

## Acceptance of mHealth technologies among Auxiliary Nurse Midwives in Andhra Pradesh, India: A mixed method study

**To Cite:**

Kodali PB, Das S. Acceptance of mHealth technologies among Auxiliary Nurse Midwives in Andhra Pradesh, India: A mixed method study. *Medical Science*, 2021, 25(111), 1052-1060

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**Peer-Review History**

Received: 14 March 2021

Reviewed & Revised: 15/March/2021 to 26/April/2021

Accepted: 27 April 2021

Published: May 2021

**Peer-review Method**

External peer-review was done through double-blind method.

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### ABSTRACT

*Introduction:* Frontline health workers such as auxiliary nurse midwives (ANMs) play an important role in implementation of mHealth programmes. Despite their extensive engagement, limited published studies examined mHealth acceptance among Indian ANMs. *Materials and Methods:* A mixed methods study was conducted to examine the acceptance of mHealth technologies by ANMs in Andhra Pradesh, India. A survey of 272 ANMs and 21 in-depth interviews (12 ANMs and 9 Planners) were conducted. Statistical analysis and thematic analysis were employed to analyse quantitative and qualitative data respectively. *Results:* 56.3% of ANMs had low acceptance of mHealth. Perceived usefulness, results demonstrability, and technical competence etc., are significantly predicted ANMs acceptance of mHealth. Additionally, government prioritization of mHealth, dynamic mHealth environment and existence of multiple data systems influenced mHealth acceptance of ANMs. *Conclusion:* Our study is among the early studies in India which examined acceptance of mHealth health technologies implemented as state run programmes. It identifies several actionable dimensions which impact the acceptance of mHealth technologies among frontline health workers like ANMs.

**Keywords:** Auxiliary Nurse Midwives; Digital Health; mHealth; Frontline health workers; Technology Acceptance

### 1. INTRODUCTION

India is currently undergoing huge challenge in responding to the global threat of COVID-19 pandemic. The present health care facilities and health care professionals are unable to adequately cater to the health care needs of the people. The growing and emerging technological interventions like tele-consultation endeavored to constantly tackle this crisis and also achieved adequate success. At the same time other technological innovations as mobile based health interventions (mHealth) have been emerging in the recent times



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for strengthening health care services in the country. In 2012, Tamrat and Kachnowski, defined Mobile Health (mHealth) as “utilisation of mobile technologies (mobile phones, wireless devices, personal digital assistants, wearable technologies) in the provision of health care services” (Tamrat & Kachnowski, 2012). The mHealth technologies account for a major share of digital health technologies used across the world (WHO, 2019). One of the common areas of application of mobile health technologies in Indian context is maternal and child health (MCH). Specifically, mHealth technologies were found to be useful in several domains of MCH care provision including (but not limited to), eligible couple enrolment, data collection and management, antenatal registration and tracking, maintaining stock registers, tracking child immunization, behavioural change communication and health worker training (WHO, 2019).

Several mHealth applications in the sphere of MCH programmes were launched by the central and various state governments in India. Some of them include ANM Digi, ANMOL, mSakhi, RCH Portal, Mobile academy, and Kilkari etc. (GSMA mHealth et al., 2016; UNICEF, 2016). One of the important characteristics observed across mHealth applications was that their deployment was usually through frontline health workers primarily Auxiliary Nurse Midwives (ANM) (GSMA mHealth et al., 2016; Kumar & Anderson, 2015; Treatman et al., 2012; UNICEF, 2016). The ANM Online (ANMOL), a mHealth application launched by Government of India was developed as a job aid to ANMs, ANM Digi launched by state of Andhra Pradesh in India aims to achieve complete paperless work for ANMs. These developments highlight the prominence of ANMs as key stakeholders in the implementation of several mHealth applications.

Within ever-changing dynamic healthcare eco-systems, effective diffusion of mHealth technologies is essential for success of mHealth strategy. Information technology acceptance is a behavioural construct defined as the “individual’s intention to use a particular information technology” (Davis, 1989). It is a basic and essential stage in the information technology (IT) diffusion process; evidence suggests that intention to use a particular information technology predicts its actual usage, providing a measurable construct for technology acceptance (Liao et al., 2009). IT acceptance by target population is influenced by several attributes such as perceived ease of use, perceived usefulness, social norms, and human technology interaction (Holden & Karsh, 2010).

Understanding IT acceptance among end users is essential for successful implementation and usage of any information technology, including mHealth approaches. This is particularly true for Indian health care system which is in initial phases of digitalization. Currently, there is limited research evidence on acceptance of provider-centric mobile health technologies in India. Literature evidence on mHealth acceptance among frontline health workers like ANMs is scant, despite the fact that several mHealth approaches are implemented through them. Moreover, no studies were conducted assessing mHealth acceptance in the context large-scale government supported mHealth programmes (such as ANMOL, ANM Digi and RCH Portal).

This research article aims to bridge literature gap and assess mHealth technology acceptance among ANMs with exposure to MCH focussed mHealth technologies such as ANMOL, ANM Digi or RCH Portal in particular. It addresses the following objectives i) to assess the mHealth technology acceptance among ANMs and ii) to understand the factors influencing mHealth technology acceptance among ANMs.

## 2. METHODS

A mixed-methods study, adopting a concurrent triangulation design was conducted to address the study objectives. Assessment of acceptance of mHealth technology amongst ANMs and its predictors was carried out using a quantitative survey. Qualitative in-depth interviews were employed to explore the factors influencing mHealth acceptance among ANMs.

### Study Setting and Study Population

The study was conducted in Krishna District of Andhra Pradesh (AP), India. The said district was selected because it is among the few districts with a history of longer duration of exposure to government funded mHealth interventions. ANMs constituted the study population for quantitative part of the study. For the qualitative phase two groups namely ANMs and implementers such as medical officers, district programme officers, IT system developers, technical support providers etc., were included.

### Sample size and Sample Selection

#### Quantitative sample

The sample size of 272 ANMs was estimated using following formula

$$n' = \frac{n}{1 + \frac{z^2 \cdot p(1-p)}{e^2 N}}$$

Here, “n and n’” represent sample size which was computed, “N” is population size (estimated at 905 ANMs), p is population proportion of variable under study (assigned as 0.5 by default), z represents Z score for 95 percent confidence level (which is a standard estimate of 1.96) and “e” represents the percentage of margin of error allowed (assigned as 5 percent).

The quantitative sampling was conducted through multistage random sampling. The primary sampling units were the primary health centers (PHC) in the district. Out of the 88 PHCs in the district, 30 PHCs were selected using simple random sampling. Using systematic random sampling 50 percent of ANMs from each of the 30 PHCs were selected achieving sample size of 272. ANMs who had exposure to at least one of the MCH focussed mHealth technology (such as ANMOL/ANM Digi/RCH portal) were included in sample.

**Qualitative sample**

Theoretical sampling was used to collect data from 21 participants through qualitative in-depth interviews for reaching data saturation. Specifically, they included 09 participants from planners group, 12 participants who were ANMs. Purposive and snow ball sampling approaches were used to sample the participants for qualitative interviews. The details of qualitative sample are given in Table 1. Individuals who were directly associated with planning, implementation and monitoring of mHealth technologies like ANMOL, ANM Digi and RCH Portal at the block, district and state levels were included in qualitative sample.

**Table 1** Characteristics of Qualitative Sample

Stakeholder group	Number of sample (n)	Specific cadres (n)
Planners	09	Public Health Nurse (1)
		Health Supervisor (1)
		Medical Officers (2)
		District Project Officer (1)
		District Medical and Health Officer (1)
		District IT Cell Coordinator (1)
		Technical Support from Private Partner (1)
State Programme Manager (1)		
ANMs	12	1 <sup>st</sup> ANMs (6)
		2 <sup>nd</sup> ANMs (6)

**Data Collection**

The data was collected from December 2018 to December 2019. Both quantitative and qualitative data was collected separately. A 34 item multi-dimensional survey questionnaire to assess mHealth technology acceptance and associated factors were developed based on existing models of IT acceptance. The tool consisted of five-point Likert type with the responses arranged in ascending order of strongly disagree < disagree < neutral < agree < strongly agree. The tool was piloted and had an acceptable level of internal consistency ( $\alpha - 0.932$ ). The acceptance of mHealth applications was assessed by two five-point Likert type items ( $\alpha - 0.801$ ), with a total score of 10. Score of score of  $\leq 6$  was considered as low acceptance, and score of 7-10 was considered as high level of acceptance.

The qualitative in-depth interview guides were developed for each of stakeholder groups. The in-depth interview guide had open-ended questions covering around 10 broad areas (perception on mHealth, acceptance of mHealth, implementation, challenges etc.). The interview guides were assessed for content validity and face validity. The interview guides were piloted prior to the main study. The interviews were conducted mostly in vernacular language (Telugu) and few in English. Each of interviews was audio-recorded with prior consent form participants. Respondent validation of interviews was done at the end of each interview to ensure credibility and validity of collected data.

**Data Analysis**

The quantitative data was entered into spread sheets, cleaned and analysed using IBMs Statistical Package for Social Sciences 20<sup>th</sup> version (Arbuckle, 2011). Composite scores were computed and categorized for each dimension using pre-established criteria. The quantitative analysis was conducted using both univariate, and multivariate analysis. Mean, standard deviation, frequencies and percentages were computed in univariate statistics. On the other hand, multivariate analysis was carried out using multiple linear regression analysis.

The audiotapes of qualitative interviews were transcribed and later translated from Telugu to English. The interviews were back translated to check for consistency. The interviews were analysed using thematic analysis approach as outlined by Braun and Clarke (2006). The interviews were familiarized by reading and re-reading and after familiarization, interviews were coded both inductively and deductively (using TAM framework). Sub themes were developed from the codes, there after themes were developed by amalgamating relevant subthemes.

**Ethical Considerations**

The study was conducted adhering to the ethical principles of conducting research. The study proposal was reviewed and approved by the Doctoral Advisory Committee at School of Health Systems Studies, Tata Institute of Social Sciences, Mumbai. All the participants were explained about the study in their own language of choice (vernacular/English) prior to their enrolment into study. The participation in the study was voluntary. All the interviews were conducted ensuring the privacy of respondents. The names/identifiers of the participants were masked to ensure confidentiality.

**3. RESULTS**

**Quantitative Results**

*Socio-demographic and occupational characteristics of ANMs*

All ANMs in the study were working in rural sub-centers (n = 272), 44.9% (n=122) of the respondents were the first ANMs group whereas, 55.1% (n=150) were second ANMs. The mean age of ANMs surveyed was 30 years of age (N=272, SD=4.68) and the mean years of work-experience as an ANM was 15.5 years (N=272, SD = 5.04). The detailed outline of socio-demographic and occupational characteristics of the ANMs is presented in Table 2.

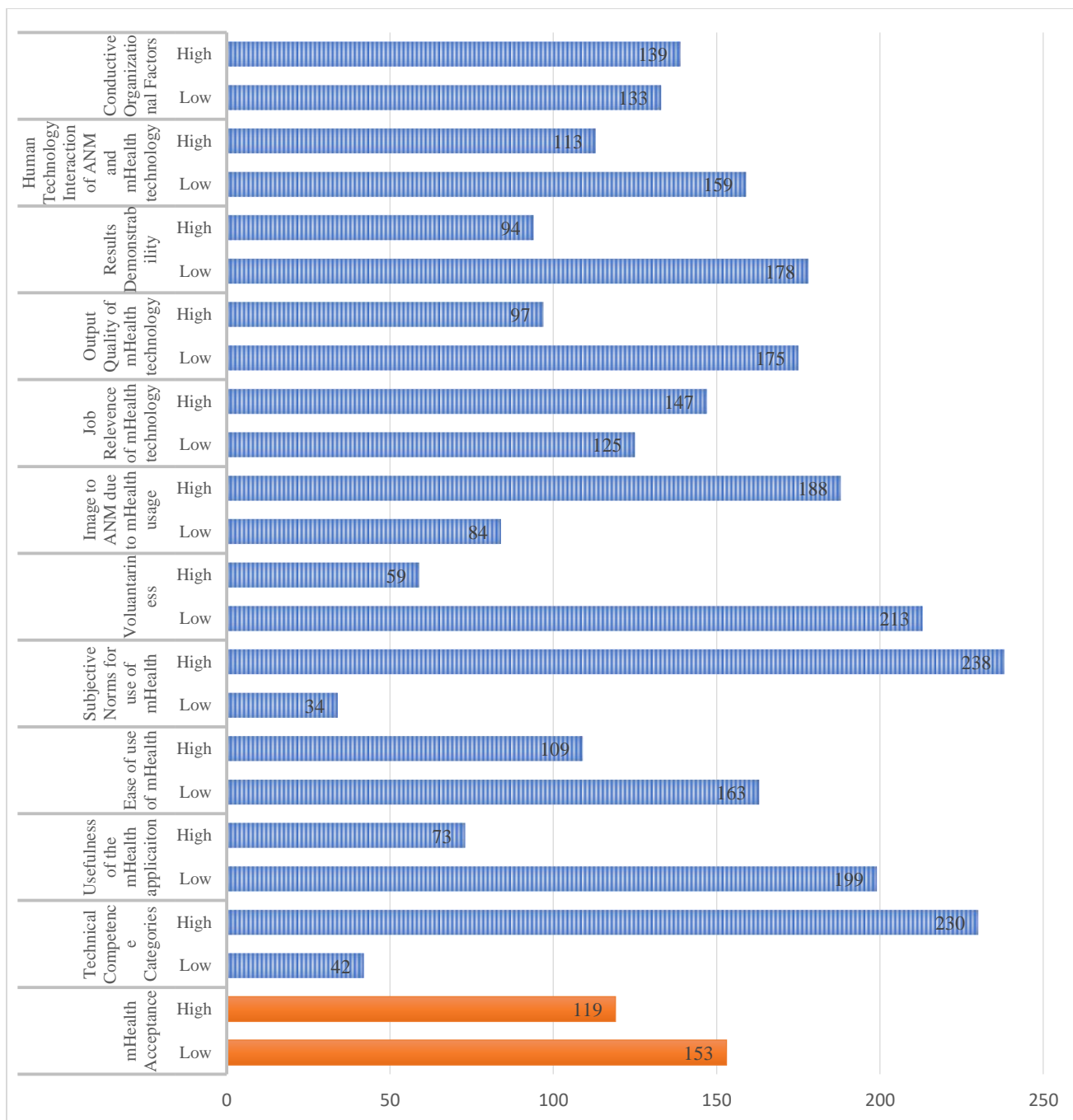
**Table 2** Table outlining the Socio-demographic and occupational characteristics of ANMs in the study

Variable	N	%	Mean	SD
<i>Type of Sub center</i>				
Rural	272	100%	NA	NA
Urban	0	0%		
<i>Type of ANM</i>				
1 <sup>st</sup> ANM	122	44.9%	NA	NA
2 <sup>nd</sup> ANM	150	55.1%		
Age of ANM (Years)	272	100%	30	4.68
Monthly income of ANM (INR)	272	100%	20140	5928.87
Years of Experience of work as ANM	272	100%	15.5	5.04
<i>Highest Educational Qualification</i>				
10 <sup>th</sup> Standard	31	11.4%		
ANM Certification	161	59.2%		
GNM Certification	67	24.6%	NA	NA
Others	13	4.8%		
<i>Previous Experience of using Smart Phones/Computers</i>				
Yes	202	74.3%	NA	NA
No	70	25.7%		
<i>Training received to use mHealth applications</i>				
Yes	264	97.1%	NA	NA
No	8	2.9%		
Daily Active Usage of mHealth apps	272	100%	3.5	1.94

\*ANM= Auxiliary Nurse Midwife, \*GNM = General Nursing and Midwifery

**Acceptance of mHealth Applications**

A composite score (range between 2-10) for mHealth technology acceptance by ANMs was calculated. The mean mHealth technology acceptance score was 6.003 (N = 272, SD = 2.09; 95% CI = 5.76 – 6.24). Among the participants, it was observed that 56% (n = 153) of ANMs had low acceptance of mHealth technologies whereas, 44% (n = 119). The detailed outline of the participant’s categorization of mHealth acceptance and its contributing factors are computed based on ANM’s responses are given in Figure 1.



**Figure 1** Bar chart outlining the level of mHealth acceptance and its contributing factors

**Factors influencing mHealth acceptance among ANMs**

A multiple linear regression model was developed with composite score for mHealth acceptance of the ANMs as the dependent variable. The regression analysis resulted in a model which significantly predicted functional relationship between the dependent and predictor variables ( $F(9,262) = 46.73, p \leq 0.01$ ). The model yielded the value of  $R = 0.785$ , and an  $R^2 = 0.616$ . i.e., 61.6% of the

variance in the composite score for mHealth technology acceptance by ANMs is explained by the predictor variables in the model. The statistics computed by regression analysis are given in Table 3.

**Table 3** Results of multiple linear regression analysis with mHealth acceptance score as dependent variable

	B	Std. error	Sig.
(Constant)	.117	.656	.859
Perceived usefulness	.149	.046	.001**
Perceived ease of use	.046	.039	.246
Results demonstrability of mHealth apps	.128	.05	.012*
Organizational factors	.150	.031	.000**
Years of experience of using mHealth apps	0.200	.099	.045*
Job relevance of mHealth apps	.057	.057	.323
Quality of output of mHealth apps	0.023	.049	.64
Human technology interaction	.054	.036	.136
Technical competency of ANM	.089	.025	.001*

\*= significant at p value ≤ 0.05, \*\* = significant at p value ≤ 0.01; ANM= Auxiliary Nurse Midwife

**Qualitative results**

A total of five recurrent themes were identified concerning the dimensions influencing mHealth acceptance amongst ANMs. Specifically, they included i) individual characteristics of ANMs ii) perceived usefulness of mHealth technologies iii) Government prioritization of mHealth, iv) dynamic mHealth environment and v) existence of multiple data entry systems

**Individual Characteristics of ANMs**

The individual characteristics of ANMs emerged as critical factor with regard to mHealth acceptance. It was found that senior ANMs with limited level education and limited technical awareness had low level of acceptance of mHealth technology. One of the participants who were working as a second ANM reported the following:

*“For those who were recruited recently, (within the last 5-10 years) it’s fine because they are comparatively more educated. However, there are still some first ANMs who do not have much education. They are usually older (above 50 years) and are finding it very difficult to work with TABs” (ANM06).*

**Perceived Usefulness of mHealth Technology**

Another important factor that emerged regarding mHealth acceptance was the perceived usefulness of the technology by the ANMs. An ANM who worked with mHealth technologies like RCH Portal, ANMOL and ANM Digi reported the following.

*“We want to get our work done quickly. When we want to deliver better services, we should be prepared to use them (mHealth technologies). We need to work hard to learn new technologies that are the part of the process” (ANM01).*

**Government Prioritization of mHealth**

The policy level prioritization of mHealth applications was identified as a key dimension that influences mHealth acceptance. It was observed that priority accorded to mHealth technologies and translated into health system as formal norms amongst ANMs. One of the respondents who were a district programme officer and overseeing mHealth implementation reported:



*“The Principal Secretary is making sure that all the interventions are implemented up to the peripheral level health facilities. Every month there are review meetings at the state secretariat. In these review meetings one of the important agenda for the discussions are ANM Digi and mHealth APPs” (Planner02).*

#### **Dynamic mHealth Environment**

It was observed that various mHealth applications came into existence within a short period of time, some replacing the existing ones. This dynamic change in mHealth systems was giving a very limited time for the ANMs to accept and adopt the new mHealth technologies. One of the ANMs reported the following:

*“Particularly, these TABs (apps) were repeatedly changed within a shortspan of time. First there was RCH portal, by the time we got used to it ANMOL came in, by the time we got used to ANMOL, ANM Digi came. Now we are still learning to get used to it” (ANM05).*

#### **Existence of Multiple Data Entry**

mHealth technologies were mainly developed to make the ANMs work paper-less. However, it was observed that even after their implementation, ANMs still fill paper-based records in addition to electronic data entry. It was also observed that same data was entered multiple times into multiple mHealth applications. One of the participants who was a district level functionary said -

*“It is not that there is just one app, we need the data to be entered in ANM Digi, similarly the center needs the data to be entered in RCH portal as NITI Ayog needs it. ANMs have to do both. They also need to enter this information in the books that they maintain and reports that they send” (Planner03).*

While the dimensions such as perceived usefulness and Government prioritization of mHealth were encouraging technology acceptance, certain individual specific characteristics, rapidly changing mHealth apps and multiple data entry (due to limited digitalization and interoperability issues) limit the acceptance of mHealth applications among ANMs.

## **4. DISCUSSION**

The current research reports mHealth technology acceptance among ANMs and factors influencing their mHealth acceptance. It was found that majority (56.3%) of ANMs had a low level of mHealth acceptance. Existing evidence from India reported on high mHealth acceptance among health workers who were medical and nursing graduates (Pande et al., 2017). ANMs often possess lesser educational qualification and technical awareness than their professional counterparts, explaining their low mHealth acceptance. This demarcation was also observed within ANMs during qualitative interviews which suggested that, older ANMs with less educational qualification had low level of mHealth acceptance. mHealth acceptance among the ANMs was identified to be significantly associated with the factors of technical competence, perceived usefulness of mHealth applications, results demonstrability, human technology interaction and organizational factors. Several of these attributes were argued to be significant predictors for technology acceptance in the earlier models (Davis, 1989; Holden & Karsh, 2010; Venkatesh et al., 2003).

Perceived usefulness is frequently reported as one of the primary dimensions determining technology acceptance. Existing models report that Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) were reported to directly impact information technology acceptance among target population (Davis, 1989). In the current study it was observed that PU was a significant predictor of mHealth acceptance among ANMs whereas PEOU was not (Table 3). Similar findings were observed in earlier studies among health workers. One study conducted in Ghana among the midwives on the usability of an android based mHealth technology (mClinic app) found that the perceptions of midwives on usefulness of the mClinic app were higher than those on its ease of use (Vélez et al., 2014). These ideas suggest that specific to mHealth technologies PU is one of important attributes dictating its acceptance among target population.

The results demonstrability was also observed as a significant predictor of mHealth acceptance. It was explicitly stated as a component impacting IT acceptance in TAM 2 model by Venkatesh & Davis (Holden & Karsh, 2010). Given that mHealth technologies like ANMOL were developed as job aids for ANMs (UNICEF, 2016), results demonstrability of mHealth applications gain importance. Van Schaik et al., (2002) argued that in order to accept medical technology by the end user a system needs to provide objective (observable) and accurate results, enable monitoring and improve the health care provision (Van Schaik et al., 2002).

The findings also highlighted the prominence of conducive organizational factors in positively impacting mHealth acceptance among ANMs. Within the public health system, the priority accorded to mHealth apps made it more of a subjective norm for ANM to use them. These arguments could be supported by observations of Zakour (2004) that IT usability in organizations with power hierarchy is dependent on the opinion of superiors towards the technology. At an individual level ANMs technical competency

(basic technical ability of ANM to use mHealth application) was a significant predictor of mHealth acceptance. The qualitative observations concerning individual characteristics of ANMs also indicate that ANMs with low competence have lesser acceptance towards mHealth applications. Whittaker et al., (2011) identified that nurses with better technical competence (while using computers) had higher acceptance of point of care systems (Whittaker et al., 2011). A similar positive association between technical competence and technology acceptance was noted in other studies (Shibl et al., 2013; Van Houwelingen, 2018; Ziefle & Schaar, 2010).

Traditionally, experience with technology was considered a positive predictor of technology acceptance. Interestingly in the current study's context it was observed that years of experience with mHealth technologies had a significant negative association ( $\beta = -0.200$ ,  $p < 0.05$ ) with acceptance of mHealth technologies. This inverse relationship could be explained by the fact that mHealth ecosystems were constantly changing with older mHealth applications being replaced by newer ones, triggering resistance to change among ANMs. This argument is supported by earlier studies (El-Wajeeh et al., 2014).

The practice of multiple data entry systems (both electronic and paper) was observed as major challenge to mHealth acceptance among ANMs. Despite the fact that mHealth technologies were implemented to make the ANMs work paperless, dual data entry still exists. Dual data entry is prevalent considering the slow technology diffusion within health systems, vertical digitalization initiatives, lack of interoperability, and lack of trust in IT systems. Studies observe that existence of dual data entry systems not just demotivate the health workers from using digital health technologies, but also reduce their efficiency in providing health care (Mechael et al., 2010).

## 5. CONCLUSION

The study revealed some interesting observations which are of abundance relevance for policy and practice. Though mHealth technologies for ANMs were actively pushed, majority of the ANMs had low level of acceptance. While conducive organizational environment, perceived usefulness, higher technical competence, and results demonstrability of the technology had a positive effect, dual data entry and resistance to change compromised mHealth acceptance. The results strengthen the arguments for improving the awareness concerning mHealth technologies among the end users, improving the organizational working environment, digitalization of health system and better training. It also calls for improving the abilities of Indian health system to absorb and utilise information technologies by developing essential IT infrastructure, standards and technical support.

### Acknowledgement

The authors thank the study participants for their participation and insights. We also thank the officials of state health and district health systems in Andhra Pradesh for providing necessary support.

### Author Contributions

The first author (Prakash Babu Kodali) developed the study, did the data collection and drafted the initial version of manuscript. The second author (Shankar Das) supervised the first author, revised the manuscript and provided important intellectual input. Both the authors contributed substantially to justify authorship.

### Funding

This study has not received any external funding.

### Conflict of interest

The authors declare that there are no conflicts of interest.

### Importance of the work

Mobile health (mHealth) technologies are increasingly used in health service delivery at the grassroots. In India, mHealth technologies are used by health works like auxiliary nurse midwives (ANMs) in provision of essential maternal and child health services. While usage of mHealth technologies is encouraged in public health system, there exists a limited understanding on end-user acceptance of mHealth technologies, specifically among ANMs. This study assessed the mHealth acceptance among ANMs and identified factors contributing to acceptance of the mHealth among them. With an increasing focus to support the digital health infrastructure in the country, this study is timely. The study identifies the need and the dimensions to act to strengthen the digital health ecosystem at grassroots. The observations could facilitate the successful implementation of mHealth programmes.



**Data and materials availability**

All data associated with this study are present in the paper.

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