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Factors affecting the use of infomediaries in mHealth Interventions: Case of Maternal Healthcare in Rural Malawi

Priscilla Maliwichi[1,2*] and Wallace Chigona[1†]

[1] University of Cape Town, Cape Town, South Africa.

[2] Malawi University of Science and Technology, Limbe, Malawi.

pmaliwichi@must.ac.mw, Wallace.chigona@uct.ac.za

Abstract

Maternal mHealth interventions in poor-resource settings are bedeviled by inequalities in mobile phone ownership. Some maternal mHealth providers facilitate the access of the mobile phones to those who do not own mobile phones using "infomediaries". Infomediaries, in this case, are individuals who have custody of mobile phones, which other potential beneficiaries may use. However, use of infomediaries to offer access to the "have nots" may be influenced by a number of factors. The aim of the study was to explore how maternal healthcare clients use infomediaries in maternal mHealth interventions. The study focused on maternal healthcare clients who do not own mobile phones but use the mHealth intervention. The study used a case of a maternal mHealth intervention project in Malawi. We used a qualitative research method and interpretive paradigm. Data was collected using secondary data from the implementing agency, semi-structured interviews, and focus group discussions. Empirical data was collected from maternal healthcare clients who do not own mobile phones and infomediaries. Data was analyzed inductively using thematic analysis. We found that characteristics of the maternal healthcare client, characteristics of the mHealth infomediary, perceived value of mHealth intervention and socio-environmental factors affect maternal healthcare clients' use of mHealth infomediaries. The study informs mHealth designers and implementers on how they can include all potential beneficiaries of an intervention. The study also proposed a framework for studying infomediaries in ICT4D. We recommend that implementers of interventions should leverage traditional systems instead of reinventing the wheel. Traditional systems may offer a good starting point for designing a system which would work for communities.

[*] Wrote the paper

[†] Revised and guided the paper

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1 Introduction

An infomediary is a liaison or broker between an individual or group of people, on the one hand, and a group or source of information, on the other hand (Gould & Gomez, 2010). In Information and Communication Technologies for Development (ICT4D), the use of infomediaries has been considered as an option to provide access to technology and information to those who do not have their own access and, therefore, help to bridge the digital divide. In essence, infomediaries have the potential to enable people who could be excluded from the information society to be included. Infomediaries could be setup as part of the interventions or could be people who volunteer to serve in that role independent of the intervention. Infomediaries have been used to provide information in communities, as well as access to ICTs for communities to access and use mHealth and e-government services (Maliwichi, et al., 2021b). Some mHealth interventions use infomediaries to give mobile phone access to clients who do not own a mobile phone (Larsen-cooper et al., 2015). In this study, we are interested in how maternal clients who do not own mobile phones use infomediaries to access an mHealth intervention.

Despite the growth in mobile phone penetration globally, mobile phone ownership still remains far from universal (GSMA, 2019). Women in low- and middle-income countries are 10% less likely than their male counterparts to own a mobile phone (Barboni et al., 2018). South Asia and Sub-Saharan Africa are the most affected regions with women 28% and 15% less likely to own a mobile phone (Barboni et al., 2018). It is likely, therefore, that maternal clients, especially in rural areas, may not own a mobile phone which they would use to access maternal mHealth interventions. mHealth infomediaries may enable such maternal clients to use mHealth interventions.

Most of the studies in mHealth so far focus on the feasibility, implementation, adoption, use, and acceptability of mHealth technologies (Chib, 2010; Lim et al., 2011). A few studies have assessed patient outcomes, as well as business outcomes of mHealth interventions (Ngabo et al., 2012). Furthermore, other studies have assessed the use of online health infomediaries (Khuntia, Yim, Tanniru, & Lim, 2017; Song & Zahedi, 2007). However, there is still dearth of studies on the use of infomediaries in mHealth interventions for clients who do not own mobile phones (Maliwichi, et al., 2021a). In addition, little is known about factors that affect the use of mHealth infomediaries (Khuntia et al., 2017; Song & Zahedi, 2007). Our focus in maternal health is driven by its significance as noted in Sustainable Development Goal 3.1. Furthermore, maternal health is surrounded with cultural beliefs that can affect the use of technology and infomediaries.

We posit that a range of factors affect the use of infomediaries, and consequently, affect the use of the maternal mHealth intervention. The aim of this study is to contribute to Information System research, specifically on the use of mHealth infomediaries in maternal health (Larsen-cooper et al., 2015; Ramachandran et al., 2010) by addressing the following research question: *What factors affect rural-based maternal clients' use of mHealth infomediaries in maternal health?*

To answer the research question, we used a case of Chipatala Cha Pa Foni (CCPF) – (which translates to Health Centre by Phone) project, a maternal and child health intervention in Malawi. The intervention provided maternal clients with pregnancy tips and reminders, and in addition, the maternal clients could call a hotline for health information and advice. The intervention allowed maternal clients who did not have mobile phones to use mobile phones of family members, community members and community volunteers. The community volunteers, who served as mHealth agents of the intervention in their communities, were provided mobile phones by the intervention. In this study, mHealth infomediaries were community volunteers, family members, and community members who provided a connection between the mHealth intervention and health information consumers (maternal clients) who do not have their own mobile phones to access the intervention.

2 Literature Review

2.1 Infomediaries

The term infomediary is formed from the combination of the words: information and intermediary (Brown & Hussain, 2016). In low-income countries, community services using Information and Communication Technologies (ICTs) are sometimes centered on infomediaries (Ngabo et al., 2012; Ramachandran et al., 2010). In most mHealth projects, health infomediaries have been Community Health Workers (CHWs) or community volunteers (Brown & Hussain, 2016). For example, "Info Ladies" were used as infomediaries to provide health information to villagers (Brown & Hussain, 2016). Large-scale adoption and deployment of mobile phone interventions using CHWs offer promising approaches to improving health care delivery (Ngabo et al., 2012). However, using CHW in mHealth has its own challenges.

2.2 Maternal healthcare and mHealth interventions in low-income countries

Maternal health refers to the health of women during pregnancy, childbirth, and the postpartum period, which includes family planning, preconception, prenatal, and postnatal care (WHO, 2012). Due to inequalities in access to quality health services, there is a high number of maternal deaths in some parts of the world (WHO, 2019). Maternal Mortality Ratio (MMR) in low-income countries in 2017 was 462 per 100 000 live births compared to 11 per 100 000 live births in high income countries (WHO, 2019). 94% of these deaths occurred in rural settings and sub-Saharan Africa had 196 000 deaths (WHO, 2019).

To reduce MMR in low-income countries, maternal mHealth interventions are used to relay health information to pregnant women especially those who live far away from the health facility. Maternal mHealth interventions are used to unlock access to reproduction health information and improved access to health facilities during pregnancy and delivery (Nyemba-Mudenda & Chigona, 2018). Tips and reminders through voice messages and SMS are the most widely used method to communicate to maternal clients (Nyemba-Mudenda & Chigona, 2018). Voice messages and SMS are commonly used since they are readily available even on a basic mobile phone, and prove to be affordable and convenient, compared with other applications (Ngabo et al., 2012). Mobile phones used to access health information and health care services can generate opportunities for women health but also for their informational wellbeing (Ngabo et al., 2012; Nyemba-Mudenda & Chigona, 2018).

2.3 Women mobile phone ownership in low-income settings

Ownership is a complex phenomenon. Ownership of mobile phones can be categorized as legal ownership and psychological ownership. Legal mobile phone ownership can constitute the right to use and sale the mobile phone (Pierce et al., 2004). In other settings such as in developed countries, legal ownership also means sole ownership of the mobile phone, and consequently, sole usage of the mobile phone (Chipchase, 2009). However, psychological ownership is a feeling of possession of an object that it is *mine* (Pierce et al., 2004). Women in rural setting in sub-Saharan Africa who do not own mobile phones may have a psychological ownership of a mobile phone which belongs to family members and community members in their settings (Pierce et al., 2004). Psychological ownership of mobile phones is important since it makes access of mobile phones to marginalized groups of people possible. In maternal mHealth, sense of ownership of mobile phones is vital since it unlocks the barrier of reaching non-mobile phone owners and consequently, enhances inclusivity of non-mobile phone owners in maternal mHealth interventions.

2.4 Mobile phone ownership of mHealth infomediaries in maternal healthcare

In low-income countries, people can have different types of mobile phone ownership. Studies have found that mobile phones of mHealth infomediaries can be categorized as: 1) personal property, 2) family property and 3) project property.

Personal mobile phones are regarded as personal property if the owner has sole ownership of the mobile phone. In a developed country context, personal mobile phones are used solely by the owner (Chipchase, 2009). However, in a developing country context personal mobile phone, which is a personal property, can be used by other people (Blauvelt et al., 2018). This is attributed to the sharing culture in such a context (Zamani & Sbaffi, 2020). Thus, if a personal mobile phone is used by other people for health purposes, the personal mobile phone owner may become an mHealth infomediary. In contexts where a sharing culture exists, sharing of personal property is a norm (Zamani & Sbaffi, 2020). Hence, mHealth intervention may succeed in such a context.

In a rural setting, ownership of property may be regarded as family property (Chipchase, 2009). In this setting, a mobile phone owned by one family member may become a home or family mobile phone (Chipchase, 2009). This could be attributed to the fact that not all family members can own personal mobile phones. This means that, if family members use the family mobile phone for health purposes, the owner of the mobile phone may become an mHealth infomediary.

Due to low mobile phone ownership among rural women, mHealth Interventions may provide mobile phones to designated infomediaries to serve as the link between maternal clients and the project. The infomediaries can be community volunteers or CHWs (Nyemba-Mudenda & Chigona, 2018). Maternal clients who do not own mobile phones prefer using project mobile phones over mobile phones owned by other people (Nyemba-Mudenda & Chigona, 2018)

3 Chipatala Cha Pa Foni (CCPF): Malawi Case Study

CCPF is an mHealth interventions running in Malawi since 2011. It was piloted in Balaka District; Balaka has low performance in maternal and child health issues.

3.1 Malawi context

Malawi is a country in southern Africa with a population of about 17.5 million people. About 85.6% of this population resides in rural areas (NSO, 2020a). The country has a Gross Domestic Product (GDP) per capita of US$411 (NSO, 2020a). The literacy rate for women is lower than that for men. About 12% female and 5% male has no education (NSO, 2020a). In rural areas of Malawi, girls are five times more likely than boys to drop out of school (Sunny, 2018). The maternal mortality rate in Malawi is at 349 per 100000 live births (NSO, 2019).

3.2 Mobile phone ownership in Malawi

Malawi has two dominant mobile operators: (i) Airtel Malawi (52.2% market share) and (ii) Telekom Networks Malawi (TNM) (48.6%) (NSO, 2020). Over the years, ownership of mobile phones has increased rapidly. Approximately, 43.2% of the population owns a mobile phone (72.3% urban, 37.3% rural) (NSO, 2020). Mobile phone ownership by male is at 44.9% while female is at 37.7% (NSO, 2020). “Mobile phones are commonly shared within families and communities, making Malawi an ideal setting for mHealth interventions” (Blauvelt et al., 2018, p.1).

3.3 CCPF case study

The underlying ideas for CCPF were:

- A two-way communication between clients and health personnel via a hotline for timely access to health information and advice
- Use of mobile phone technology for tips and reminders on maternal health issues, together with a booking system and databases at health facilities to improve documentation

The main objective of the CCPF project was to maximise healthcare access and utilisation by remote maternal clients who were facing so many challenges such as walking long distances to access a health facility, resulting in delays in seeking care and unnecessary expenditures.

Components of the CCPF system

At first, CCPF had two main components: 1) toll-free case management hotline (which is available on an Airtel line) and 2) tips and reminders. These components were designed to work on a basic mobile phone which is common in poor-resource settings.

Case management hotline: The toll-free case management hotline was stationed at the district hospital and was managed by qualified hotline workers (HLWs). The HLWs were trained on maternal and child health community case management; this is a training which is also provided to CHWs. The hotline was available for 12 hrs per day (7:00AM to 7:00PM). On their first call, the clients were registered (their personal details captured) and oriented on how the system works. The women were told about their expected date of delivery (EDD) and the current stage of pregnancy.

Tips and reminders: Tips were personalized messages according to the stage of the pregnancy. Reminders were messages for antenatal appointments, medication and supplements during pregnancy. The messages were in two vernacular languages of the district. The voice messages were retrieved on any Airtel line upon authentication, using the EDD and password (voice messages were common for non-mobile phone owners). Text messages were sent direct to the personal mobile phone.

After the pilot phase, CCPF was scaled-up and handed over to the Malawi Government in 2018 (VillageReach, 2018). CCPF is now available in all districts of Malawi around the clock. The tips and reminders component has been replaced with pre-recorded voice messages and everyone can access them using an Interactive Voice Response (IVR) system when they call the toll-free number. The callers choose whether they want to talk to a hotline worker or listen to the voice messages.

mHealth infomediaries for CCPF

The implementing agency recruited about 400 community volunteers across the four catchment areas and each village was assigned a community volunteer. Community volunteers were people within the community; the minimum qualification for the volunteers was that they should have basic literacy and could use a mobile phone. The volunteers were not Health Surveillance Assistants (HSAs) (in Malawi HSAs are CHWs employed by the government). Their role was to provide maternal clients with access to a mobile phone for the intervention and demonstrate how to use the system. In addition, community volunteers were visiting maternal clients in their homes for registration and follow up on tips and reminders so that women could listen to their messages. The project provided volunteers with mobile phones to be used for CCPF for maternal clients in their communities. Some infomediaries were not appointed by the intervention; they were either community members or family members who provided mobile phone access to maternal clients. Therefore, maternal clients who did not own mobile phones could call the hotline using the mobile phone of community volunteers, community members or family members. Some took on the role of infomediary because of their roles in the community; an example was a wife of a village headman.

4 Methodology

The study used qualitative research method and interpretive paradigm. Qualitative research was appropriate since it is subjective in the sense that it points to the role of human subjectivity in the research process and provided new meaning to knowledge (Creswell, 2014). The study employed a single holistic case study. Single case studies are appropriate for studies focusing on individuals in one environment because they are unique or extreme (Yin, 2003) This study is looking at a group of women within the same environment or context who do not own a mobile phone but access the mHealth intervention using infomediaries. These women represent a minority of the population of maternal clients who used the mHealth intervention. The study used a case of CCPF and data was collected in Balaka District in Malawi where the initiative was piloted.

4.1 Data collection

Data was collected using documents on CCPF, semi-structured interviews with maternal clients, family members, community volunteers and Focus Group Discussions (FGDs) with the maternal client. Data was collected in three phases as presented in Table 1.

PHASE	DATA TYPES AND METHOD	DATES
1st phase	Secondary data collection using project website and peer-review journals	January 2019
2nd Phase	Semi-structured interviews	June 2019
3rd Phase	FGDs	August 2020

Table 1: Phases of data collection

Documents relating to the project were collected from the internet and peer-reviewed research outputs, as well as accessed directly from the project. For project documents from the internet and the peer-reviewed articles, we used Google, Google Scholar and Web of Science databases to search for articles using relevant search terms. Appendix A summarizes these documents. We used documents to develop the context of the study and to triangulate with empirical data. Project reports provided a good window to the background and the main objectives of the intervention, and highlighted some activities and processes involved in the maternal clients' use of the intervention.

We conducted semi-structured interviews with the maternal clients as well as the infomediaries (refer to Table 3). The sample comprised of maternal clients with low parity (number of live births less than five) and high parity (the number of live births equals 5 or more). The sample had 20 maternal clients. All the maternal clients had attended the minimum required antenatal visits and they all delivered at the health facility. The demographic profile of the maternal clients in this study are summarised in Appendix B. We used the following procedure to access the respondents:

- The project team queried the Caller Database for CCPF for the period of August 2017 to December 2018 to obtain mobile numbers for maternal clients who indicated that they were using a mobile phone that was not theirs. We chose this period to find more active mobile numbers. We identified "hotspots" (areas which made more calls from the caller's database) in Balaka District.
- We obtained mobile numbers of mobile phone owners from Callers' Database of CCPF. We asked the mobile phone owners to identify maternal clients who used their mobile phone for the initiative. We interviewed both the maternal clients and the owner of the phone.

We interviewed two community volunteers and a community member, and asked them to identify maternal clients who were using their mobile phones. We asked the community volunteers and community member to invite these women to participate in the FGDs. We had two FGDs with maternal clients who were using community volunteer and community member mobile phones. Table 2 summarizes the sample of mobile phone owners and maternal clients who used their mobile phones.

Mobile phone owners	**Maternal client**
Husband 1	Client 1
Husband 2	Client 2
Husband 3	Client 3
Husband 4	Client 4, Neighbours (other maternal clients in his community)
Mother-in-law 1	Client 5
Community Volunteer 1	Client 6 – Client 13
Community Member 1	Client 14 – Client 20

Table 2: Mobile phone owners and maternal clients who used their mobile phones

The interviews took 45 to 60 minutes each. The interviews were conducted in Chichewa; Chichewa is a national local language of Malawi, so all respondents understood the language. For each interview, the researcher took notes and recorded the calls using CallX mobile application.

We used the community volunteer and community member as facilitators of the FGDs in two catchment areas; the researchers could not travel to the interview site due to Covid-19 travel restrictions. The facilitators identified a quiet place where they could conduct the FGDs. We used an interview guide to ask focused questions and facilitated the discussions by encouraging participation and points of view. The discussions were audio-recorded using CallX mobile application, and an assistant took notes of the discussions as well. During the FGDs, the researchers, the community volunteer and a community member put the mobile phone on the loudspeaker for all the participants to hear the discussion at each end of the call. The maternal clients and the facilitators were compensated for the transport used to attend the FGDs. The discussions lasted two hours on average each.

4.2 Data analysis

We conducted data analysis in two phases. The first phase focused on document analysis. The second phase of data analysis triangulated data from secondary sources and empirical data collected using semi-structured interviews and FGDs. The audio-recordings were transcribed and coded using Nvivo 12. We employed an inductive thematic analysis to analyze the data. Several phases, as stipulated by Braun & Clarke (2006), guided the analysis process.

4.3 Ethical considerations

Before data collection, we obtained permission to use CCPF as a case study from the implementing agency of CCPF, Malawi Ministry of Health and Balaka District Health Office. Further, we obtained ethical clearance from the National Health Sciences Research Committee (Malawi).

During the interview sessions, the researchers introduced themselves as researchers studying CCPF Project. Consent was sought before interviews started and issues of privacy and confidentiality of the data collected were discussed. For FGDs the participants were told that privacy and confidentiality of the things discussed was difficult since the discussion involved the group. We were

aware of the risks of interviewing pregnant women: there could be an emergency during interviews or women could recall traumatic experiences related to the pregnancy. To mitigate against this risk, our sample was limited to mothers who were not pregnant at the time of data collection; they were all women who had previously used the system. Further, we informed the respondents that participation of the study was voluntary and they could withdraw from the study any time. For the analysis, we anonymized the maternal clients as *Client x*.

5 Findings and Discussion

The study found that several factors affected how maternal clients used mHealth infomediaries in maternal healthcare. As summarized in Figure 2, these factors include (i) perceived value of the mHealth intervention, (ii) characteristics of the health client, (iii) infomediary characteristics, and (iv) socio-environmental factors.

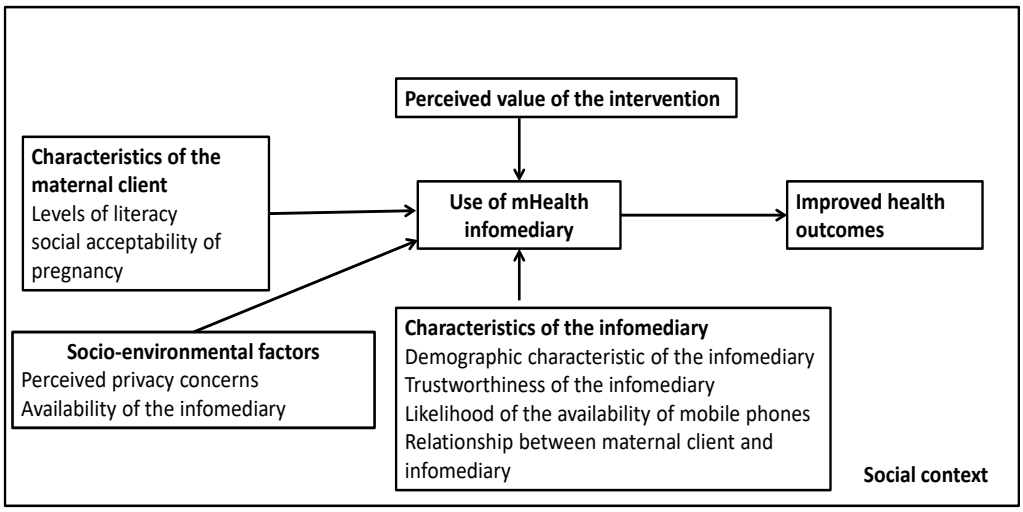

Figure 1: Proposed framework of mHealth infomediary use

5.1 Perceived value of the mHealth intervention

Maternal clients in this study sought to use infomediaries since they perceived the mHealth intervention as valuable. The use of infomediaries involves social costs such as negotiation and, in some cases, being obligated to gift back to the infomediary. The healthcare client is likely to use the intervention and the infomediary if they perceive the service being offered by the intervention to be valuable. The maternal clients perceived the mHealth intervention as useful and the information received from the intervention as quality information. The maternal clients felt that they learnt new information and practices on safe motherhood through CCPF.

"CCPF information is very helpful. We were just staying and we were ignorant. We didn't know what to do. Most women were dying because they did not know when to go to the hospital when problems arise, because of lack of proper advice …" [Client 17].

The women perceived the information as valuable partly because they believed that it was provided by the Ministry of Health. Maternal clients are likely to trust the information from an intervention which is affiliated to the national health framework (Blauvelt et al., 2018). Willcox et al (2019) noted that maternal clients in Ghana perceived the information from an mHealth intervention

as quality information because it was originating from health professionals. In light of this discussion, the study suggests the following proposition:

Proposition 1: *When healthcare clients without own mobile phones perceive the intervention as valuable, they are more willing to use mHealth infomediaries.*

5.2 Characteristics of the maternal client

Characteristics of the maternal client, which affected how maternal clients used the infomediaries, include levels of literacy and social acceptability of the pregnancy.

Levels of Literacy

Levels of literacy of maternal clients affected how maternal clients who needed to use mHealth technologies actually used them (Maliwichi et al., 2021a; Nyemba-Mudenda & Chigona, 2018). On one hand, maternal clients with low literacy levels depended on mHealth infomediaries to operate the mobile phone on their behalf to use mHealth interventions (Larsen-cooper et al., 2015), on the other hand, the clients with high literacy level used the infomediary just to access the mobile phone. The latter group tended to use the interventions with ease since they might have had technology self-efficacy (Venkatesh & Bala, 2008).

Most maternal clients in this study, like women in most rural parts of Malawi, had low literacy; most of them were lower primary school dropouts. These maternal clients depended on the infomediary to operate the mobile phone on their behalf.

"The method that was used to access CCPF was difficult at first. It depended on the level of education to use it comfortably. But now it is easy, they have simplified everything …" [Community Volunteer 1].

Some studies in maternal mHealth have found that low literacy not only affects the ability to use the mobile phone, but also level of comprehension of the messages (Larsen-cooper et al., 2015).

Social acceptability of pregnancy

Social acceptability of a pregnancy affected how maternal clients used mHealth infomediaries. Many societies have norms which define the conditions for a pregnancy to be acceptable, who can get pregnant and when can they get pregnant (Omoloso et al., 2017). Women who get pregnant at the wrong time may be shunned off (Hamal et al., 2020). Malawi, especially the rural parts, is a conservative society and as such being pregnant out of wedlock is a taboo (Nyemba-Mudenda & Chigona, 2018). Women, especially, teenagers who get pregnant out of wedlock are stigmatized and may even be cast out of their families (Levandowski et al., 2012). As such, young unmarried women who fall pregnant, struggle to inform other women about their pregnancy (Hackett et al., 2019). This may have negative consequences for the health of the pregnancy. A study in India found that even married under-age maternal clients find it difficult to use maternal healthcare services (Hamal et al., 2020).

An mHealth intervention offers opportunity for such women to obtain medical information without dealing with the shame. However, when the women do not have their own phone, they still would have to go through an infomediary within their society (Larsen-cooper et al., 2015). This was a barrier for the women to access the service.

"I remember starting to attend antenatal care when I was six months pregnant and registered for CCPF … it was shameful to approach people on anything" [Client 1].

The society's perception of what is an acceptable pregnancy may affect the use of mHealth infomediaries. Thus, in a society which frowns upon teenage pregnancy and pregnancies out of wedlock, teen maternal clients could find it challenging to use maternal mHealth infomediaries. In light of this discussion, the study suggests the following propositions:

Proposition 2: *When a society does not accept circumstances surrounding maternal client pregnancy, the maternal client may not be comfortable to use infomediaries in that society.*

To mitigate against this challenge, interventions should make deliberate efforts to reach out to women who may be excluded from accessing the infomediaries.

5.3 Characteristics of the infomediary

Characteristics of the infomediary affected how maternal clients used the mHealth infomediary. These characteristics include demographic characteristics (such as gender, age and technical skills to support the maternal client), trustworthiness of the infomediary and likelihood of the availability of the mobile phone.

Demographic characteristics of the infomediary

The gender and age of the infomediary affected how comfortable the maternal clients were to use the services. The maternal clients were more comfortable using a mobile phone owned by a woman than those owned by a man. Due to the cultural beliefs around pregnancy, maternal clients found it challenging to visit and negotiate use of a mobile phone from a man who was not their husband. It would be socially unacceptable for a maternal client to make this agreement with a man other than her husband. Furthermore, the maternal clients were not comfortable using a community volunteer who was younger than themselves.

The implication of this was that the women could delay in accessing the services from the intervention. Other studies in maternal mHealth have also found that the gender of an infomediary could affect the use of mHealth infomediaries (Duclos et al., 2017; Nyemba-Mudenda & Chigona, 2018).

Due to cultural reasons, women prefer seeking assistance and advice on pregnancy related matters from other women, especially older women. In most cases old women are perceived as custodians of maternal health matters in their communities. However, the design and implementation of the initiative did not involve older women. As it would have been beneficial for the project to involve them as custodians of the mobile phones for the project

When the infomediary struggled to use the mobile phones on behalf of the maternal client, the maternal clients were discouraged from continuing to use the infomediary. This was common during the pilot phase because the steps that maternal clients had to follow to retrieve their personal messages was long. *"Sometimes, even some community volunteers were finding it difficult to use the intervention"* [Project Document 5]. Probably the clients felt they were burdening the infomediary.

Trustworthiness of the infomediary

In Malawi, like in most developing countries, cultural beliefs dictate that women do not disclose their pregnancy to anyone except to their husbands and mother. Pregnancy is secretive and women find it easier to discuss pregnancy-related issues amongst women than with men. Moreover, maternal clients would prefer to discuss their pregnancy with someone whom they trust that would keep their pregnancy a secret.

"*Normally, I receive maternal related advice from my older aunt or grandmother because they take my pregnancy serious and they cannot disclose my pregnancy to anyone*" [Client 1].

A study in South Africa found that maternal clients accept interventions at the community level if they trust the CHWs in their community (Grant et al., 2017). Trustworthiness at an individual level for CHWs, community volunteers and community members who are involved in maternal health is important for maternal health interventions to succeed (Grant et al., 2017). Trustworthiness of infomediaries in maternal mHealth interventions is fragile, since maternal clients could stop using infomediaries if the maternal clients encounter a bad experience with the mHealth infomediary (Zahedi & Song, 2008).

Likelihood of the availability of mobile phones

The likelihood of the availability of mobile phones at the infomediaries affected the experience of the maternal clients. Factors contributed to the phones at the infomediaries not being available for use include battery challenges, faulty mobile phones as well as just the mobile phones being not easy to

use. The area where the study was conducted, like most rural parts of Malawi, do not have grid power and this results in difficulties in charging mobile phones (Taulo et al., 2015). Most users had to pay for charging their phones. It is, therefore, foreseeable that mobile phones may not be charged.

"Most of the times the problem is with the volunteers mobile phone… sometimes the phone is not charged… so she tell us to come again …" [Client 15].

Furthermore, the maternal clients walked a long distance to the community volunteer to use the mobile phone. Therefore, they felt discouraged when they found that the mobile phone was not working for whatever reason. Hence, the likelihood of the availability of technologies has the potential to exacerbate inequalities in poor-resource setting.

Relationship between maternal client and infomediary

The maternal clients choose infomediaries where there was a high likelihood of being granted permission to use the mobile phone as well as where the interaction with the infomediary would be perceived to be within acceptable social norms. Maternal clients noted that *"other people sometimes do not allow us to use their mobile phones.* Consequently, *most of the times, we used our relative's mobile phones …"* [Client 17]. Due to social norms surrounding pregnancy, the negotiations for phone use were not always like other "*standard personal calls*".

The study noted that most maternal clients were using a particular mobile phone for CCPF after creating a relationship with the mobile phone owner. This was particularly true for non-emergency maternal issues. During an emergency, maternal clients could use mobile phones from anybody. Therefore, family members and relatives are crucial in providing mobile phone access to maternal clients on maternal health issues.

Studies in maternal mHealth have found that maternal clients prefer to use project mobile phone for maternal related issues since there is guaranteed access for the mobile phone from the infomediary (Duclos et al., 2017; Larsen-cooper et al., 2015). Other studies have stated that maternal clients prefer mobile phones of family members since they cannot deny them access to their mobile phones (Nyemba-Mudenda & Chigona, 2018). These findings suggest that even though mobile phone sharing is common in poor-resource communities, long-term sharing of mobile phones is still a challenge in maternal-related issues (Duclos et al., 2017). This could be attributed to the sensitivity of maternal–related issues to both parties (maternal client and mobile phone owner). Based on this discussion, the study suggests the following propositions:

Proposition 3: *When a maternal client finds the characteristics of maternal mHealth infomediary not appropriate, maternal client may not use that infomediary.*

Proposition 3a: *The demographic characteristics of the infomediaries may affect maternal client use of infomediaries.*

Proposition 3b: *When the infomediary is trustworthy and more likely to be available for maternal clients, maternal clients may use those infomediaries.*

5.4 Socio-environmental factors

Socio-environmental factors that affected how maternal clients used infomediaries include: i) choice of infomediary to provide mobile phone access, ii) perceived privacy concerns and iii) availability of the infomediary. Therefore, the study suggests the following proposition.

Proposition 4: *When maternal clients are affected by socio-environmental factors, maternal clients may find it difficult to use mHealth infomediaries.*

Perceived privacy concerns

The privacy concerns relating to their pregnancy information affected the use of the infomediaries. Privacy is the "individual's ability to control what information is disclosed, to whom, when and under what circumstances" (Song et al., 2018, p.295). Individual privacy concerns include who is authorized to view their health information and if that information should be shared (Ambrose & Basu, 2012). This is particularly concerning where the information is perceived to be sensitive such as pregnancy

related information in the context of rural Malawi. Similarly, a study in Pakistan found that maternal clients would not visit a health facility because they do not want the secret of them being pregnant being disclosed (Ullah et al., 2019).

In this study maternal client perceived privacy concerns affected the use of mHealth infomediaries. Maternal clients were more comfortable using mHealth infomediaries whom they believed that their privacy would not be compromised.

The maternal clients in this study perceived the use of a Personal Identification Number (PIN) to retrieve voice messages as a way of securing messages, which they considered personal. Even though the PIN was meant for identification in CCPF, it was perceived as a privacy and security feature by the women using shared phones: "*... once I key in the secret number; they know it's me and give me my messages... and only me can listen to them ....*" [Client 8]. The majority of the maternal clients using infomediaries preferred voice messages to text messages because anyone could read text messages and some women felt that their privacy would be invaded.

"I used to get messages on my mother's phone ... what was happening was that she could open my message, read it first and then give it to me. Sometimes she could tell me that I received a message from CCPF but someone was playing with her phone and it got deleted" [Client 8].

Availability of the infomediary

Availability of the mHealth infomediary affected maternal clients' use of the mHealth infomediary, and consequently, the use of the mHealth intervention. When maternal clients live far away from the infomediary, they find it difficult to access the infomediary and the mobile phone. Furthermore, if the maternal client experienced a maternal health-related problem at night, it was not easy to visit the mobile phone owner and access the mobile phone before planning to go to the hospital [Project Document 5].

"You know in a village setup, houses are far apart, so to travel to the mobile phone owner who lives far away and find that the mobile phone owner is not at home is disappointing" [Client 11].

Maternal clients who reside in poor-resource settings may struggle to find access to a mobile phone since mobile phone ownership in these areas is low (Larsen-cooper et al., 2015). Studies in maternal mHealth have found that distance to the infomediary may inhibit maternal clients access of mobile phone for maternal health-related issues (Duclos et al., 2017; Nyemba-Mudenda & Chigona, 2018). This is evident especially when the maternal client is in her third trimester of her pregnancy and cannot travel long distances (Larsen-cooper et al., 2015; Nyemba-Mudenda & Chigona, 2018). Furthermore, when the infomediary travels, it means that the maternal client may not have access to the mobile phone.

The study also noted that there was volunteer fatigue; this affected the level of motivation and, consequently, the availability of the volunteers. This could have been attributed to volunteers not compensated for their work and they had to look for financial resources to support their families. This affected their work. Proper volunteer management would contribute towards mitigating against this.

6 Conclusion

Despite the increase in mobile phone ownership, there are still inequalities in mobile phone ownership in rural settings. The poorest among the poor still face challenges in accessing mobile-phone mediated interventions that are meant to serve them. Use of shared mobile phones has the potential to mitigate against those challenges. This study focused on the use of infomediaries in maternal mHealth interventions in a rural setting. The study concludes that the characteristics of the maternal client, the characteristics of the infomediary as well as the social context affects how maternal clients use and benefit from infomediaries. This study points to the need for managing

infomediary systems to ensure that people at the bottom of the pyramid are able to benefit from the interventions.

Interventions should acknowledge that there are already people who serve as infomediaries for other purposes in communities. A number of women in the study used mobile phones of family members and other members of the community as well as traditional leaders. Such systems already define who may be acceptable infomediaries in a community. Interventions should leverage such systems instead of reinventing the wheel. We acknowledge that the existing systems may still be fraught with challenges that may exclude other potential beneficiaries. For example, a system based on a traditional system may still be punitive to young women falling pregnant out of wedlock. However, we are proposing that the traditional systems may offer a good starting point for designing a system that would work for communities. For example, one of the limitations of the study was the use of male infomediaries instead of the use of elderly women as infomediaries in the communities. We, therefore, recommend that future research may explore these possibilities.

One challenge noted in the study was volunteer fatigue. Managing the volunteer system in a way that would reduce the burden on volunteers would ensure sustainability of the volunteers. Further, the interventions should be designed in a way to minimize the burden on the infomediaries. For instance, the use of frugal technologies, such as basic mobile phones, could ensure that there are more infomediaries since the mobile phone would be readily available. Furthermore, there would be little effort on the infomediaries to train potential beneficiaries. In addition, the provision of power banks and durable portable solar panels to volunteers to ensure that mobile phones are charged all the time. This could address the limitation of mobile phone battery not charged when the beneficiaries want to use the mobile phone. At the same time, reduce the burden on volunteers of walking long distances to the trading centre to charge the mobile phones.

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Appendices

Appendix A. Summary of documents used in the study

DOCUMENT TITLE	DOCUMENT TYPE	AUTHORS	DOCUMENT NAME
Impact Evaluation of Malawi's Maternal Child Health and Nutrition Hotline: Chipatala Cha Pa Foni (CCPF) - Preliminary Report	Project information and CCPF use	JIMAT, (2018)	Project document 1
Chipatala Cha Pa Foni: Healthcare through mobile phone	Project Information	IWG, (2016)	Project document 2
Evaluation of the Information and Communication Technology for Maternal, Newborn and Child Health Project: Improving Access to Reproduction, Maternal and Newborn Health Information and Services in Malawi	CCPF use Report	Watkins et al., (2013)	Project document 3
Evaluation of the Information and Communications Technology for Maternal Newborn and Child Health Project (Chipatala cha pa Foni)	CCPF evaluation report	VillageReach, (2014)	Project document 4
Where there is no phone: The benefits and limitations of using intermediaries to extend the reach of mHealth to individuals without personal phones in Malawi	Published article	Larsen-cooper et al., (2015)	Project document 5
Scaling up a health and nutrition hotline in Malawi: The benefits of multi-sectoral collaboration	Published article	Blauvelt et al., (2018)	Project document 6
SMS versus voice messaging to deliver MNCH communication in rural Malawi: Assessment of delivery success and user experience	Published article	Crawford et al., (2014)	Project document 7
Strengthening the home-to-facility continuum of newborn and child health care through mHealth : Evidence from an intervention in rural Malawi	Published article	Fotso et al., (2015)	Project document 8

Appendix B. Summary of demographic characteristics of the maternal clients in the study

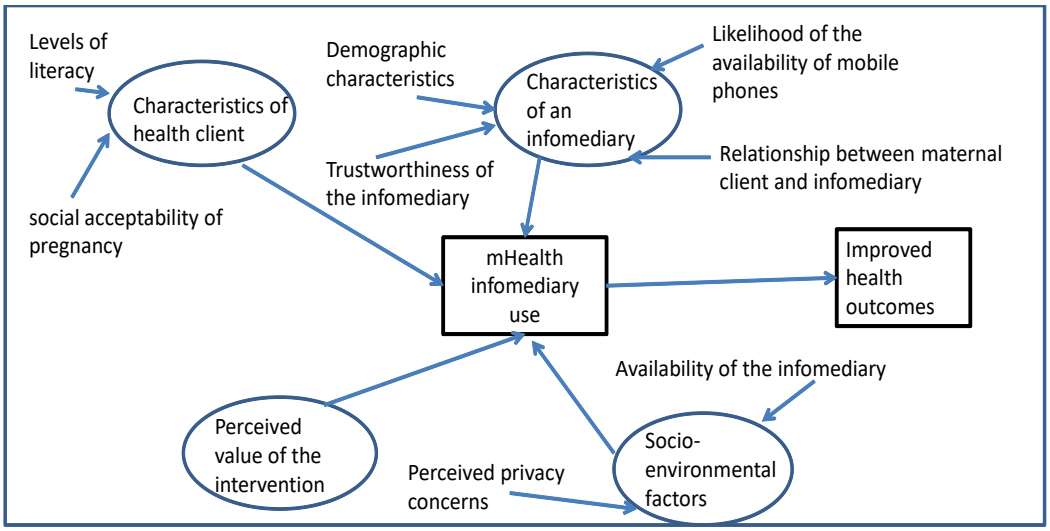
CHARACTERISTICS	NO OF CLIENTS
Age range	
15-19	2
20-25	6
26-35	8
36-45	4
Educational level	
Primary	17
Junior Secondary	3
No of pregnancy used CCPF	
1	13
2	4
3	3
Months started ANC	
2	7
3	13
No of ANC visits	
4	9
5	11

Appendix C: Summary of activities done in data analysis

PHASES OF INDUCTIVE THEMATIC ANALYSIS	ACTIVITIES DONE
Familiarisation	We translated and transcribed the audio interviews from Chichewa into English. The raw transcribed data (including the notes) was then imported into Nvivo 12 for analysis.
Theme development and coding	We used the concepts that we identified to create themes and subthemes (nodes and sub-nodes) in Nvivo 12. Data from secondary sources and empirical data was then coded in Nvivo 12. Using the whole data set, the researcher finalised coding the data
Reviewing themes	We reviewed the coded data extracts, where collated data extract of each theme were read to see if the current theme make a coherent pattern. If the data extract does not fit, they were moved to themes where they fit. The validity of individual themes in relation to the entire data set was also checked. Using Nvivo 12, the researchers developed a thematic map (*see Appendix D*) to see if it accurately reflects the whole data set's meaning compared to the conceptual framework.
Defining and naming	This phase involves defining and refining the themes that are going to be present in the finding chapter. The researcher identifies what is of interest in the data set and why, and the story that each theme tells. Themes and sample codes are presented in *Appendix E.*

Writing up	The findings and discussion section of this study present the results and the interpretation of the analysed data.

Appendix D. Thematic map of mHealth infomediary use



Appendix E. Theme definitions of the main themes and sample codes

MAIN THEMES AND SUB-THEMES	SAMPLE CODES
Perceived value of the intervention	
	"It is a quick hospital service; they help us quickly" [Client 2].
	"CCPF information is very helpful, we were just staying and we were ignorant, we didn't know what to do. Most women were dying because they did not know when to go to the hospital when problems arise, because of lack of proper advice …" [Client 17].
Characteristics of the maternal client	
Literacy	*"The method that was used to access CCPF was difficult at first. It depended on the level of education to use it comfortably. But now it is easy, they have simplified everything …"* [Community Volunteer 1]
social acceptability of pregnancy	*"I remember starting attending antenatal care when I was six months pregnant and registered for CCPF … it is shameful to approach people on anything"* [Client 1]
Characteristics of the infomediary	

Demographic characteristics	*"I was shy and uncomfortable when I found that the community volunteer was a man, I failed to speak about the problems I was facing"* [Client 10]
Trustworthiness	"*Normally I receive maternal related advice from my older aunt or grandmother because they take my pregnancy serious and they cannot disclose my pregnancy to anyone*" [Client 1].
Likelihood of the availability of mobile phones	*"Most of the times the problem is with the volunteers mobile phone… sometimes the phone is not charged… so she tell us to come again …"* [Client 15].
Relationship between maternal client and infomediary	*"Other people sometimes do not allow us to use their mobile phones. Most of the times, we used to use our relative's mobile phones …"* [Client 17]
Socio-environmental factors	
Perceived privacy concerns	*"I used to get messages on my mother's phone... what was happening is that she could open my message, read it first and then give it to me. Sometimes she could tell me that I received a message from CCPF but someone was playing with my phone and it got deleted"* [Client 8]
Availability of infomediaries	*"You know in a village setup, houses are far apart, so to travel to the mobile phone owner who lives far away and find that the mobile phone owner is not at home is disappointing"* [Client 11].
Improved health outcomes	*"There was a time when my unborn child position was not good, so I called CCPF about it, so they helped me with advice on what I should do so that the child can turn properly... it worked and I had a normal delivery"* [Client 9].