.006$, fairly adequate mean increase of 0.224, and a moderate effect size (0.1). On whether a **patient with malaria may suffer from jaundice**, the training significantly increased their knowledge from pre-test time (mean=0.49, SD=0.503) to post-test time (mean=0.86, SD=0.354), T-test=5.286, $p<0.0001$, fairly adequate mean increase of 0.368, and a large effect size (0.27). Also, on which **organs are affected by*P. falciparum***, the training had a statistically significant increase on their knowledge from pre-test time (mean=0.58, SD=0.497) to post-test time (mean=0.84, SD=0.367), T-test=3.842, $p<0.0001$, fairly adequate mean increase of 0.263, and a large effect size (0.17). Regarding the **diagnosis of malaria**, the training significantly increased their knowledge from pre-test time (mean=0.64, SD=0.482) to post-test time (mean=0.86, SD=0.354), T-test=2.970, $p=0.004$, fairly adequate mean increase of 0.211, and a moderate effect size (0.11). On the **type of plasmodium associated with malaria relapse**, the training had a statistically significant increase on their knowledge from pre-test time (mean=0.55, SD=0.501) to post-test time (mean=0.89, SD=0.309), T-test=5.155, $p<0.0001$, fairly adequate mean increase of 0.342, and a large effect size (0.26). On various **precautions on how to prevent malaria**, the training significantly increased their knowledge from a pre-test time (mean=0.67, SD=0.473) to post-test time (mean=0.95, SD=0.225), T-test=4.531, $p<0.0001$, fairly adequate mean increase of 0.276, and a large effect size (0.22).

Healthcare workers perspectives on the malaria training

One HCW said that "*I am very, very excited and glad to attend this training and ahh it is, a timely reminder to me to always educate my patient's on how to appropriately use the medicines I have prescribed to them*". *Another*

Table 3 Effect of malaria training on healthcare workers knowledge ($n = 76$, DF = 75)

Characteristic		Paired samples statistics			Paired differences					t-test	*P* value	Eta squared
		Mean	SD	Std Error Mean	Mean	SD	Std Error Mean	95% CI of the Difference				
								Lower	Upper			
Malaria transmission	Post	0.91	0.291	0.033	0.066	0.471	0.054	-0.042	0.174	1.217	0.228	0.02
	Pre	0.84	0.367	0.042								
Causes of malaria	Post	0.93	0.250	0.029	0.632	0.538	0.062	0.509	0.754	10.240	0.000	0.58
	Pre	0.30	0.462	0.053								
Symptoms of malaria like fever, chills, and sweating are seen when the parasite enters the liver	Post	0.96	0.196	0.022	0.487	0.554	0.064	0.360	0.613	7.666	0.000	0.44
	Pre	0.47	0.503	0.058								
Most dangerous malaria type	Post	0.89	0.309	0.035	0.382	0.541	0.062	0.258	0.505	6.151	0.000	0.34
	Pre	0.51	0.503	0.058								
Fever in Plasmodium vivax malaria is seen every 48 h	Post	0.79	0.410	0.047	0.224	0.685	0.079	0.067	0.380	2.847	0.006	0.10
	Pre	0.57	0.499	0.057								
A patient with malaria may suffer from jaundice	Post	0.86	0.354	0.041	0.368	0.608	0.070	0.230	0.507	5.286	0.000	0.27
	Pre	0.49	0.503	0.058								
Organ(s) affected by Plasmodium falciparum	Post	0.84	0.367	0.042	0.263	0.597	0.068	0.127	0.400	3.842	0.000	0.17
	Pre	0.58	0.497	0.057								
Diagnosis of malaria?	Post	0.86	0.354	0.041	0.211	0.618	0.071	0.069	0.352	2.970	0.004	0.11
	Pre	0.64	0.482	0.055								
Type of Plasmodium causing malaria relapse	Post	0.89	0.309	0.035	0.342	0.579	0.066	0.210	0.474	5.155	0.000	0.26
	Pre	0.55	0.501	0.057								
Precaution(s) of preventing malaria	Post	0.95	0.225	0.026	0.276	0.532	0.061	0.155	0.398	4.531	0.000	0.22
	Pre	0.67	0.473	0.054								

n = sample size, SD = standard deviation, std = standard, CI = confidence interval, Mean Scale: 0.00–0.20 = very low mean (very inadequate), 0.21–0.40 = low mean (fairly adequate), 0.41–0.60 = moderate mean (somehow adequate), 0.61–0.80 = high mean (adequate), 0.81–1.00 = very high mean (very adequate)

worker hinted the need for a full refresher malaria training course for all workers. Another HCW *warned that having knowledge alone can't improve the community adherence to prescriptions as very often public facilities run short of medicines and other supplies and sometimes patient's do not have money to buy drugs*. One public health facility administrator *promised to work very hard and set up outpatient department trainings on proper use and taking of various medicines to fight drug resistance.*

Discussion

Based on the pre-test mean results, the community members had low knowledge about various topics on malaria. This is in agreement with other studies done elsewhere where at baseline, participants were found to have low knowledge about malaria concepts [8, 10, 14, 26–28]. However, the rudimentary information possessed by the community could be due to the ever-present malaria occurrence in the area [11], and some knowledge gain through interaction with service providers and VHT. However, such means cannot properly build the capacity to adequate knowledge levels. First, during their interaction with service providers, they are seeking for treatment to manage their disease condition hence lack of focus to properly articulate the issues. Second, for the VHTs, many are not well-grounded in educating the community members on some malaria aspects. In addition, a study in the Democratic Republic of the Congo showed that in spite of the usefulness of VHT in provision of health information, the community doesn't value much advise from them [29]. It is on that basis that the current study employed healthcare workers and pre-trained them to deliver the community trainings. The current study adopted a didactic and participatory learning approach and this gave the community more room to discuss and understand deeper the current developments in several malaria domains. More so, the community trainings at parishes were able to engage the locals within their normal living environments and reach out to a great number of citizenries. As was noted in a Tanzanian study that women are always blamed for delays in health-seeking decision yet the real power lies with the male counterparts [11], the current intervention incorporated the male family members. This is crucial as they tend to hold the much-needed financial resources, and final say in decision-making within the setting. The post-test results show a great improvement and knowledge gain among the community members; therefore, the education intervention had a significant positive effect ($p<0.0001$) across all measured domains on the knowledge of community members. Similar findings have been posited in various studies [5, 6, 10, 11, 14, 26–28]. This is in agreement with the hypothesized goal of training intervention's ability to enhance the knowledge of trainees. It is hoped further that the good knowledge gain could result into better adoption of malaria prevention and control methods in the community [14, 26, 27], and eventual good adherence to antimalarial prescriptions. The study further demonstrated the community satisfaction with education intervention through high and continuous attendance of community trainings as was the case in an intervention study in Ecuador, Colombia and Nicaragua [14]. This attendance shows community willingness to share and learn new better ways of healthy living and the need for continuous education of the community to build their knowledge base and change their health behaviour and attitudes.

The intervention further significantly and positively improved the HCW knowledge [5, 6, 14], except on the domain of malaria transmission ($p=0.228$) where the training effect was very inadequate. The better performance of HCW on malaria transmission and somewhat average performance during pre-test assessment could be attributed to prior knowledge from medical schools, ongoing learning from internet and ongoing staff supervisions as was noted in a rural Chinese study [30]. However, the current intervention demonstrates its power to enhance the power of technocrats and need for refresher trainings in this group. The great post-test performance of HCW gives a pool of health champions who can take lead in delivering the intervention for sustainability beyond the lifetime of the current study. This novel approach of empowering healthcare professionals has been a major limitation in previous studies [14, 26–28]. Therefore, we assume that the current intervention could continue delivering its intended results even afterwards.

Limitations

The education trainings were only conducted at selected parishes and public facilities, hence leaving out some community members who were unable to attend. In addition, not all HCWs in the district attended the training which are thought to be early adopters of medical knowledge. However, the participatory approach employed could ensure that all those trained could become champions and cascade the information within the community. Also, minors were not trained. An appropriate training package on the same, targeting this category is much needed.

Conclusion

The community malaria training demonstrates that proper training of the community improves their knowledge which could trigger patient adherence and optimization of ACT. This intervention might not work in isolation as other factors such as lack of ACTs at public facilities needs to be addressed. The training also illustrates that HCWs needs to undergo refresher trainings

from time to time for them to have potential to fully manage their clients wholly. To maximize efforts in the prevention and control of malaria, we recommend that; (1) all health facilities and workers carry out patient education on proper use of medicines at facilities and within their area of jurisdiction, (2) Ministry of Health takes HCWs under refresher courses always on common ailments they manage, (3) HCWs change their attitude towards facility-based mentorships, (4) a robust assessment of the patients' adherence in this community after this training intervention can help better understand the effect of the intervention on improving patients' adherence to ACT prescriptions, (5) community to always seek and follow professionals advise at all times.

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

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Author contributions
CB conceived the study, took lead in data collection, analysis and drafted the manuscript. STCC, BG, and CO reviewed the study design, and CO reviewed the manuscript. All authors read and approved the final manuscript.

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Data availability
The datasets used and/or analyzed during the current study are available from the corresponding author on a reasonable request.

Declarations

Ethics approval and consent to participate
The study was approved by the Maseno University Scientific and Ethics Review Committee (MUSERC/01122/22), the Mengo Hospital Research Ethics Committee (MH/REC/144/10-2022) and the Uganda National Council for Science and Technology (HS2576ES). Kamuli District Local Government and Kamuli Municipal Council provided clearances to visit the facilities and communities. The training objectives, its benefits and potential risks and its procedures were explained to the participants. Informed consent was obtained from all participants and/or legal guardian(s) for minors before participation in the study. Further informed consent was obtained from all subjects and/or their legal guardians for publication of identifying information/ images in an online open-access publication. Subject names were removed from all text/figures/tables/images for anonymization.

Consent for publication
"Not applicable" in this section.

Competing interests
The authors declare no competing interests.

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