



A model for the adoption of ICT by health workers in Africa

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ABSTRACT

Purpose: To investigate the potential of information and communication technology (ICT) adoption among maternal and child health workers in rural Nigeria.

Methods: A prospective, quantitative survey design was used to collect data from quasi-randomly selected clusters of 25 rural health facilities in 5 of the 36 states in Nigeria over a 2-month period from June to July 2010. A total of 200 maternal and child health workers were included in the survey, and the data were analyzed using a modified theory of acceptance model (TAM).

Results: There was no significant difference between ICT knowledge and attitude scores across states. There were significant differences in perceived ease of use ($P < .001$) and perceived usefulness scores ($P = .001$) across states. Midwives reported higher scores on all the constructs but a lower score on endemic barriers (which is a more positive outcome). However, the differences were only statistically significant for perceived usefulness ($P = .05$) and endemic barriers ($P < .001$). Regression analysis revealed that there was no interaction between worker group and age. Older workers were likely to have lower scores on knowledge and attitude but higher scores on perceived ease of use and perceived usefulness. Lastly, we found that worker preference for ICT application in health varied across worker groups and conflicted with government/employer priorities.

Conclusions: Although the objective of this study was exploratory, the results provide insight into the intricacies involved in the deployment of ICT in low-resource settings. Use of an expanded TAM should be considered as a mandatory part of any pre-implementation study of ICT among health workers in sub-Saharan Africa.

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1. Introduction

In the developing world, there has been an upsurge in Internet penetration and the use of mobile technology. Particularly in the health sector, experts believe mobile phones can revolutionize the health system in the developing world [1]. This

premise has led to the launch of several information and communication technology (ICT) projects in developing countries, such as MoTech in Ghana [2], Medic Mobile in Malawi [3], and RapidSMS in India [4].

In Nigeria, the National Primary Health Care Development Agency (NPHCDA) is charged with championing primary health care in the country. Nigeria is the most populous

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African nation, with an estimated population of more than 160 million. The country is approximately 923,000 km² (about the size of California), and the literacy rate is 39–51% [5]. Nigeria has 6 geopolitical zones, and maternal and child health care delivery in the public sector is typically organized into clusters of access points (1 general hospital and 4 primary health care centers). Maternal mortality is a serious problem in Nigeria. In 2009, the number of women dying from childbirth was an estimated 50,000 per year [6]. According to UNICEF, the maternal mortality rate is 840 per 100,000 live births [7]. This statistic spurred the creation of the Midwifery Services Scheme (MSS) in 2009 to address the shortage of skilled birth attendants [8]. The MSS also supplied computers, solar panels, and mobile phones to 200 health facilities out of more than 10,000 health facilities in the country.

Although ICT infrastructure in Nigeria is poor overall, including Internet penetration of less than 16% [9] and average broadband download speed of 1.38 Mbps (compared with 10.1 Mbps in the United States) [10], the Global System for Mobile Communication (GSM) has experienced a boom in Nigeria and much of sub-Saharan Africa. Within 10 years of GSM availability in Nigeria, more than 90 million Nigerians had mobile phones [11]. Given this success, health sector leaders have sought to complement efforts to reinforce frontline maternal and child health workers with technological tools. This led to the partnership between the NPHCDA and Duke University to explore the possibility of an ICT intervention in Nigeria's public health sector, particularly in maternal and child health care. Frontline workers in maternity-related care in Nigeria are mostly midwives and community health extension workers, because of a shortage and maldistribution of doctors.

Because many technology projects fail at the implementation stage as a result of human factors [12], as evidenced by a similar project in Uganda [13], the need arose for an end-user assessment study to understand the prevailing human environment in working out a customized solution that would meet the ICT needs of the primary health sector in Nigeria. The primary goal of the study was to investigate the base level of ICT knowledge and attitudes, perceived usefulness, and perceived ease of use of the 2 main maternal and child health worker groups.

Ours is the first study to propose a model for predicting ICT adoption in health in sub-Saharan Africa. Generally, a review of the literature suggests that studies like this are limited even in developed countries [14]; the closest example in a developing country was conducted in India by Chattopadhyay [15]. Therefore, we sought to access end users and predict their adoption potential, patterns, and practice, and to understand and address end-user needs appropriately before implementation, so as to increase chances of success in implementation, and ultimately the chances of better patient care.

2. Methods

Our goal was to investigate the adoption potential of midwives and community health extension workers using the technology acceptance model (TAM) as a framework. The TAM is the most widely accepted model of behavioral intention in the

information systems literature [16]. The original TAM suggests that an intention to accept technology is determined by 3 constructs: attitude, perceived usefulness, and perceived ease of use [17]. Despite a 30–40% predictive power [18], a major limitation of the TAM is its failure to consider the influence of external variables and barriers to technology, such as access [19]. We expanded the framework to account for this peculiar environment by including knowledge as a separate factor from attitude, because we could not safely assume that knowledge would be adequately reflected in attitude. We also added a group of questions about endemic barriers to technology, an important consideration in low-resource settings such as Nigeria, and ICT use-case preferences of different workers across geopolitical zones. We believed such a modified TAM would be more appropriate, given the end users and the local context [20].

2.1. Questionnaire design

The questionnaire was designed primarily to assess 5 constructs: knowledge, attitude, perceived ease of use, perceived usefulness, and endemic barriers. Each construct was represented on the survey by multiple question items. Survey questions were written in English and designed with guidance from Fink [21]. Some of the questions were adapted from a previous computer knowledge survey [22], but most were original. The questionnaire was structured and in multiple parts. Questions within the same construct were grouped in some cases and not in others. Likert scales were employed wherever possible, depending on the complexity of the information desired and the level of understanding of the respondents. There were a total of 60 items in the survey (6 items on knowledge, 4 on attitude, 2 on perceived ease of use, 3 on perceived usefulness, and 4 on endemic barrier). Lastly, we asked a rank-order question on individual worker preference on the type of technology application they would like to incorporate into their daily work activities. After all question items were generated, the instrument was revised with expert opinion. The institutional review board of the Duke University Health System reviewed the study and classified it as “exempted from consent.”

We pretested the questions in 2 locations in Kwara State with 10 health workers who were not from the 6 states included in the study (Fig. 1) to assess the clarity, content validity, wording, and understanding of the questions. The feedback was helpful, and a few modifications were made after the pretest. The changes were finalized before the commencement of the study. There were no changes made to the questionnaires during the course of the study.

2.2. Data collection

Data collection was conducted mostly by the first author, a physician, and 6 volunteers (often indigenous senior community health professionals). Surveys were handed out to the health workers to complete individually. (In 3 of the 25 facilities, investigators assisted in local language translation for some of the community health extension workers). The investigators were available to the health workers for clarification of questions as they completed the surveys. All respondents

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