Original Paper

A Mobile Health Wallet for pregnancy-related healthcare in Madagascar: a mixed-methods study on opportunities and challenges
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Abstract

Background: Mobile savings and payment systems have been widely adopted to store money and to pay for a variety of services, including healthcare. However, the possible implications of these technologies on financing and payment for maternal healthcare services – which commonly require large one-time out-of-pocket payments – have not yet been systematically assessed in low-resource settings.

Objectives: This study aims to determine the structural, contextual, and experiential characteristics of a mobile-phone-based savings and payment platform, the Mobile Health Wallet (MHW), for skilled healthcare during pregnancy among women in Madagascar.

Methods: We used a two-stage cluster random sampling scheme, to select a representative sample of women utilizing either routine antenatal (ANC) or routine postnatal care (PNC) in public-sector health facilities in two of 8 urban and peri-urban districts of Antananarivo, Madagascar (Atsimondrano and Renivohitra districts). In a quantitative structured survey, we identified saving habits, mobile phone use, media consumptions, and perception of a mobile health wallet with both savings and payment functions. To confirm and explain the quantitative results, we used qualitative data from 6 semi-structured focus group discussions (24 participants in total) in the same population.

Results: Out of 412 randomly selected women attending ANC or PNC, 59.3% (95% confidence interval (CI) 54.5-64.1%) saved towards the expected costs of delivery and, out of those, 64.4% (95% CI 58.6-70.2%) used household cash savings for this purpose. 80.3% (95% CI 76.5-84.1%) had access to a personal or family phone and 35.7% (95% CI 31.1-40.3%) previously used mobile money services. Access to skilled healthcare during pregnancy was primarily limited due to financial obstacles like saving difficulties or unpredictability of costs. Another barrier was the lack of information about health benefits or availability of services. The general concept of a MHW for saving towards and payment of pregnancy-related care including the restriction of payments was perceived as beneficial and practicable by the majority of participants. In the discussions, several themes pointed to opportunities for ensuring the success of a MHW through design features: (i) intuitive technical ease of use; (ii) clear communication and information about benefits and restrictions; (iii) availability of a personal customer support.

Conclusions: Financial obstacles are a major cause of limited access to skilled maternal healthcare in Madagascar. A MHW for skilled healthcare during pregnancy was perceived as a useful and desirable tool to reduce financial barriers among women in urban Madagascar. The design of this tool and the communication strategy will likely be the key to success. Particularly important dimensions of design include technical user-friendliness and accessible, personal customer service.
Keywords: Pregnancy; Healthcare Inclusion; Mobile Payment; Telemedicine; Maternal Mortality; Health Expenditures; New Product Design for Health Impact; Mixed Methods; Madagascar
Introduction

Despite widespread political commitment to improve accessibility and utilization of skilled care during pregnancy by user fee exemption policies, out-of-pocket payments (OPP) remain the predominant mode of healthcare financing in several sub-Saharan countries [1]. However, the costs for skilled care frequently exceed the savings or assets which can be accessed at one time by a low-income household, potentially leading to medical impoverishment [2-4]. Besides selling assets or receiving emergency funds or loans by family or friends, personal or household savings can help protect from the financial burden of health shocks [1,5]. Setting money aside on a regular basis to save for healthcare however is difficult for the poor, who often face the need for imminent expenses, which undermine long-term saving goals [6]. Expectant mothers from low-income households in sub-Saharan Africa (SSA) therefore often do not seek skilled birth attendance or emergency obstetric care in order to avoid the large costs associated with delivery [7].

Within the last decade, mobile phone ownership has grown exponentially and mobile communication has become pervasive in SSA. Today, more than 70% of worldwide mobile phone subscriptions come from low- and middle-income countries (LMICs) with more than 74 subscriptions per 100 people in SSA in 2016 [8-9]. In the footsteps of this revolution have followed mobile payment systems, colloquially known as Mobile Money (MM), which commonly utilize low-tech systems such as unstructured supplementary service data (USSD) to enable financial transactions without the need for a bank account. MM is suitable for virtually all widely used handsets independently of smartphone capability or internet access and allows subscribers to send, save, and receive funds on a digital platform held by a mobile operator. Cash can be converted into electronic value (and vice versa) at retail stores or agents [10]. With almost 80% of adults in SSA not having access to formal banking services, economies are increasingly relying on mobile
payment systems [11]. In turn, this allows for financial inclusion of households with low transaction volumes or limited access to the formal banking system [12].

Leveraging this technological development, mobile payment-based hospital insurance or savings mechanisms enable low-income households to set aside funds exclusively for healthcare. In Kenya, an electronic health savings account including e-vouchers and micro-insurance schemes to improve healthcare access was launched in 2008 [13-14]. In addition, a mobile-phone-based payment and savings platform allowing clients to send, save and spend funds specifically for medical treatment in contracted health facilities has been commercially available in Kenya since 2016 [15]. Among the variety of medical conditions, maternal healthcare seems particularly well suited for a medical savings scheme as expenses are mostly predictable both in their timing and amount. However, these mechanisms have yet to be systematically applied to maternal healthcare savings.

In Madagascar, a low-income country with a population of 25 million, financial obstacles are a major cause for a lack of access to basic healthcare during pregnancy with 44% of pregnant women not seeking skilled birth attendance [16-17]. The national maternal mortality rate was estimated to be 353 per 100,000 live births in 2015 and up to three times higher in the poorest districts of the island [18-19]. Less than 6% of Madagascans have a formal bank account and the risk of impoverishing health expenditures as a result of pregnancy is high [19-20]. Similar to other countries from SSA, however, Madagascar has undergone rapid digitization: since 2005, the mobile phone subscription rate in the country increased 14-fold from less than 3 subscriptions per 100 people in 2005 up to 42 per 100 in 2016 [8]. The figures suggest that mobile phones may be a promising tool to improve financial access to skilled healthcare delivery. However, little is known about current saving habits, use of mobile phones and mobile payment systems among pregnant women in Antananarivo, and in particular those from low-income households.
This mixed-methods study is among the first to identify the major opportunities and challenges related to the implementation of a mobile-phone-based payment and savings platform, the so-called mobile health wallet (MHW), for maternal healthcare in low-resource settings. A two-stage cluster sampling design was used to randomly select 412 pregnant women and new mothers among basic health center visitors in urban areas of Antananarivo, Madagascar. To confirm, explain, and complete the quantitative survey results, we used qualitative data from 6 semi-structured focus group discussions (FGDs) in the same population (24 participants in total). We assessed the following characteristics: (i) perceived obstacles to skilled birth attendance, (ii) saving methods and habits; (iii) usage of mobile phones and mobile payment systems; (iv) perception of the usefulness and acceptability of the MHW for maternal healthcare; and, finally (v) media access and consumption for program information purposes.

**Methods**

**Study design**

We used quantitative population-representative survey data and qualitative FGDs in a sequential explanatory mixed-methods design [21-22]. The quantitative part was used to measure the prevalence of multiple characteristics relevant among pregnant women in Madagascar. The qualitative data contributed to a deeper understanding of the respective findings. Integration of both methods occurred during the sampling and analysis stage. Participants were sampled from the same study populations for both the survey and FGDs. The analysis was integrated by using similar thematic coding for major barriers and facilitators of the MHW. Results were then triangulated for each of the themes across data sources.
Study setting

The study was conducted in Atsimondrano and Renivohitra, two out of 8 districts within the region of Analamanga, Madagascar. Both districts are mostly urban and include Antananarivo, the capital of the island.

Quantitative methodology

A quantitative survey was developed for the Madagascan context to collect general information on structural and contextual elements of the MHW for skilled healthcare during pregnancy. To quantify the need for the MHW, we elicited information about household income, use of mobile phones and mobile payment services, and savings methods and mechanisms during pregnancy.

Sampling

We carried out a two-stage cluster-random sampling of women utilizing routine antenatal care (ANC) or routine postnatal care (PNC) in the public-sector health facilities in the Malagasy districts of Atsimondrano and Renivohitra. In the first stage, we randomly sampled public-sector health facilities in these two districts. To be eligible to be included in our sampling frame, the facilities needed to be approved by the Ministry of Health. Of 38 public-sector health facilities in the two districts, we randomly selected 14 with equal probability. We excluded 4 because they were characterized by at least one of the following three exclusion criteria: (1) they did not perform ANC at a minimum quantity (defined as less than 10 ANC visits per week in 2016), (2) they were not reachable within 2 hours from the city center of Antananarivo by public transportation, or (3) they refused to participate in this study. From the remaining 10 public-sector health facilities, 8 were so-called CSBs (French: Centres de Santé de Base or basic government-run healthcare centers) and 2 were referral hospitals. Most of the randomly
selected facilities provided elective maternal healthcare only on specific days of the week. In the second stage, we thus randomly sampled two facilities for each calendar day during the period from November 29th 2017 to January 22nd 2018 out of the sampling frame of those randomly selected clinics that were open on that day. All women utilizing ANC or PNC on the selected clinic-days were eligible to participate in the survey interview and were approached for consent to participate. Sampling occurred on 23 working days in total. For sample size determination, a number of 83,297 pregnant women at a given moment in the study area was calculated based on 2017’s population size of 1,851,024 for the districts Atsimondrano and Renivohitra and 4.5% of the population were considered pregnant at a given moment as estimated by the Malagasy Ministry of Health (non-published data). Using the open source online calculator OpenEpi Version 3 with a 95% confidence interval and a 0.05 significance level, a sample size of 383 was determined [23]. Out of a total of 416 eligible women, 412 gave consent and were included in the study. Participant recruitment was done by the data collectors while at a health facility.

**Data collection**

Three experienced interviewers (two women and one man), who were native speakers of Malagasy, were recruited from Analamanga region to serve as data collectors. Training included a one-day standardized curriculum. Supervisors were present throughout the study period to ensure data quality and accuracy. Data collectors administered a paper-based questionnaire which covered sociodemographic and economic characteristics, saving habits, mobile phone access, previous experience with mobile payment systems, and intended place to give birth, as well as multi-media consumption.
Data analysis

We calculated descriptive statistics for the study sample including percentages, means and 95% confidence interval. Poverty status was estimated based on the poverty line of $1.90 referring to 2011 dollars and taking into account US inflation (corresponding to $2.03 in 2016). With a Purchasing Power Parity factor for Madagascar of 847.2 in 2016, the poverty line was calculated to be at 1,719.8 Ariary (Ar) a day or 51,594 Ar a month [24]. Monthly revenue per household member was calculated by dividing the household’s monthly income by the household size. Quantitative data were analyzed using Microsoft Excel version 15.32.

Qualitative methodology

FGDs focused on assessing the motivation, expectations, and general attitude of a mobile-phone-based savings and payment platform for skilled healthcare during pregnancy among clients.

Sampling

Criterion-based purposeful sampling was employed with the goal of obtaining information rich data [25]. The criteria considered included women in reproductive age being pregnant at the time of sampling or having recently given birth, visiting a public health facility for ANC or postpartum care. As validity, meaningfulness, and insights generated from qualitative inquiry have more to do with the information-richness of the cases selected and the observational capabilities of the researcher, sample size was determined based on saturation of themes across FGDs [26]. We included 2 to 5 participants per group discussion. Women who took part in the questionnaire of the quantitative component of the study were excluded from participation in FGDs. If, upon consultation with local colleagues or upon piloting tools, we found that combining
participants by a certain characteristic (economic status, age etc.) was impeding or
undermining the quality of data collected, we altered the make-up of FGDs to be more
sensitive to a particular dynamic.

**Data collection**

Data collection occurred during the same time period as the quantitative survey
(between November 29th 2017 and January 22nd 2018). FDGs were led by a trained and
experienced interviewer from the study team and were audio-recorded for analysis. FGDs
were conducted in Malagasy, transcribed verbatim and translated into English by two
bilingual speakers. The qualitative instrument contained 15 open-ended questions
relating to barriers to skilled care, attitudes and habits towards healthcare savings and
motivation, expectations, and general attitude towards the MHW for healthcare during
pregnancy. All data collection activities took place at the healthcare facility in a separate
room ensuring confidentiality during the interview and discussions.

**Data analysis**

Two of the authors conducted content analysis. A deductive approach was used to
identify common themes, which were hand-coded and analyzed. Themes arising from the
qualitative component were matched unto themes employed by the questionnaire survey,
such as finance-related issues during pregnancy, barriers towards saving, and potential
benefits seen for the application of the MHW [27].

**Results**

**Quantitative results**

A total of 412 participants were included in the study. Table 1 shows selected
characteristics of study participants. The mean age of participants in the quantitative
section was 25 years (range: 15-45 years). 63.3% (95% CI 58.6-68.0) of participants had
at least attended the first year of secondary school and 94.1% (95% CI 91.8-96.4) were literate. At the time of the survey 77.9% (95% CI 73.9-81.9) and 22.1% (95% CI 18.1-26.1) of women attended ANC or PNC, respectively. Based on average monthly household income, 56.0% (95% CI 50.8-61.2) of participants whose answers allowed calculation of poverty status lived in extreme poverty, i.e. of less than $1.90 per person per day (2011 value, adjusted for purchasing power parity, 1719.8 Ar per day, 2016 value). 89.2% (95% CI 86.0-92.4) of households had an income of less than 400,000 Ar per month (equivalent to $126). Despite the overall low-income level, 58.7% (95% CI 53.5-63.9) of participants owned a television, whereas 76.1% (95% CI 71.6-80.6) of the households did not own a vehicle (i.e. bicycle, moped, car or any other wheel drive). The majority of the participants’ households (71.4%, 95% CI 67.0-75.8) had access to a source of electricity, i.e. municipal electricity supply, solar or generator.

Table 1. Selected characteristics of study participants in the quantitative component.

<table>
<thead>
<tr>
<th>Age group</th>
<th>15-18</th>
<th>19-21</th>
<th>22-25</th>
<th>26-30</th>
<th>31-35</th>
<th>&gt; 35</th>
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<tbody>
<tr>
<td>% (n=411)</td>
<td>14.8</td>
<td>20.4</td>
<td>26.3</td>
<td>20.0</td>
<td>9.5</td>
<td>9.0</td>
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<tr>
<th>Marital status</th>
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<th>Married</th>
<th>Partnership</th>
<th>Widowed</th>
<th>Divorced</th>
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<tbody>
<tr>
<td>% (n=412)</td>
<td>5.3</td>
<td>65.3</td>
<td>29.4</td>
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<td>0</td>
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<table>
<thead>
<tr>
<th>Number of children</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>&gt; 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>% (n=412)</td>
<td>36.9</td>
<td>31.6</td>
<td>18.4</td>
<td>7.3</td>
<td>2.7</td>
<td>3.2</td>
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<tr>
<th>Highest school attended</th>
<th>None</th>
<th>Primary</th>
<th>Secondary</th>
<th>Bac</th>
<th>Higher</th>
</tr>
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<tbody>
<tr>
<td>% (n=412)</td>
<td>1.9</td>
<td>34.7</td>
<td>40.3</td>
<td>12.9</td>
<td>10.2</td>
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<tr>
<th>Occupation</th>
<th>None</th>
<th>Merchant</th>
<th>Farmer</th>
<th>Teacher</th>
<th>Other</th>
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<tbody>
<tr>
<td>% (n=406)</td>
<td>42.6</td>
<td>25.1</td>
<td>10.6</td>
<td>2.5</td>
<td>19.2</td>
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<th>Monthly household revenue band</th>
<th>&lt;50,000 Ar</th>
<th>50,000 - 100,000 Ar</th>
<th>100,000 - 200,000 Ar</th>
<th>200,000 - 400,000 Ar</th>
<th>&gt;400,000 Ar</th>
</tr>
</thead>
<tbody>
<tr>
<td>% (n=351)</td>
<td>12.5</td>
<td>15.1</td>
<td>39.0</td>
<td>22.5</td>
<td>10.8</td>
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<tr>
<th>Vehicle ownership</th>
<th>None</th>
<th>Bicycle</th>
<th>Moped</th>
<th>Moped + bicycle</th>
<th>Car</th>
<th>Car + other vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>% (n=348)</td>
<td>76.1</td>
<td>9.5</td>
<td>8.6</td>
<td>0.9</td>
<td>2.9</td>
<td>2.0</td>
</tr>
<tr>
<td>Television ownership</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% (n=346)</td>
<td>58.7</td>
<td>41.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<th>Electricity at household</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
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<td>% (n=405)</td>
<td>71.4</td>
<td>28.6</td>
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</table>

<table>
<thead>
<tr>
<th>Mobile phone ownership</th>
<th>Personal phone</th>
<th>No personal but family phone</th>
<th>No personal or family phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>% (n=412)</td>
<td>50.7</td>
<td>29.6</td>
<td>19.7</td>
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</table>

<table>
<thead>
<tr>
<th>Knowledge about MM</th>
<th>Never heard about MM</th>
<th>Knowing about MM without having used</th>
<th>Having ever used MM</th>
</tr>
</thead>
<tbody>
<tr>
<td>(% (n=412))</td>
<td>9.5</td>
<td>54.9</td>
<td>35.7</td>
</tr>
</tbody>
</table>

* Bac = Baccalauréat (A-level, European Qualifications Framework Level 4)

**Use of mobile phones and mobile payment services**

80.3% (95% CI 76.5-84.1) of participants made regular use of a mobile phone (50.7% and 29.6% owned or had access to a mobile phone within the immediate family, respectively). Out of four mobile phone providers active in Madagascar, 96.3% (95% CI 94.3-98.3) of women with phone access were registered with either one or both of the two most popular operators and 18.7% (95% CI 14.5-22.9) of these were registered with more than one provider at the time of the survey. Almost all respondents (90.5%, 95% CI 87.7-93.3) had heard about mobile payment services. However, only 35.7% (95% CI 31.1-40.3) of these women had ever used it before. Of those, 67.4% (95% CI 59.5-75.3) reported to use MM services solely for receiving or sending funds to and from relatives and friends or for making cash withdrawals at registered agents. Surprisingly, 26.1% (95% CI 18.7-33.4) used the technology additionally or solely for saving whereas at the time of the survey none of the phone operators offered a dedicated mobile savings account. Payment of bills and services using MM was uncommon (3.6% of MM users).

One quarter of MM users reported ever having sent money to relatives for healthcare and
only 1.4% had ever used MM to pay for drugs or services at a healthcare facility. Three quarters of the users (75.0%, 95% CI 67.6-82.4) reported to use MM technology between one and four times per month.

Savings habits and mechanisms

Despite a low average household income, 59.3% (95% CI 54.5-64.1) of women put money aside in the form of savings (Figure 1). The most prevalent method were household cash savings (64.4%, 95% CI 58.6-70.2). Of those saving money, more than half did so on a regular basis and 69.5% (95% CI 63.7-75.3) of participants saved for delivery or newborn care. Only 34.4% (95% CI 28.5-40.3) of participants who do save used formalized savings mechanisms such as a bank or MM account or used a microcredit scheme especially for saving.

Figure 1. Saving habits among pregnant women and new mothers in Antananarivo (Atsimondrano and Renivohitra districts), Madagascar
Intended place of delivery

33.8% (95% CI 29.1-38.5) and 52.2% (95% CI 47.2-57.2) of pregnant women stated the intention to deliver in a basic health care facility or in a community hospital, respectively. Only 5.1% (95% CI 2.9-7.3) of women planned to deliver at home. 5.6% (95% CI 3.3-7.9) of respondents mentioned the intention to deliver in a private hospital.

Media access and consumption habits

67.4% (95% CI 62.9-71.9) and 55.5% (95% CI 50.7-60.3) of participants reported having regular (at least once a week) access to radio and television, respectively (Figure 2). They cited 34 radio stations and 12 TV channels that they listened to or watched, with the most popular radio station (Radio Record) and TV channel (TV plus) being cited by 18.3% (95% CI 14.1-22.5) and 25.9% (95% CI 31.1-20.7) of the women, respectively.
Reported times of radio listening were spread across the day whereas TV watching mainly took place during the evening hours from 5pm to 8pm. Only 20.6% (95% CI 16.7-24.5) of respondents were connected to the social media platform Facebook and most of the users (82.1%, 95% CI 73.9-90.3) consulted the platform on a mobile device.

Figure 2. Media consumption among pregnant women and new mothers in Antananarivo (Atsimondrano and Renivohitra districts), Madagascar
Qualitative results

Barriers to utilizing skilled care

24 participants in total attended 6 sessions of FGDs. The average age of participating women was 23.3 years (range: 14-39). FGDs revealed that major barriers to skilled care included inadequate information (in particular on the medical necessity, health benefits, availability, and costs of maternal healthcare services), financial obstacles, and cultural aspects. Although Madagascar implemented a user fee exemption policy for maternal healthcare services in 2008, out-of-pocket costs for routine drugs and lab tests or hospitalization remain a major obstacle for seeking skilled care [28]. Some respondents explained that even minor expenses (i.e. for iron and folic acid supplements) prohibited pregnant women from seeking institutional care. Several of the respondents stated that fear of unexpected and expensive hospitalization in case of complications detected during a routine ANC visit made them hesitate to seek skilled care. One pregnant woman stated:

“I am wondering if it will be a normal birth or if it will require surgery. I see the other women and I become anxious: When the delivery is normal, we don’t have any problem and can pay for it. But if it happens to be a complicated delivery, we need an operation and spend a lot of money.” (Pregnant woman)

Another aspect contributing to financial obstacles for seeking skilled care were non-consistent prices at the provider level. Participants stated that prices for drugs and services vary over time and between individual patients (including among patients treated at the same public-sector health facility), thereby adding to the unpredictability of costs. Time constraints caused by the necessity to generate income to cover daily costs
of living were cited as an obstacle for women who did not have a regular job, as explained by the following respondent:

“They [unemployed women] are busy searching for income. Instead of coming for an antenatal care visit they have to work. They don’t have time to spend here [at the health center].” (Young mother)

Overall, there was agreement that costs for home deliveries without qualified birth attendance or traditional birth attendance were more predictable and generally cheaper than facility-based births and were the preferred alternative for delivery if savings appeared to be insufficient. Cultural aspects including low prioritization of maternal healthcare and general skepticism towards skilled care were further commonly cited obstacles.

“I am afraid of going to hospital because you have mainly students there and you are used for their op [surgical] training, so people are really afraid and don’t go there anymore. They are all trainees and that is scary. And even for small problems – for instance you [the birth process] take longer, they are not patient to wait and send you directly to the operating room.” (Pregnant woman)

Savings habits and mechanisms

Respondents mostly saved on a weekly or monthly basis by putting aside a part of their cash earnings in a savings box at home. However, participants acknowledged that expenses such as school fees, funeral costs, or other substantial unforeseen financial crises within the family frequently endangered their healthcare saving.

“When I will be in the 8th month of my pregnancy, I will begin to buy baby clothing. I don’t save but hope - I really pray for it - that the baby will come at the time my husband will receive his salary. We do not have the possibility to save. But when I save and there is nothing else left, I break the savings box... I really pray that I will deliver the baby around pay day.” (Pregnant woman)
A major motivation to use formalized savings mechanisms was to preclude savings from being used other than for the intended savings goal. However, the majority of FGD participants expressed only low levels of frustration when savings goals weren’t met. Some respondents stated that borrowing money for healthcare from a relative or friend was culturally accepted and common under such circumstances.

“I bring my savings to the post office. Because if I keep it home, I will use it. When I don’t have [money] I have no choice but using it. Now when the delivery date is approaching, I will take it in person because they [the financial institution] don’t give it to someone else. Only to the owner.” (Pregnant woman)

Attitude and expectations towards a mobile-phone-based healthcare savings platform

FGD participants perceived the concept of the MHW for maternal healthcare as generally beneficial. A particular value was seen in conditional funds that can only be spent on maternal healthcare. Respondents emphasized, however, that inaccurate or incomplete information about benefits or restrictions of the service could inhibit its acceptance and use by the target population. A comprehensive sensitization campaign was deemed crucial by respondents for a successful implementation of the service and should certainly include personal contact between program agents and users. Ease of use of the MHW and personal customer support by a health worker or dedicated agent was mentioned by some respondents to be essential for the acceptance by the population.

“Once the money is in it [the platform] you are not allowed to take it. This point is what attracts me because the saving remains untouched, not like with savings box. That is the money dedicated to face delivery. Or to buy drugs.” (Pregnant woman)
Discussion

Principal findings

Our study revealed three salient findings. First, the target population in the peri-urban areas of Antananarivo is relatively privileged with regard to the Madagascan average, with high rates of secondary school attendance and media access and almost universal literacy. While more than half of the study group falls below the World Bank absolute poverty line of $1.90/day, this proportion is still well below the average for the entire country. Second, while the concept of mobile money was familiar to almost all respondents, and mobile phone access was widespread, only a minority were currently using the technology, predominantly for sending and receiving money between friends and relatives but less commonly as a savings tool. The use of mobile money to pay for healthcare services was infrequent. Third, in our study’s FGDs, many participants raised the issue of financial limitations to accessing ANC and PNC resulting from OPP and opportunity costs. Participants reported difficulties in saving for healthcare and reported a variety of informal tools to help them save as well as interest in a mobile-phone-based savings and payment platform such as the MHW. To our knowledge, our study includes the first qualitative research analyzing general and financial barriers of access to skilled healthcare for pregnant women in the capital of Madagascar.

This finding is supported by data of the Enquête Nationale sur le Suivi des indicateurs des Objectifs du Millénaire pour le Développement (ENSOMD – national survey on the progress towards the Millennium Development Goals) conducted by the Madagascar National Institute of Statistics in 2012-2013. This report listed financial restrictions as a major obstacle towards healthcare for pregnant women in Antananarivo [17]. Fear of lack of drugs and absence of healthcare staff were not raised in our FGDs. This might reflect the urban and peri-urban setting of our study resulting in lower staff absenteeism (due to high visibility of the health centers) and better supply routes for drugs and
materials. Another potential explanation could be the difference in location of interviews: whereas our study was conducted in public-sector health facilities, ENSOMD interviews were held in pregnant women's homes, potentially reducing barriers to reporting system deficiencies.

In addition to the ENSOMD survey, only two other studies have analyzed obstacles to healthcare access for pregnant women in Madagascar, though neither focused on financial birth preparedness. One study investigated the available sources of funds utilized to pay for obstetric emergency care in a hospital in Mahajanga, a town in the north-western part of Madagascar [5]. One in six households included in the study were able to pay the costs incurred during hospital admission from routine income or savings. Borrowing money from family and friends was needed in most cases in order to complete payments for maternal healthcare services. These findings are in line with our results, albeit for a different urban area of Madagascar. However, the study was limited in scope (including 103 mothers in a single hospital) and only focused on emergency obstetric and neonatal care in a referral hospital, rather than financial preparation. The second study, conducted in Fort Dauphin, an urban center in the south-east of the island [29], identified lack of knowledge (as observed in our study), risky practices, delay in seeking medical care and family and community expectations as major obstacles. We suspect that these factors are rather specific to the region under study, which is known to be one of the poorest area of the country and with high levels of influence exerted by traditional social norms [29- 30]. A further obstacle - the distance of travelling to the next healthcare facility – was not an important barrier among the population in our study, likely because Antananarivo is densely populated and the average distance to the nearest healthcare facility is relatively short [31].

Our results show that despite national policies promising free ANC and delivery, in practice the majority of obstacles to ante-, perinatal and post-partum healthcare access
cited by the participants were of a financial nature [28]. High and highly variable financial contributions - i.e. for complementary clinical diagnoses or the treatment of complications - represent a tremendous burden for poorer women and can create fear of engaging with formal healthcare. Not a single facility observed in our study had price information visibly displayed within the center. Indeed, among all our respondents from FGDs, a considerable lack of knowledge about prices for healthcare services was identified: Services that were free of charge were unknown, and prices for specific services were unclear. The women in our study feared pregnancy-related complications and the need for unexpected additional care because of the threat of impoverishment due to high healthcare expenditures.

Unpredictable pricing of healthcare services can have a number of different origins, including: discontinuous availability of drugs and consumables that are donated and thus free-of-charge at point-of-care, prices set by individual healthcare centers and outside of official regulations, as well as costs differing by the individual health worker providing care. In all of these cases, the lack of transparency and absence of predictable and clearly communicated costs of pregnancy-related care are likely to discourage pregnant women from taking advantage of healthcare services and motivate them to search for alternative care outside of the formal sector. Transparency of prices was mentioned as a critical issue by respondents to plan for delivery and needs to be taken into consideration by policymakers or program managers considering the implementation of a MHW in Madagascar.

Rotating Savings and Credit Associations (ROSCAs) or community savings groups (known in Madagascar as ‘tontines’ [32-33]), were not cited by respondents and do not seem to play a major role for healthcare financing in the study setting. Similarly, the role of the Madagascan Fond d’Équité (an ‘equity fund’ established by the Ministry of Health to finance health expenditures for the poorest section of the population) was suggested to be modest. One reason was a reluctance to be stigmatized as in need of financial help, as
in order to benefit from these funds, patients need to prove their neediness and register at the community level (Malagasy: Fokontany) [34]. Taken together, our findings underline the importance of identifying an implementing novel means of healthcare financing to eliminate or mitigate OPPs, facilitate financial birth-preparedness and reduce the risk of health shocks. The MHW may play an important role for inclusion in healthcare in LMICs [35].

Limitations

Our study has several limitations. First, we recruited study participants in randomly selected public-sector health facilities and the questionnaire and FGDs occurred in this setting. This means that all the participants were privileged by already having access to public healthcare. We decided for this method of sampling as it gave us the opportunity to include a representative number of pregnant women and young mothers and as this group of women will be included during an intervention study to examine the impact of a MHW on skilled birth attendance in Madagascar. Future research should include women without pre-existing access and women who had decided not to engage with the public-sector health facilities who are likely a poorer sub-population. Second, this study only evaluates perception of usefulness and practicability of the MHW by pregnant women. However, as widely described for several resource-low settings, successful implementation and sustainability is not solely depending on the acceptance by the target population but also by other stakeholders like community heads, healthcare professionals and health officials. Additional research on the acceptance of the tool by other healthcare stakeholders is therefore needed. Third, solutions for demand-side affordability alone will not be sufficient to deliver adequate antenatal and obstetric care. Concurrent improvements in healthcare infrastructure and staff skills will also be necessary. Finally, our results may not apply to other countries. Nevertheless, given the
current gap in the literature, our results may be informative to researchers and policymakers in similar settings in SSA.

Conclusions

Financial obstacles are a major cause of limited access to skilled maternal healthcare in low-resource settings and especially in urban Madagascar. A mobile-phone-based savings and payment platform for skilled healthcare during pregnancy was perceived as a useful tool to reduce financial barriers among women in the capital of Madagascar. Key factors that may contribute towards a successful implementation of the MHW among this population include: (i) a high willingness to save, (ii) broad mobile phone usage, (iii) cultural acceptance of a mobile payment and savings tool, and (iv) the perceived usefulness of the system by pregnant women. However, to enhance the access towards maternal healthcare by the tool, a number of financial obstacles need to be tackled. Out-of-pocket costs of basic treatment were high and transparency about free services and prices was inadequate. A culturally sensitive communication and sensitization strategy and comprehensive technical support will be essential to fill the existing gap of knowledge and overcome cultural restrictions. Future research must determine whether and how a mobile-phone-based payment platform can enhance access to improve maternal healthcare delivery and ultimately maternal health outcomes.

Acknowledgments

The authors thank the Madagascan Ministry of Health, all health officials and healthcare professionals who provided their support for this study. The authors thank Alexej Funke for his contribution to the quantitative data collection, Mialy Rakontondraina for critical revision of the data collection tools and Dr Jeannot Randriantsoa for his support during data collection.
Declarations

*Ethics approval and consent to participate*

Ethical clearance for the study was obtained from the Heidelberg University Hospital Ethics Committee (No. S-703/2017) and the study was approved by the Madagascan Ministry of Health. Written informed consent was obtained from all study participants prior to enrollment and participants were informed that participation would not affect their access to healthcare or the quality of care they receive. All participants were explicitly given the right to refuse participation.

*Consent for publication*

Not applicable.

*Availability of data and material*

The datasets analyzed during the current study are available from the corresponding author on request.

*Conflicts of Interest*

None declared.

*Funding*

The study was funded by Doctors for Madagascar, a non-governmental organization registered in United Kingdom, Germany and the Grand Duchy of Luxembourg.

Authors’ contributions

NM designed the study protocol, performed data collection and analysis and wrote the manuscript. ER was involved in data collection, transcription, translation, and analysis of qualitative data. PMFE cross-checked the data analysis and critically revised the manuscript. ME revised the manuscript. JWDN and TB contributed to the study design and protocol and made critical revisions to the manuscript. JVE and SK revised the study
protocol, were involved in data collection and analysis, and revised the manuscript. All authors read and approved the final manuscript.
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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>ANC</td>
<td>Antenatal care</td>
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<tr>
<td>CI</td>
<td>Confidence interval</td>
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<td>ENSOMD</td>
<td>Enquête Nationale sur le Suivi des indicateurs des Objectifs du Millénaire pour le Développement (engl.: national survey on monitoring the indicators of the Millennium Development Goals)</td>
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<tr>
<td>FGD</td>
<td>Focus group discussion</td>
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<td>LMIC</td>
<td>Low and middle-income country</td>
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<td>MHW</td>
<td>Mobile Health Wallet</td>
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<td>MM</td>
<td>Mobile Money</td>
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<td>Out-of-pocket payment</td>
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<td>Postnatal care</td>
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