

Impact of Mobile Technologies on Cervical Cancer Screening Practices in Lagos, Nigeria (mHealth-Cervix): A Randomized Controlled Trial

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PURPOSE We assessed the impact of mHealth on Pap test screening uptake and also determined the factors that affect screening uptake among women in Lagos, Nigeria.

MATERIALS AND METHODS A randomized controlled trial was carried out among women in two tertiary health institutions in Lagos, Nigeria, between July 2020 and March 2021. Participants were randomly assigned to either a text message (mHealth) intervention or usual care arm. The main study outcome was the uptake of Pap smear testing within 6 months of enrollment in the study. We tested the associations between two groups of continuous variables using the unpooled independent-sample *t*-test (normal distribution) and that of two groups of categorical variables with the chi-square (χ^2) test. Using a multinomial logistic regression model, we adjusted for relevant sociodemographic and clinical predictors of uptake of Pap smear screening. Statistical significance was defined as $P < .05$.

RESULTS There was a significantly higher rate of uptake of Pap smear screening among women in the mHealth arm compared with those in the usual care arm (51.0% v 35.7%, $P = .031$). Following adjustment in the final multivariate model, level of income (odds ratio [OR] = 5.13, 95% CI, 1.55 to 16.95), awareness of Pap smear (OR = 16.26; 95% CI, 2.49 to 76.64), General Outpatient clinic attendance, and introduction of mHealth intervention during follow-up (OR = 4.36; 95% CI, 1.44 to 13.22) were the independent predictors of Pap smear uptake.

CONCLUSION The use of mHealth technologies intervention via short-text message services is a feasible solution for cervical cancer prevention in low- and middle-income countries, and thus, the widespread use of mHealth services by health care providers and policymakers could contribute to the implementation of cervical cancer prevention services in Nigeria and in the settings of other low- and middle-income countries.

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INTRODUCTION

Cervical cancer is a major public health problem, accounting for an estimated 604,000 new cases and 342,000 deaths globally every year.¹ There is a significant reduction in the incidence of cervical cancer because of the early detection of its precursor lesions through the use of Pap smear (cytology) especially in high-income countries.² The incidence of the disease and its associated mortality have, however, remained high in resource-constrained countries such as Nigeria because of many barriers to the implementation of organized screening programs.³

The use of mobile technologies has increased significantly in recent years^{4,5} and because of this, there is increased opportunity for the development of mobile health technologies (mHealth), or medical and public health practices involving the use of mobile devices,⁶

which has great potential in health promotion and prevention.⁷ The introduction of mHealth to health care may potentially empower patients to control their health, reduce inequalities, and improve the cost-effectiveness of health services delivery.⁸ There are currently no reported studies in sub-Saharan Africa that examined the use of mHealth in cancer prevention. We conducted this randomized controlled trial to assess the impact of mHealth using text messages on Pap smear screening uptake, and also determined the predictors of screening uptake among women in Lagos, Nigeria.

MATERIALS AND METHODS

Study Design and Settings

This was a randomized controlled trial that involved women who attended the General Outpatient (GOP) clinics of the two public tertiary health institutions in

ASSOCIATED CONTENT

Protocol

Author affiliations and support information (if applicable) appear at the end of this article.

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CONTEXT

Key Objective

Would the introduction of mobile health technologies (mHealth) increase the uptake of Pap smear screening when compared with usual care among women in Lagos, Nigeria?

Knowledge Generated

The results showed that there was a significantly higher rate of uptake of Pap smear screening among women in the mHealth arm compared with those in the usual care arm, and a woman's level of income, her previous awareness of Pap smear, and attendance at the General Outpatient clinic during the follow-up period were the independent predictors of Pap smear uptake.

Relevance

The use of mHealth technologies intervention via short-text message services is a feasible solution for cervical cancer prevention in low- and middle-income countries, and thus the widespread use of mHealth services by health care providers and policymakers could contribute to the scale up of cervical cancer prevention services in Nigeria and in the settings of other low- and middle-income countries.

Lagos, Nigeria, between July 2020 and March 2021. The trial Protocol was registered on the Pan African Clinical Trial Registry ([PACTR202002753354517](https://pactr202002753354517)). The detailed Protocol is published elsewhere⁹ and some of the details are described below.

Study Population and Eligibility Criteria

We enrolled sexually active women age between 25 and 65 years with no prior history of cervical cancer or cervical dysplasia; those who were not strictly adherent to the current Pap smear screening recommendations (have not had a Pap smear in more than three years); those owning and using a personal mobile phone; those without any mental or physical disabilities that could inhibit them from understanding the purpose of the study; and those who were not considering relocation from their current residential address during the 6 months following their enrollment. The exclusion criteria were women with an ongoing pregnancy and those who refused or withdrew their consent during the study.

Study Procedures

The study investigators identified eligible women from the GOP clinics of the two study sites on each day of the study period after which a 20-30-minute educational health talk on cervical cancer and its prevention was given to all the women in the clinics by the midwives with the assistance of the clinics' health care teams as part of their usual standard of care (usual care). Eligible women were then invited by the investigators to provide consent for participation in the study upon explanation of the purpose and nature of the study. Once consent was obtained, a structured questionnaire was administered by the investigators to obtain baseline information on the relevant sociodemographic and clinical characteristics. We used an individual's monthly income and educational status as independent determinants of socioeconomic status according to Yoon et al.¹⁰

Low-income earners received 30,000 naira (₦) or less per month—the minimum wage in Nigeria; the middle-income class earned ₦150,000 or less per month—about the salary level of a newly employed Nigerian graduate, whereas the upper-income class earned more than ₦150,000 per month (\$1 US dollar was equivalent to ₦364 as at February 2020). Educational level is the highest education attained by each participant and this was categorized into uneducated; primary; secondary; and tertiary education.

Random Assignment

Following the baseline assessment, enrolled women were randomly assigned to either the text message (mHealth) arm or the standard of care (usual care) arm using a 1:1 random assignment sequence generated by the study statistician from the Random Allocation software version 1.0 (May 2004). The allocation sequence was kept in sealed opaque envelopes that were stored in locked file cabinets at the study sites until participants' assignments were completed.

- *mHealth arm*—We modified the study Protocol⁹ by choosing MultiTexter Bulk SMS as the platform to deliver the mHealth text messages. Participants were sent messages containing health promotion information on cervical cancer screening twice monthly for 6 months after enrollment. Information on the Cytology clinic hours, contact information, and locations in the two participating hospitals were also provided.
- *Usual care arm*—Participants in this study arm only received the health talk (usual care) at enrollment with no additional follow-up text messages.

After random assignment, each woman received a ₦2,000 credit charge on their mobile phone as a token to enable the investigators to keep their phone numbers throughout the study duration. The women were also encouraged at enrollment to schedule an appointment for their Pap smear

testing in person at the GOP or Cytology clinics at any time during the 6-month follow-up period. On completion of the 6-month follow-up, data were collected from each woman on their GOP clinic attendance and Pap test screening uptake at any time during the follow-up period. Although we were not able to conceal the study arms to the participants and the study staff, GOP clinic staff who were not part of the study team were not informed of the participants' group assignments. Participants were also asked by the study staff not to communicate their study arm to the clinic staff.

Study End Points

The study end points were Pap smear screening uptake (defined as the completion of a Pap smear within 6 months of enrollment in the study) and predictors of Pap smear screening adherence. Participants in both study arms were tracked via phone calls as well as through the review of their medical records at 6 months after their study enrollment.

Statistical Methods

We used the G*Power for Windows version 3.1.9.2 (Kiel University, Germany) to calculate the sample size. With data from our previous study¹¹ and a 10% attrition rate, a sample size of 100 women for each study arm was estimated to provide 80% power to establish the superior impact on screening uptake of mHealth intervention to the usual standard of care. We used the intention-to-treat principle in the final data analyses. We adopted SPSS version 27.0 for Windows (IBM Corp, Armonk, NY) for statistical analyses. Pap smear screening uptake was coded as a binary variable and the intervention was evaluated based on the completion of Pap smear screening at 6 months. We tested the associations between two groups of continuous variables using the unpooled independent-sample *t*-test (normal distribution) and that of two groups of categorical variables with Pearson's chi-square (χ^2) test. Using multinomial logistic regression analysis, we adjusted for age, parity, marital status, educational level, income level, the distance of residence from the clinics, awareness, and previous Pap smear testing and GOP clinic attendance during the follow-up period as predictors of screening uptake. Statistical significance was defined as *P*-value < .05.

Ethical Considerations

This study was approved by the Health Research Ethics Committee of the College of Medicine, University of Lagos (approval number CMUL/HREC/12/19/704). The trial conformed to local and international guidelines based on the Declaration of Helsinki and Good Clinical Practice guidelines of the International Conference on Harmonisation. We reported the trial in line with the checklist for Consolidated Standards of Reporting Trials (CONSORT).

RESULTS

We enrolled and randomly assigned 200 women to the study arms. At the time of random allocation, the mean age of the participating women was 37.4 ± 10.2 years, whereas

the mean distance of their residential location and mean duration of use of mobile phones were 15.8 ± 8.5 km and 11.8 ± 4.2 years, respectively. There were no significant differences in the baseline characteristics of the participant in the two study arms (Table 1). Of the randomly assigned women, four withdrew their consent during the study for personal reasons, 10 were lost to follow-up, and three had incomplete or missing data (eight in the mHealth arm and nine in the usual care arm; Fig 1).

As shown in Table 2, the overall rate of uptake of Pap smear screening during the 6-month follow-up was 43.5% (*n* = 87) with the rate of 51.0% (*n* = 52) among women in the mHealth arm compared with 35.7% (*n* = 35) among those in the usual care arm (*P* = .031). In the univariate multinomial regression analysis, level of participant's income (*P* = .001), being previously aware of Pap smear testing (*P* = .001), having had Pap smear in the past (*P* = .001), and attending the GOP clinic during the follow-up period (*P* = .001) were significantly associated with the uptake of Pap smear screening. However, following adjustments in the final multivariate model, level of income (odds ratio [OR] = 5.13; 95% CI, 1.55 to 16.95; *P* = .007), awareness of Pap smear (OR = 16.26; 95% CI, 2.49 to 76.64; *P* = .001), GOP clinic attendance during the follow-up (OR = 4.36; 95% CI, 1.44 to 13.22; *P* = .009), and mHealth intervention (OR = 5.76; 95% CI, 1.65 to 20.08; *P* = .006) were recorded as the independent predictors of Pap smear uptake (Table 3).

DISCUSSION

In this randomized controlled trial, the introduction of mobile health (mHealth) technologies intervention using short-text message services (SMS) had a significant impact on the uptake of Pap smear screening among women in Lagos. We also recorded that factors such as a woman's level of income, her prior awareness of Pap smear for cervical cancer screening, and attendance for care at the GOP clinic during the period of follow-up were significant independent predictors of Pap smear screening uptake.

The mean age of the participants in this study (37.4 ± 10.2 years) is almost similar to the mean ages of 35.9 ± 9.5 ¹¹ and 35.7 ± 9.74 years¹² recorded in our previous studies that assessed women's knowledge of cervical cancer and its prevention, thus attesting to the usual age distribution of apparently healthy women who readily participate in similar clinical research in Lagos. We recorded an overall uptake rate of 43.5% for Pap smear testing in this study and this is far higher than the 22.9% rate of previous screening reported in a study conducted in a similar setting in Lagos¹¹ and the 27.0% reported by the participants in this study. This indicates the overall impact of the mobile SMS intervention as evidenced by the significant difference observed in the screening uptake during follow-up among women in the mHealth arm compared with those in the usual care arm.

TABLE 1. Baseline Characteristics of Participants in the Study Arms^a

Characteristic	Total (N = 200)	mHealth (n = 102)	Usual Care (n = 98)	P
Age, years	37.4 ± 10.2	36.8 ± 10.1	38.0 ± 10.3	.422
Residential location, km	15.8 ± 8.5	16.5 ± 8.5	15.1 ± 8.5	.249
Duration of mobile phone use, years	11.8 ± 4.2	12.1 ± 4.2	11.4 ± 4.2	.228
Prior pregnancies				.823
0	34 (17.0)	19 (18.6)	15 (15.3)	
1-3	152 (76.0)	76 (74.5)	76 (77.6)	
> 3	14 (7.0)	7 (6.9)	7 (7.1)	
Marital status				.431
Never married	42 (21.0)	24 (23.5)	18 (18.4)	
Married	134 (67.0)	63 (61.8)	71 (72.4)	
Divorced	16 (8.0)	10 (9.8)	6 (6.1)	
Widowed	8 (4.0)	5 (4.9)	3 (3.1)	
Level of education				.564
No formal education	12 (6.0)	7 (6.9)	5 (5.1)	
Primary education	50 (25.0)	28 (27.5)	22 (22.4)	
Secondary education	87 (43.5)	45 (44.1)	42 (42.9)	
Tertiary education	51 (25.5)	22 (21.6)	29 (29.6)	
Level of income				.360
Lower	86 (43.0)	47 (46.1)	39 (39.8)	
Middle	75 (35.7)	39 (38.2)	36 (36.7)	
Upper	39 (19.5)	16 (15.7)	23 (23.5)	
Awareness of Pap test				.623
Yes	81 (40.5)	43 (42.2)	38 (38.8)	
No	119 (59.5)	59 (57.8)	60 (61.2)	
Previous Pap test screening				.863
Yes	54 (27.0)	27 (26.5)	27 (27.6)	
No	146 (73.0)	75 (73.5)	71 (72.4)	

Abbreviations: mHealth, mobile Health intervention; SD, standard deviation.

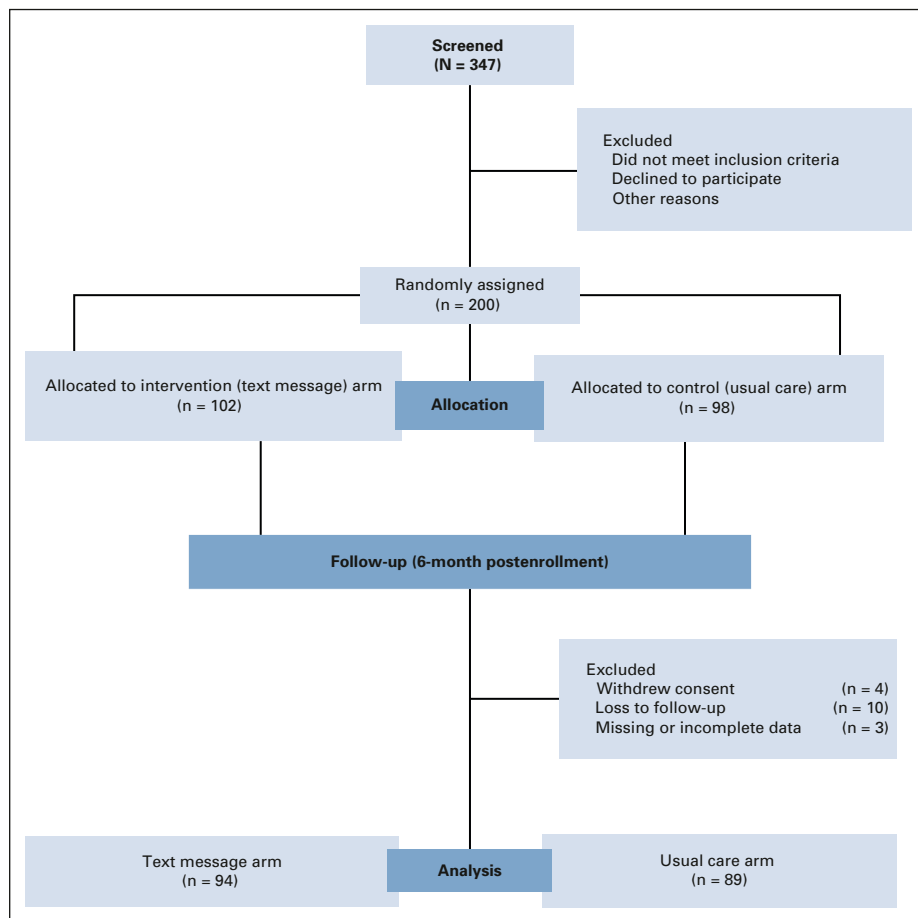
^aValues are given as mean ± SD, or number (percentage) unless indicated otherwise.

Having some levels of formal education was not significantly associated with increased uptake of Pap smear among the participants in this study and other previous studies in Africa,^{11,13} whereas it was reported as a significant predictor of uptake of cervical cancer screening in another study.¹⁴ This thus suggests that the determinants of health care practices of individuals are usually multifactorial, and education, despite being a vital tool in health promotion, may not be the sole determinant. However, having a high- to middle-income status is a significant independent predictor of Pap test uptake in this study, and this is not surprising as women of higher economic status are more empowered to take independent health care decisions and are thus better able to access health care services irrespective of any other factors. The uptake of Pap smear screening among women with previous screening awareness in this study corroborates the finding from our previous study¹¹ that suggests that Pap smear screening

awareness is likened to having a good knowledge of the impact of invasive cervical cancer on morbidity and mortality. Because of the constraints of available time, individuals tend to use the opportunity of attending health care facilities during the period of infirmities to simultaneously seek necessary health care prevention services. This is now considered as a pivotal aspect of health care provision as most health institutions including ours have now integrated health promotion and prevention services to almost all aspects of health care service delivery in most outpatient clinics. This, therefore, is corroborated by the finding of significant uptake of Pap smear screening among women who attend the GOP clinics for evaluation and treatment of other ailments during the period of their follow-up in the current study.

The major limitation of this study was the inability to assess the participant's adherence to the use of text message services despite having mobile phones. Furthermore, the

FIG 1. CONSORT diagram.



extreme difficulty in ensuring with absolute certainty that participants, especially those in the mHealth arm, who attended the GOP clinics during the period of their follow-up did not unknowingly reveal their study group with resultant undue influence on their screening uptake. We also acknowledge that giving phone credit to participants as incentives may be creating bias. However, this was a one-off payment intended to encourage participants' engagement with the study and to facilitate their retention for the follow-up. Following the positive findings from the study, we

will need to consider sustainable and feasible ways of supporting engagement with the intervention when delivered as part of routine care.

In conclusion, the use of mobile health (mHealth) technologies intervention via SMS was significantly associated with the uptake of Pap smear screening among women in Lagos. A woman's level of income, her prior awareness of Pap smear screening, and attendance for care at the GOP clinic during the period of follow-up were significant independent predictors of Pap smear screening uptake. As the effects of mHealth intervention campaigns are often short-lived, only involve one-way communication, and do not benefit those in most need, our subsequent implementation research agenda will attempt to explore the role of mHealth and its effect in the context of routine care, alongside exploring approaches to increasing the flow of information and value of content for patients. In the meantime, we recommend that regular health education of women about cervical cancer and its screening strategies, together with the upscale use of mHealth services interventions by health care providers and policymakers, will go a long way to reduce the high incidence and overwhelming burden of cervical cancer in Nigeria and other low- and middle-income settings.

TABLE 2. Uptake of Pap Smear Screening Among Participants in the Study Arms^a

	Total	mHealth	Usual Care	
Pap Smear Screening	N = 200 (%)	n = 102 (%)	n = 98 (%)	P ^b
Uptake	87 (43.5)	52 (51.0)	35 (35.7)	0.031
Nonuptake	96 (48.0)	42 (41.2)	54 (55.1)	
Dropout	17 (8.5)	8 (7.8)	9 (9.2)	

Abbreviation: mHealth, mobile Health intervention.

^aN = 200.

^bValue is based on multinomial logistic regression.

TABLE 3. Sociodemographic and Clinical Predictors of Pap Smear Screening Uptake Within 6 Months of Enrollment (N = 200)

Covariates	Estimates of Effect on Pap Smear Screening Uptake					
	Uptake n = 87 (%)	Nonuptake n = 96 (%)	Univariate		Multivariate	
			OR (95% CI)	P	Adj OR (95% CI)	P
Age, years						
< 37	46 (52.9)	55 (57.3)	0.84 (0.47 to 1.50)	.549		
≥ 37	41 (47.1)	41 (42.7)	1.00 (ref)	—		
Residential location, km						
< 16	40 (46.0)	48 (50.0)	0.85 (0.47 to 1.52)	.587		
≥ 16	47 (54.0)	48 (50.0)	1.00 (ref)	—		
Use of mobile phone, years						
< 12	36 (41.4)	53 (55.2)	0.57 (0.32 to 1.03)	.062	1.21 (0.38 to 3.83)	.744
≥ 12	51 (58.6)	43 (44.8)	1.00 (ref)	—	1.00 (ref)	
Prior pregnancies						
Parous	69 (79.3)	83 (86.5)	0.60 (0.28 to 1.31)	.201		
Nulliparous	18 (20.7)	13 (13.5)	1.00 (ref)	—		
Marital status						
Ever married	67 (77.0)	78 (81.3)	0.77 (0.38 to 1.58)	.481		
Never married	20 (23.0)	18 (18.8)	1.00 (ref)	—		
Educational status						
Educated	86 (98.9)	89 (92.7)	6.76 (0.82 to 56.14)	.077	6.44 (0.59 to 9.10)	.083
No formal education	1 (1.1)	7 (7.3)	1.00 (ref)	—	1.00 (ref)	—
Level of income						
Upper-middle	71 (81.6)	38 (39.6)	6.77 (3.43 to 13.36)	.001	5.13 (1.55 to 16.95)	.007
Lower	16 (18.4)	58 (60.4)	1.00 (ref)	—	1.00 (ref)	—
Awareness of Pap smear						
Yes	71 (81.6)	6 (6.3)	66.56 (24.77 to 178.87)	.001	16.26 (2.49 to 76.64)	.001
No	16 (18.4)	90 (93.7)	1.00 (ref)	—	1.00 (ref)	—
Previous Pap smear						
Yes	47 (54.0)	5 (5.2)	21.39 (7.91 to 57.79)	.001	0.27 (0.03 to 2.99)	.288
No	40 (46.0)	91 (94.8)	1.00 (ref)	—	1.00 (ref)	—
GOP clinic attendance						
Yes	44 (50.6)	14 (14.6)	3.47 (1.71 to 7.02)	.001	4.36 (1.44 to 13.22)	.009
No	43 (49.4)	82 (85.4)	1.00 (ref)	—	1.00 (ref)	—
Intervention						
mHealth	52 (59.8)	42 (43.8)	1.91 (1.06 to 3.44)	.031	5.76 (1.65 to 20.08)	.006
Usual care	35 (40.2)	54 (56.2)	1.00 (ref)		1.00 (ref)	

Abbreviations: Adj OR, adjusted odds ratio; GOP, gynecologic outpatient; mHealth, mobile health intervention; OR, odds ratio.

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DISCLAIMER

The views expressed in this publication are those of the authors and do not necessarily reflect the official views of the American Society of Clinical Oncology or Conquer Cancer and the National Institutes of Health.

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CLINICAL TRIAL INFORMATION

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AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

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