ORIGINAL PAPER

https://dx.doi.org/10.4314/njpr.v18i2.7

Nig. J. Pharm. Res. 2022, 18 (2) pp 157-168
ISSN 0189-8434 e-ISSN 2635-3555

Available online at http://www.nigjpharmres.com

Evaluation of the Use of Digital Technologies to Improve Case Management of Uncomplicated Malaria by Community Pharmacists in Nigeria

***M. R. IHEKORONYE[A, B, D], K.P. OSEMENE[C,F], B. O. ALLI[B,C], W. O. ERHUN[E.F]**

Department of Clinical Pharmacy and Pharmacy Administration, Faculty of Pharmacy, Obafemi Awolowo University, Ile-Ife, Nigeria

A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation; D – writing the article; E – critical revision of the article; F – final approval of article.

Abstract

Background: Malaria remains a tropical disease of public health concern. Treating malaria infection without parasitological diagnosis and follow-up yields poor outcomes.

Objectives: This study assessed knowledge, attitudes, use of Malaria Rapid Diagnostic Tests (mRDTs), and evaluated impact of a mobile health intervention on case management by community pharmacists.

Materials and Methods: The mixed - method study enrolled 112 community pharmacists in Kwara State Nigeria, randomized into control and intervention groups (n = 56 each). Same validated questionnaires were used to obtain baseline and post-intervention data. Only intervention group received educational YouTube videos, mRDT kits and twice-weekly short message service follow-up for six months. Pre- and post- intervention scores were measured and compared in both groups using Mann-Whitney U and t-tests at $p < 0.05$.

Results: Baseline knowledge was moderate in both control (5.56 ± 1.41) and intervention (5.70 ± 0.81) groups; significantly improved to high level (8.90 ± 3.20) post-intervention in intervention group ($t = 13.07$, $p = 0.04$*) unlike control group ($t = 11.25$, $p = 0.06$). Attitude of intervention cohort improved significantly from 'borderline' (around 2.5) pre-intervention to 'positive' (above 2.5) post- intervention ($Z = 3.379$, $p = 0.001$*), unlike control group which remained negative (below 2.5) pre- and post-intervention, ($Z = 0.159$, $p = 0.874$). Among controls, mRDT use remained low pre- and post-intervention (6.41 ± 1.21 and 6.65 ± 1.02) ($t = 1.1784$, $p = 0.255$); intervention cohort moved from low to moderate (6.58 ± 1.13 to 11.04 ± 1.18) ($t = 15.407$, $p < 0.05$*).

Conclusion: Both primary (mRDT use) and secondary (knowledge and attitude) outcomes were significantly improved by mHealth intervention. It is recommended that community pharmacists be trained and incentivized to deploy mRDT and digital technologies in routine management of malaria.

Keywords: mHealth, Rapid diagnostic tests, Community pharmacy, Malaria, Nigeria

INTRODUCTION

Malaria, which is caused by the *Plasmodium* parasite and transmitted by female Anopheles Mosquito, remains a tropical disease of enormous public health concern (Cox, 2020). It is a leading cause of high morbidity and mortality, particularly among children and pregnant women in many developing countries (Zekah & Sharman, 2021). Reports indicate that an estimated 214 million cases of malaria occurred worldwide in 2015 with 438,000 mortalities, and children under five years of age accounted for 61 per cent of these mortalities (WHO, 2016). *Plasmodium vivax* is predominant in Central America and South East Asia while *P. falciparum* is more widely distributed in Nigeria and other African countries. In

2018, India and Nigeria alone accounted for 53 per cent of the global mortality numbers from malaria (WHO, 2018).

In Nigeria, malaria continues to exert significant short- and long-term economic burden both to individuals, their households, and the entire health system. A household survey found that 57.6 per cent of Nigeria households experienced an episode of malaria per month causing a health expenditure of USD12.57 for out-patient treatments and USD23.20 for in-patient treatments. On the health system, the report found a recurrent provider cost of USD30.42 for out-patient treatment and USD48.02 for in-patient treatment per malaria case. Non-recurrent provider costs stood at USD133.07 and USD1857.15 for out-patient and in-patient treatments respectively (Onwujekwe *et al*., 2013). The aggregation of these costs continues to exert enormous pressure on the limited health care budgets both in household and the entire health system.

The World Health Organization (WHO) recommends that parasitological diagnosis of malaria be confirmed before treatment and that prompt parasite-based diagnoses be made of all patients (both adults and children) suspected of malaria (WHO, 2018a). This recommendation is important because several other disease conditions present malaria-like symptoms. Hence, reserving treatment for only parasite-confirmed cases not only protects patients from unnecessary medication but also prevents wrong diagnosis.

Malaria rapid diagnostic tests (mRDTs), which are accurate and reliable in the diagnosis of malaria infection, are currently the most widely used tests (Diggle *et al*., 2014). These instrument-free tests yield results within fifteen minutes (Wilson, 2012). They detect antigens produced by Plasmodium parasite, such as Plasmodium falciparum histidine-rich protein-II (pfHRP-II) and Plasmodium lactate dehydrogenase (pLDH) (Onwujekwe et al., 2015). The accuracy of mRDT for the diagnosis of uncomplicated infection with *P. falciparum* is equal to or greater than routine microscopy, but less than expert microscopy. *Plasmodium vivax* sensitivity is 75–100 per cent while diagnostic performance is poor at 42 per cent for *Plasmodium ovale* and *Plasmodium malariae* (Wilson, 2012). Generally, mRDTs are easy to use, cheap, readily available, and do not require specialized storage arrangements.

In practice however, notwithstanding WHO recommendations, many health workers in endemic countries such as Nigeria and Ghana, among others, tend to diagnose malaria based solely on symptoms (Diggle *et a*l., 2014; Onwujekwe *et al*., 2015; Endeshaw *et al*., 2018). This trend informed government intervention by way of the "test before treatment" public health policy backed by strong publicity campaigns. The campaigns were targeted at health workers and the general population, and aimed at imparting knowledge, improving perceptions, and promoting use of mRDTs in routine management of uncomplicated malaria. There is strong evidence that the "test before treatment" strategy has worked elsewhere. China was recently certified malaria-free by the World Health Organisation making it the 40th in the world (Endeshaw *et al*., 2018). Other countries that recently achieved this milestone include Uzbekistan and Paraguay (2018), Algeria and Argentina (2019), and El Salvador (2021). However, some authors have argued that the government's "test before treatment" campaigns were too shallow and presented insufficient evidence basis to convince health care professionals to drive the desired practice shifts (Mukkala *et al*., 2018). It is not known how successful this campaign has been in influencing knowledge, attitudes and practice among primary health care professionals in Nigeria, including community-based pharmacists (Oladepo et al., 2019). While researchers have documented the impact of targeted training on consumers and non-professional providers of over-the-counter medicines (Ajibaye *et al.*, 2019), there is dearth of evidence on those of community pharmacists in Nigeria.

Studies have shown that community pharmacies are the first ports of call for most children and adults with suspected cases of malaria in Nigeria (Osemene et al., 2011 ; International Pharmaceutical Federation, 2015). It is therefore necessary that community pharmacists possess adequate and accurate knowledge of the nature and use of mRDT in order to maximize its contributions to the case management of malaria. While data from other African countries such as Tanzania (Maloney *et al*., 2017) and Cameroon (Mangham-Jefferies, 2014) show that community pharmacists are adequately knowledgeable in mRDTs, the Nigeria scenario remains poorly documented. Moreover, for the use of mRDTs to become routine in malaria case management certain behavioral changes are required among care providers and these changes can be imparted by appropriate training on mRDTs.

METHODOLOGY

Study Design

The mixed - method study involved community pharmacists across the 16 Local Government Areas of Kwara State. The initial stage of the study was a questionnaire – driven census survey of all 151 community pharmacists registered in the State by the Pharmacists Council of Nigeria as at 31st March, 2019. This cross-sectional survey generated baseline data for respondents' knowledge, attitudes and use of mRDTs in routine case management of uncomplicated malaria. The second stage was an experimental study in which consenting respondents (n = 112) were randomized (using the Randomizer(R) software) into two equal - sized (n = 56) control and intervention groups (Figure 1). The intervention group received a telepharmacy intervention comprising one 8.39 minutes educational YouTube video to demonstrate the right techniques for mRDT use and reading of results in addition to a smartphone-based short message service (SMS) follow-up sent twice every week. Participants in the intervention group accepted to bear the cost of mobile phone data to watch the educational YouTube video as they perceived the intervention as beneficial to their practice enhancement as lifelong learners. Both the control and intervention groups were given a uniform documentation form (in this study, referred to as *Malaria Action Form*) to record their malaria treatment services for the six-month period of the study. The Malaria Action Form was a one-page document that captured information on patients' characteristics, date of presentation and symptoms presented at the pharmacy as well as the pharmacist's intervention. Primary outcome measure for effectiveness of the intervention was improvement in the extent of use of mRDT in case management of uncomplicated malaria, while improvements in respondents' knowledge and attitudes were secondary outcome measures. Primary and secondary outcomes were measured by a quantitative assessment of the difference in the scores of participants on mRDT use (primary outcome); and knowledge and attitudes (secondary outcomes) over the six months duration of the study. The experimental design of the intervention offered a high level of control to the researchers so as to attain specific conclusions. It also ensured the research could easily be replicated elsewhere.

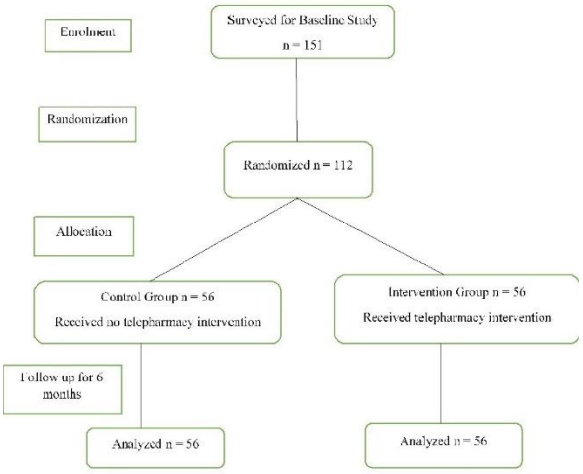

Figure 1: Flow Chart of Study Participants

Inclusion and Exclusion Criteria

All community pharmacists registered in the study area by the Pharmacists Council of Nigeria (PCN) as at 31st of March, 2019 were eligible to be included provided they gave their informed consents. Only the superintendent pharmacist in each premise was included. Interns and locum (part-time) pharmacists, as well as those who did not give their written informed consents were excluded.

Study Setting

The study was conducted among community pharmacists in Kwara State Northcentral Nigeria. The State (with a population of about 3.2 million) is located within latitude 8.49^0N and longitude 4.55^0E with warm and wet climatic conditions conducive to a high, all-year transmission of malaria parasites making it holo-endemic for malaria (Musa, 2018).

Development and Validation of Questionnaire

The structured questionnaire used for primary data collection had four sections. The first section sought information on relevant demographic characteristics of respondents including gender, age, educational qualifications, practice experience and location of practice.

The second section of the questionnaire examined respondents' knowledge of mRDT using 9 items which addressed the biochemical basis for the RDT (2 items), correct use (3 items), storage (1 item), and results of the test (3 items). Items were adapted from the Training Manual for "Generic Pf-Pan Test for

falciparum and non-falciparum malaria" developed by the United States Agency for International Development (USAID) and the World Health Organisation (WHO) (USAID, 2009). Responses were captured on a dichotomous scale of "Yes" and "No" with a neutral option of "Cannot say". For data analysis, every "Yes" response was scored 1 while "No" and "Cannot say" were scored 0. The reason for this scoring strategy was because the scale was set up to measure knowledge and, at the point of taking the survey, respondents either knew or did not know the correct answer. Providing a "cannot say" category was to eliminate any possibilities for an erroneous "yes" answer in cases where respondents were unsure of the right answer. The knowledge index ranged from 0 – 9. A respondent who answered all nine questions correctly will gain the maximum possible score of 9. Based on their total scores, respondents' knowledge were categorized into poor (0 - 3), moderate (4 – 6), and high (7 – 9). Mean knowledge scores (± SD) were computed for control and intervention groups at baseline and after the intervention (6 months) in line with established norms (Krosnick & Presser, 2010). Paired samples T- test was performed to test the equality of the pre- and post- intervention mean scores of the control and intervention groups.

The third section of the questionnaire measured respondents' attitudes using eight (8) items drawn from detailed literature review and previous work of the authors (Osemene et al., 2011). Items were presented on a five-point Likert-type agreement scale. Items 1-4 were statements of positive attitude while items 5-8 were statements of negative attitude. The blend of positive and negative attitude statements was to ensure maximum engagement of respondents while minimizing acquiescence - "same as above" response bias. Responses to positive attitude statements (items 1-4) were scored sequentially from "strongly disagree" (1), "disagree" (2), "cannot say" (3), "agree" (4), to strongly "agree" (5). This scoring order was reversed for the negative attitude statements (items 5-8) at the point of data analysis as suggested by Ogunbameru & Ogunbameru, (2018). The score of 2-5 was chosen as the midpoint between negative attitude (depicted by any score below the 2.5) and positive attitude (any score above 2.5). Median scores per item were computed and the Mann-Whitney U test was conducted to compare the pre- and post-intervention scores for both the control and intervention groups.

The last section of the questionnaire sought information on self-reported levels of use of mRDTs by the community pharmacists. The section comprised 7 task sets, broken down into 18 specific tasks related to the correct use of the mRDTs in real life scenarios. The task sets were given alphabetic codes ranging from Task-Set A (assembling the right supplies for the test- 3 tasks), B (correct labelling/documentation- 2 task), C (correct communication with the patient who is being tested -1 task), D (actual test performance – 7 tasks), E (correct implementation of safety practices – 3 tasks), F (observing the correct waiting time for test results- 1 task); and G (correct reading of test results – 1 task). Each task was assigned a score of 1, hence a respondent who accurately identified all the tasks would score a total of 18 points. Pre- and post-intervention mean (± SD) scores for each task item was computed for both control and intervention groups while the paired sample t-test was used to compare the overall means of both groups. Aggregate scores of respondents were used to categorize them into three levels of mRDT use: Aggregate scores 1-6 = Low; 7 - 12 = Moderate; 13 – 18 = High

The questionnaire was subjected to the expert scrutiny of two senior faculty members with expertise in pharmacotherapy of malaria who reviewed the items and made useful corrections to ensure face and content validity. To ensure construct validity, the researchers chose two pairs of items which they subjectively judged not to be related. The items of each pair were however judged by the researchers to be related and dependent on each other (Trochim, 2008). Construct validity of the instrument was determined by computing the convergent and discriminant validities of these items. Convergence and discrimination were established using the Pearson coefficient to determine the bivariate correlation. The test- retest technique was used to ensure reliability of the instrument using fifteen community pharmacists outside the study area. Responses from the 15 respondents was used to ensure feasibility of data collection with the instrument. Modifications were made to the questionnaire based on problems identified during the feasibility study. The Cronbach's alpha reliability coefficient was found to lie above α=0.78 for all sections of the questionnaire.

Development and Validation of SMS Messages

A total of thirty short message service (SMS) messages were developed based on the principles of the Diffusion of Innovation theory (Rogers, 2003). The messages contained information on rationale, correct use, storage, documentation, and reading of results of mRDTs and were reviewed by the same senior faculty members earlier mentioned. A randomization software (Randomizer$^{(R)}$) was used to assign messages to only the members of the intervention group. Randomization meant that different participants received different messages to educate and remind them on mRDT. Participants were

informed at the beginning of the intervention that they were not expected to reply the SMS messaging. Examples of the messages include:

Several other disease conditions can give malaria-like symptoms,

mRDTs are important to prevent wrong diagnosis

mRDTs are important to avoid unnecessary medication therapies

Best practices in case management of uncomplicated malaria require parasitological diagnosis

mRDT kits are best stored under room temperatures, away from sources of heat

Testing before treatment boosts patients 'confidence in pharmacists' interventions

Did you use mRDT for managing cases of uncomplicated malaria today?

Did you follow up on your patients on antimalarial medication today?

Data Collection

With the help of the leadership of the Association of Community Pharmacists of Nigeria (ACPN) in the study area, the researchers met with the prospective participants during one of their monthly meetings and explained the goals of the study and the expected roles of participants. With the informed consent of participants, same questionnaires were used for primary data collection in the pre- and post-intervention stages and were self-administered by the researchers. A combination of physical questionnaires and online forms (google forms) were used for data collection. Online forms were sent by email as well as social media to all participants within twenty four hours following the initial group interaction at the ACPN meeting. The use of multiple channels to administer the questionnaires was to provide timely opportunity for every prospective participant to take the survey in line with the census approach to the cross- sectional design. Each participant received a set of *Malaria Action Forms* for uniform documentation of the malaria interventions. Each form captured relevant data including patient characteristics, data of presentation at the pharmacy, symptoms presented as well as pharmacist's interventions. Filled *Malaria Action Forms* were retrieved at the end of each month via self-addressed and stamped envelopes provided to participants. The option of returning soft copies of completed *Malaria Action Forms* via online platforms was provided to participants. The study adopted a single blinding strategy in which participants did not know if they were in the treatment group or in the control group.

Data Analysis

Frequency and percentages were used to analyse demographic data of respondents. Weighted means with standard deviations were computed for respondents' scores of knowledge and use of mRDT while paired sample t-test was conducted to compare pre- and post- intervention means of both control and intervention groups. Median scores were computed for respondents' attitudes towards mRDT. Mann-Whitney U test was conducted to compare median scores of pre- and post- intervention attitude in both control and intervention groups. The IBM SPSS software version 21 for Windows was used for statistical analysis at the $p<0.05$ level of significance.

RESULTS

The two pairs of items used to determine the construct validity of the questionnaire were items 1 and 2 and items 5 and 6 on the attitudes section (Table 3). Pearson correlation coefficients from 0 - 0.5 were set to indicate divergent validity while correlation values between 0.5 – 1.0 would represent convergent validity. Item 1 versus item 2 had a correlation value of 0.997 ($p = 0.05$) while item 5 versus item 6 had a correlation value of 0.948 ($p = 0.02$) showing that both pairs of items had strong convergence. However, for items 1 versus item 5, item 1 versus item 6, item 2 versus item 5, and item 2 versus item 6, the Pearson correlation coefficients were 0.98 ($p = 0.014$), -0.03 ($p = 0.97$), 0.32 ($p = 0.67$), and -0.7 ($p = 0.29$) respectively, showing discriminant validity. In other words, items from the different scales were significantly different and independent of each other.

Out of 151 community pharmacists who were administered questionnaires to collect baseline data, a total of 112 completed and returned useable responses for analysis, giving a response rate of 74.2%. As shown in Table 1, majority of respondents (71; 63.4%) were males and about the same number 72 (64.3%) were in the 30-50 year age bracket. Most (91; 81.2%)) of the respondents had only the basic entry qualifications (B.Pharm or Pharm. D.) required to practice pharmacy in Nigeria while over two thirds (86;76.8%)) of the participants were located in urban centres. There was no significant association between

genders of respondents or their lengths of practice experience and their scores of knowledge, attitudes and use of mRDT.

Table 1: Demographic Characteristics of Respondents (N = 112)

Variable	Category	Frequency (%)
Gender	Male	71 (63.4)
	Female	41 (36.6)
Age (Years)	Below 30	10 (8.9)
	30-50	72 (64.3)
	Above 50	30 (26.8)
Qualifications	B.Pharm.	79 (70.5)
	Pharm.D.	12 (10.7)
	Higher Degrees	21 (18.8)
Practice Experience (Years)	Below 5	29 (25.9)
	5-10	66 (58.9)
	Above 10	17 (15.2)
Location of Practice	Urban	86 (76.8)
	Semi-Urban	18 (16.1)
	Rural	8 (7.1)

Pre- and Post- Intervention Knowledge Scores of Participants

It can be seen from Table 2 that, prior to the intervention, the level of knowledge for both the control (5.56 ± 1.41) and intervention (5.70 ± 0.81) groups were moderate (score range 4 - 6). After the intervention, knowledge scores of both groups increased to different extents. While the mean score for the control group improved slightly (6.28 ± 1.32), this was not statistically significant (t = 11.25, p = 0.06). Hence, the improvement may have been due to some random effect beyond the scope of the current study. However, for the intervention group, the improvement in knowledge (8.9 ± 3.20) was statistically significant (t = 13.07, p = 0.04*)

Table 2: Effect of Health Education and Follow-Up Intervention on Knowledge of mRDT by Community Pharmacists

Time	Control Group (n = 56) Mean ± SD	Intervention Group (n = 56) Mean ± SD
Baseline (Pre-Intervention)	5.56 ± 1.41	5.70 ± 0.81
Post-Intervention	6.28 ± 1.32	8.90 ± 3.20
Paired Sample T-test Results	t = 11.25, p = 0.06	t = 13.07, p = 0.04*

*significance at p< 0.05, 2-tailed.

Pre- and Post- Intervention Attitude Scores of Respondents

Table 3 presents the pre- and post- intervention attitude scores of respondents. For the control group, item performance on the attitude scale shows that respondents largely had negative attitudes (median scores below 2.5) towards mRDT at baseline, a trend which did not significantly improve at the post-intervention review (Z = 0.159, p = 0.874). The respondents were however positively disposed to receiving relevant training both at baseline (median score 2.6) and post-intervention (median score 2.7). For the intervention group, baseline attitudes were either negative or weakly positive (median scores between 2.4 - 2.7) However, after the intervention, their attitudes were significantly improved (Z = 3.379, p = 0.001*) with median scores ranging from 2-8 – 3.9.

Table 3: Effect of Health Education and Follow-Up Intervention on Attitude of Community Pharmacists towards mRDT.

S/N	Statement	Control Group (n = 56; Median Scores)		Intervention Group (n = 56; Median Scores)	
		Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
1	I believe mRDT is a vital tool in combating malaria	2.2	2.4	2.5	3.0
2	There should always be parasitological diagnosis before treatment of uncomplicated malaria	2.4	2.3	2.6	3.9
3	The benefits of mRDT outweigh the costs	2.2	2.3	2.7	3.5
4	I am willing to be trained in mRDT use	2.6	2.7	2.4	3.2
5[a]	I feel mRDT mostly confuses the malaria treatment plan	2.2	2.5	2.5	3.5
6[a]	I do not trust the results of mRDT most times	2.7	2.4	2.6	3.4
7[a]	I believe mRDT only increases the cost of malaria treatment	2.5	2.3	2.4	2.9
8[a]	I feel mRDT should be used in combination with microscopy and clinical diagnosis	2.1	2.0	2.6	2.8
Mann-Whitney U test results		Z = 0.159, p = 0.874		Z = 3.379, p = 0.001*	

[a] Scores were reversed at the point of data analysis; * significance at $p < 0.05$, 2- tailed

Pre- and Post- Intervention Scores on Use of mRDT by Respondents

As presented in Table 4, the pre-intervention Mean ± SD scores for the level of use of mRDT among the control group was (6.41 ± 1.21) which lies within the low use category (1 - 6). The post-intervention mean score (6.65 ± 1.02) remained low and did not represent a significant improvement over the baseline performance ($t = 1.1784$, $p = 0.255$). For the intervention group the pre-intervention use score was (6.58 ± 1.13) similar to that of the control group. However, following the intervention, the Mean ± SD use score in the intervention group grew to 11.04 ± 1.18 which lies within the moderate use category (7 - 12). This improvement was statistically significant ($t = 15.407$, $p < 0.05$*).

Table 4: Effect of Health Education and Follow-Up Intervention on Self-Reported Use of mRDT by Community Pharmacists

S/N	Task Set	Task	Score on Correct Task Execution			
			Control Group (Mean ± SD) n =56		Intervention Group (Mean ± SD) n=56	
			Pre-intervention	Post-intervention	Pre-intervention	Post-Intervention
1	A	Assembling necessary supplies to perform test	7.11 ± 1.89	6.91 ± 1.21	6.73 ± 1.23	13.14 ± 1.98
2	A	Accurately read RDT expiry date	6.81 ± 0.93	7.41 ± 1.11	7.11 ± 1.21	12.73 ± 1.22
3	B	Write patient's name on cassette	5.89 ± 1.65	6.11 ± 0.12	6.97 ± 1.23	11.76 ± 1.23
4	C	Explain test procedure to patient	6.48 ± 0.91	6.43 ± 1.11	6.45 ± 1.21	14.11 ± 1.78
5	A	Wear hand gloves correctly	8.37 ± 1.51	7.95 ± 1.92	6.98 ± 0.11	10.79 ± 1.21
6	D	Select 4th finger on the hand less used by patient for blood collection	6.71 ± 0.43	4.45 ± 1.76	5.37 ± 1.25	9.97 ± 1.11
7	D	Clean 4th finger with alcohol swab	6.71 ± 1.32	7.12 ± 1.21	6.56 ± 0.12	11.37 ± 1.23
8	D	Prick 4th finger with sterile lancet	5.32 ± 1.02	6.12 ± 0.37	7.31 ± 1.71	14.11 ± 1.34
9	E	Discard used lancet in sharps bin	6.56 ± 1.51	6.91 ± 0.34	6.37 ± 1.28	10.01 ± 1.21
10	D	Gently squeeze 4th finger to produce blood	5.51 ± 1.89	6.53 ± 1.11	6.13 ± 1.23	11.73 ± 1.09
11	D	Collect sufficient blood with capillary straw	4.73 ± 1.21	6.56 ± 1.16	5.79 ± 1.11	12.56 ± 1.23
12	D	Dispense sufficient blood in correct well	5.56 ± 1.01	6.11 ± 0.13	6.57 ± 1.01	11.73 ± 1.34
13	E	Discard capillary straw in sharps bin	6.56 ± 0.11	5.98 ± 1.11	6.56 ± 1.65	10.45 ± 1.51
14	E	Dispose of gloves in non-sharps bin	7.89 ± 1.25	7.23 ± 0.56	6.87 ± 1.32	9.11 ± 1.34
15	D	Dispense sufficient buffer in correct well	6.76 ± 1.43	6.98 ± 1.23	7.11 ± 1.03	11.32 ± 1.24
16	F	Observe for 15 minutes	7.56 ± 1.31	7.19 ± 1.21	6.59 ± 1.21	11.56 ± 1.22
17	G	Read test results correctly	5.79 ± 1.17	7.54 ± 1.67	6.68 ± 1.27	10.11 ± 1.21
18	B	Record result in register	4.98 ± 1.11	6.11 ± 0.98	6.32 ± 1.21	12.21 ± 1.68
Mean of Means			6.41 ± 1.21	6.65 ± 1.02	6.58 ± 1.13	11.04 ± 1.18
Paired Sample T-test results			t = 1.1784, p = 0.255		t = 15.407, p < 0.05*	

Task Sets: A-assembling correct supplies for test; B- correct labelling/documentation; C- correct communication with patient; D- correct test performance; E- correct safety practices; F- correct waiting time for results; G – correct reading of results

DISCUSSION

The response rate of 74.2% was considered high enough given that participants consented to stay in the study for six months. The kind support and cooperation of the leadership of the Association of Community Pharmacists in the study area was responsible, to a large extent, for the total retention of all the participants in the study, leading to zero loss to follow-up. The high Cronbach alpha reliability coefficient of the instrument reflected its consistency. Moreover the instrument demonstrated high content and construct validity which indicate its suitability to measure the constructs of interest in this study (Ogunbameru, Ogunbameru, 2018). The extent of use of rapid diagnostic tests in the management of uncomplicated malaria in a typical outpatient setting such as community-based pharmacy is considered an appropriate primary outcome measure for this study because it signals the application of a systematic, evidence-based protocol (Bernard, 2000), away from the subjective approach to diagnosis and treatment of malaria with its attendant sequelae. However, routine adoption of best practices in case management of malaria requires adequate knowledge and a positive attitude by service providers (in this case, the community pharmacists); hence knowledge and attitude scores are considered appropriate secondary outcome measures for the study.

A recent analysis of strengths, weaknesses, opportunities and threats (SWOT) of Nigeria community pharmacies found that the Doctor of Pharmacy (Pharm. D.) qualification, with attendant improvements in clinical skills presented the greatest opportunity for service improvements (Ihekoronye *et al*., 2020). With only 12 (11%) of the respondents in this study possessing the Pharm.D. qualification, it means the evolution of clinical pharmacy in the study area is still nascent. While the Pharm.D programme is still gaining traction, there is urgent need for targeted training of practicing community pharmacists in the use of mRDTs. Notably the Pharmacists' Council of Nigeria (PCN) recently approved a major shift in undergraduate pharmacy curriculum, establishing the Pharm.D as baseline entry qualification into the pharmacy profession in Nigeria (Mohammed, 2020).

Recent reports from the World Bank indicate that 50 per cent of Nigerians reside in rural communities (World Bank, 2018). However, this study revealed that only 8 (7%) of the community pharmacies were located in the rural areas while 86 (77%) were cited in urban centres. While this finding agrees with evidence from similar studies (Ekpenyong *et al.*, 2018; Taiwo, Panas, 2018; Ihekoronye *et al*., 2020), it has important implications for the quest for universal health coverage in Nigeria.

Due to the endemic nature of malaria in Nigeria, considerable stock of knowledge about the disease, its causation, vector's role, prevention, diagnosis and treatment, including myths and anecdotes can be found in every home and culture in the general population. Hence, as expected, the baseline score of knowledge of mRDTs among respondents in both control and intervention groups were moderate (score ranges of 4 - 6). In context, the pre-intervention knowledge by the community pharmacists in this study was higher than those found in similar studies in Ethiopia (Endeshaw *et al*., 2018), Tanzania (Maloney *et a*l., 2017), and Cameroun (Mangham-Jefferies et al., 2014). Without exposure to the health education and follow-up intervention, the knowledge scores of the control group remained within the moderate level (6.28 ± 1.32) at the post-intervention review. However, the knowledge score of the intervention group was significantly improved by the intervention ($t = 13.07$, $p = 0.04$*). This finding is important as no university undergraduate pharmacy curriculum can supply all the knowledge and skills needed for life-long practice. There is therefore the need for relevant reforms in the content and mode of delivery of the mandatory continuing professional development (MCPD) and other learning opportunities for community pharmacists in Nigeria as already advocated by earlier studies (Daniel-Ebune & Joda, 2017).

The attitude scores found in this study represent a composite expression of the feelings, beliefs, preferences, perceptions, likes and dislikes of the community pharmacists towards the propriety and efficacy of mRDTs (Bernard, 2000). Attitudes have been shown to have a causal relationship with behavior (Ogunbameru and Ogunbameru, 2018). Participants in both groups in this study had largely negative pre-intervention attitudes. This negative attitude among health care providers may be blamed for the lack of positive behavioral response anticipated by the "test before treatment" campaign of the Federal Ministry of Health in Nigeria (Aregbesola, 2016). The health education and follow-up intervention proved effective to improve this negative attitude as seen in the intervention cohort ($Z = 3.379$, $p = 0.001$*). This suggests that training and re-training of practicing community pharmacists remains vital for practice evolutions especially as the government increasingly integrates community pharmacists in the national primary health care architecture in the country (Boyce et al., 2018). The respondents expressed high willingness to be trained in mRDTs being life-long learners (International Pharmaceutical Federation , 2015). In a separate study to evaluate the participation

of community pharmacists in health promotion activities in Nigeria, participants had requested for training in the use of rapid diagnostic test kits (Osemene and Erhun, 2018). The significant improvement in attitude scores in the intervention group seemed to validate this request for training on mRDTs.

Consistent with trends in other African countries, (Mangham-Jefferies *et al*., 2014; Maloney *et al*., 2017; Endeshaw *et al*., 2018), this study found a pre-intervention low level use of mRDT (mean scores between 1- 6) in routine case management of malaria among respondents in both control and intervention groups. There was no significant increase in use among the control group in the post-intervention evaluation ($t = 1.1784$, $p = 0.255$). However, the health education and follow-up intervention had a significant impact in the intervention group ($t = 15.407$, $p < 0.05$*) as their mean score increased from the low- to the moderate - use bracket (7-12). While this increase is significant, what is required ultimately would be a high level adoption of mRDT in everyday management of uncomplicated malaria (mean scores 13-18). It is expected that if similar interventions are escalated nationwide, there would be sustainable improvements in treatment outcomes. This enthusiasm is supported by previous evidence from the Chinese experience. From 2003, supported by the Global Fund to Fight AIDS, Tuberculosis and Malaria, China implemented a strategy to improve prevention, control, diagnosis, and treatment of malaria, including testing services (WHO, 2021). A key success factor was the basic public health package of services to improve access to diagnosis and treatment, which was provided free of charge for all residents irrespective of legal and financial status. Further lessons can be learnt from the three African countries that have been certified malaria-free by the WHO namely Mauritius (1973), Morocco (2010), and most recently Algeria (2019) (WHO, 2021).

Given the poor health financing ecosystem, driven mainly by out-of-pocket payments for pharmaceutical products and services (Aregbesola, 2016), one issue that remains unresolved is the evidence that most Nigeria community pharmacists expect their volume of sales of antimalarials to drop if the "test before treatment" policy is enforced (Ezennia, Nduka, Ekwunife, 2017). Moreover, many community pharmacists report that patients are impatient to wait for the mRDT but simply request to be sold antimalarials. This customer preference in the face of competitive market forces and alternative sources of antimalarial medications (classified as over-the-counter drugs) continues to hamper the widespread use of mRDTs in community pharmacies (Ezennia, Nduka, Ekwunife, 2017).

CONCLUSION

The community pharmacists demonstrated a fair (moderate) knowledge of malaria rapid diagnostic tests and this was significantly improved to a high level knowledge by the health education and follow-up intervention. Their attitudes towards routine use of these tests were largely negative but this was reversed to a positive attitude by the intervention. The study found that the level of use of mRDT was low but was significantly improved to a moderate use level by the intervention. More technology-driven trainings and sustained education campaign are strongly recommended to drive needed reforms in malaria treatment programme and improve treatment outcomes in the general population in Nigeria.

Limitations of the Study

Information provided by some respondents on the Malaria Action Forms were not useable for the study, apparently due to inadequate documentation skills which lie beyond the scope of this study.

ACKNOWLEDGEMENTS

We acknowledge the Chairman of Association of Community Pharmacists of Nigeria, Kwara State, for helping to mobilize participants.

ETHICS CONSIDERATIONS

Ethics approval (number MOH/KS/EU/777/320) was obtained from Kwara State Ministry of Health, Ilorin. Written informed consents were obtained from participating community pharmacists before questionnaires were administered to them.

REFERENCES

Ajibaye, O., Balogun, E.O., Olukosi, Y. A,, Orok, B.A., Oyebola, K.M., Iwalokun, B.A., Aina, O.O., Shittu, O., Adeneye, A.K., Ojewunmi, O.O., Kita, K., and Awolola, S.T. (2019). Impact of training of mothers, drug

shop attendants and voluntary health workers on effective diagnosis and treatment of malaria in Lagos, Nigeria. *Tropical Parasitology*. 9 (1): 36–44.

Aregbesola, B. (2016). Out-of-pocket payments in Nigeria. *The Lancet.* 387 (10037): 2506. https://doi.org/10.1016/S0140-6736(16)30798-X

Bernard, H. (2000). Social research methods: Qualitative and quantitative approaches, SAGE Publications, Thousand Oaks. C.A, pp. 285–312.

Boateng, G. O., Neilands, T.B., Frongillo, E.A., Melgar-Quiñonez, H. R. and Young, S. L. (2018). Best Practices for Developing and Validating Scales for Health, Social, and Behavioral Research: A Primer. *Front. Public Health* 6: 149. doi: 10.3389/fpubh.2018.00149

Boyce, M.R., Menya, D., Turner, E. L., Laktabai, J. and Prudhomme-O'Meara, W. (2018). Evaluation of malaria rapid diagnostic test (RDT) use by community health workers: a longitudinal study in western Kenya. *Malaria Journal*, 17 (1): doi: 10.1186/s12936-018-2358-6. PMID: 29776359; PMCID: PMC5960182.

Cox, F. (2010). History of the discovery of the malaria parasites and their vectors. *Parasite Vectors*. 3: 1–9.

Daniel-Ebune, E.O. and Joda, A. E. (2017). Assessment of continuing professional development activities among pharmacists in Nigeria. *West African Journal of Pharmacy*; 28 (1): 11-21

Diggle, E., Asgary, R., Gore-Langton, G., Nahashon, E., Mungai, J., Harrison, R., Abagira, A., Eves, K., Grigoryan, Z., Soti, D., Juma, E. and Allan, R. (2014). Perceptions of malaria and acceptance of rapid diagnostic tests and related treatment practices among community members and health care providers in Greater Garissa, North Eastern Province, Kenya. *Malaria Journal.* 13 (1): 502–13.

Ekpenyong, A., Udoh, A., Kpokiri, E and Bates, I. (2018). An Analysis of Pharmacy Workforce Capacity in Nigeria. *Journal of Pharmaceutical Policy and Practice*, 11 (20): 112-23

Endeshaw, T., Gebre, T., Ngondi, J., Graves, P., Shargie, E., Ejigsemahu, Y., Ayele, B., Yohannes, G., Teferi, T., Messele A., Zerihun, M., Genet, A., Mosher, A.W., Emerson, P.M. and Richards, F.O. (2008). Evaluation of light microscopy and rapid diagnostic test for the detection of malaria under operational field conditions: a household survey in Ethiopia. *Malaria Journal*. 7 (1): 118–24.

Ezennia, I., Nduka, S.and Ekwunife, O. (2017). Cost benefit analysis of malaria rapid diagnostic test: the perspective of Nigerian Community Pharmacists. *Malaria Journal*. 6 (1): 7–16.

Ihekoronye, R. and Osemene, K. (2020). Evaluation of the participation of community pharmacists in primary healthcare services in Nigeria: a mixed method survey. *International Journal of Health Policy and Management*. 20: 1. https://doi.org/10.34172/ijhpm.2020.224

Ihekoronye, R., Osemene, K., Erhun, W. and Afolabi, M. (2020). Qualitative analysis of strengths, weaknesses, opportunities and threats of professional services by community pharmacies in Nigeria. *Journal of Health and Medical Sciences*. 3 (4): 437–48. https://doi.org/10.31014/aior.1994.03.04.138

International Pharmaceutical Federation. (2015). Vision of a Community-based Pharmacist: Community Pharmacy Section. Available from: www.fip.org/community_pharmacy; accessed 11th February, 2022

Krosnick, J.A., Presser, S. Question and Questionnaire Design, in; Handbook of Survey Research, Second Edition Copyright 2010 by Emerald Group Publishing Limited. ISBN: 978-1-84855-224-1 pp 263-313

Maloney, K., Ward, A., Krenz, B., Petty, N., Bryson, L., Dolkart, C., Visser, T., Le Menach, A., Scott, V.K., Cohen, J.M., Mtumbuka, E. and Mkude, S. (2017). Expanding access to parasite- based malaria diagnosis through retail drug shops in Tanzania: evidence from a randomized trial and implications for treatment. *Malaria Journal*. 16 (1): 6–15.

Maltha, J., Gillet, P. and Jacobs, J. (2013). Malaria rapid diagnostic tests in endemic settings. *Clinical Microbiology and Infectious diseases Journal.* 19 (5): 399–407.

Mangham-Jefferies, L., Hanson, K., Mbacham, W., Onwujekwe, O. and Wiseman, V. (2014). Mind the gap: knowledge and practice of providers treating uncomplicated malaria at public and mission health facilities, pharmacies and drug stores in Cameroon and Nigeria. *Health Policy and Planning.* 30 (9): 1129–41.

Mohammed, N. (2020).Why Nigeria Universities delay in starting Pharm.D. programme [Internet]. [Cited 2021 May 10]. Available from: https://psnnational.org/index.php/2020/02/02/why-nigeria-varsities-delay-in-starting-pharm-d-degree-pcn-registrar

Mukkala, A., Kwan, J., Lau, R., Harris, D., Kain, D. and Boggild, A. (2018). An update on malaria rapid diagnostic tests. *Current Infectious Diseases Report*. 20 (12): 49–62.

Musa A. (2018). Kwara at 50: Achievements and Aspirations. Nigeria: Fifty-fifty Institute Ltd, Ilorin. pp 1–16.

Nunnally, J. and Bernstein, I. (1994). The Assessment of Reliability. *Psychometric Theory*. 3: 248-292.

Ogunbameru, A. and Ogunbameru, B. (2018). The dynamics of social science research. 2nd ed. Penthouse Publications (Nig.) Ibadan, pp 133–139.

Oladepo, O., Oyeyemi, A.S., Titiloye, M.A., Adeyemi, A.O., Burnett, S.M., Apera, I., Oladunni, O. and Alliu, M. (2019). Malaria testing and treatment knowledge among selected rural patent and proprietary medicine vendors (PPMV) in Nigeria. *Malaria Journal* 18 (103): doi: 10.1186/s12936-019-2732-z

Onwujekwe, O., Mangham-Jefferies, L., Cundill, B., Alexander, N., Langham, J., Ibe, O., Uzochukwu, B., and Wiseman, B. (2015). Effectiveness of provider and community interventions to improve treatment of uncomplicated malaria in Nigeria: a cluster randomized controlled trial. *PloS ONE*. 10(8):e0133832.

Onwujekwe, O., Uguru, N., Etiaba, E., Chikezie, I., Uzochukwu, B.and Adjagba, A. (2013). The economic burden of malaria on households and the health system in Enugu State, South East Nigeria. *PLoS ONE*. 8 (11): e78362. https://doi.org/10.1371/journal.pone.0078362

Osemene, K., Awogbemi, K. and Akinyemi, O. (2011). Evaluation of Community Pharmacists' Involvement the Treatment of Malaria in Nigeria. *International Journal of Pharmacy and Pharmaceutical Sciences.* 3 (5): 107–12.

Osemene, K.and Erhun, W. (2018). Evaluation of Community Pharmacists Involvement in Public Health activities in Nigeria. *Brazilian Journal of Pharmaceutical Science*. 54 (3). https://doi.org/10.1590/s2175-979020180003/7447

Rogers, E. (2003). Diffusion of Innovations. 5th ed. Simon and Schuster; Boston, U.S.A. pp 137-149

Taiwo, O.and Panas, R. (2018). Roles of community Pharmacists in improving oral health awareness in Plateau State, Northern Nigeria. *International Dental Journal*. 68 (4): 287–94.

Trochim, W.M.K. and Donnelly, J.P. (2008). The research methods knowledge base. Ceegage Learning, Mason Ohio, pp 198-219

United States Agency for International Development (2009). How to use a rapid diagnostic test (RDT): A guide for training at a village and clinic level (Modified for training in the use of the Generic Pf-Pan Test for falciparum and non-falciparum malaria). USAID, Bethesda, MD, and Geneva, pp 37-94.

Wilson, M. (2012). Malaria Rapid Diagnostic Tests. *Clinical Infectious Diseases*. 54 (11): https://doi.org/10.1093/cid/cis228

World Bank (2018). Rural population (% of total population) estimates based on the United Nations Population Division's World Urbanization Prospects 2018 Revision [Internet]. World Bank; Available from: www.data.worldbank.org/indicator/SP.RUR.TOTL.ZS; accessed 10th February, 2022

World Health Organization. (2015). World malaria report 2015. World Health Organization. https://apps.who.int/iris/handle/10665/200018; accessed 10th February, 2022

World Health Organization. (2018). World malaria report 2018. World Health Organization. https://apps.who.int/iris/handle/10665/275867. License: CC BY-NC-SA 3.0 IGO. Accessed 13th March, 2022

World Health Organisation. (2018a). Malaria rapid diagnostic test performance: results of WHO product testing of malaria RDTs: round 8 (2016–2018). Word Health Organisation, Geneva Switzerland. Available at https://apps.who.int/iris/bitstream/handle/10665/276190/9789241514965-eng.pdf; accessed 10th February, 2022

World Health Organisation. (2021). From 30 million cases to zero: China is certified malaria-free by WHO. World Health Organisation, Geneva Switzerland; Available from: https://www.who.int/news/item/30-06-2021-from-30-million-cases-to-zero-china-is-certified-malaria-free-by-who, accessed 10th February, 2022

Zekar, L., Sharman, T. (2021). Plasmodium Falsiparum Malaria. Statpearls Publishing, Treasure Island (FL). Ebook available at https://www.ncbi.nlm.nih.gov/books/NBK555962/

*Address for correspondence: Maduabuchi Romanus Ihekoronye

Department of Clinical Pharmacy and Pharmacy Administration,
Faculty of Pharmacy,
Obafemi Awolowo University,
Ile-Ife, Nigeria
Telephone: +2348079508822
E-mails: m.ihekoronye@gmail.com

Conflict of Interest: None declared

Received: April 25, 2022

Accepted: July 12, 2022