

**roadmap: A feasibility study for a smart travel application to improve
maternal health delivery in a low resource setting in Zimbabwe**

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Abstract

Background: Travel time and health care financing are key determinants to the provision of quality maternal health care in low resource settings. Despite the availability of pregnancy-related mHealth and smart travel applications, there is a lack of evidence on their usage to travel to health facilities for routine antenatal care and emergencies in low resource settings like Zimbabwe. Little is known about the feasibility of the usage of custom-made mobile technologies that integrate smart travel and mHealth. This paper explores the feasibility of implementing a custom-made geographically enabled mobile technology-based tool (RoadMApp) to counter the negative effects of long travel times and poor financing strategies for maternal care in Kwekwe District, Zimbabwe.

Methods: Focus group discussions were conducted with pregnant women, women of childbearing age, men (household heads) and elderly women. Participatory learning approaches with stakeholders (community members) and in-depth interviews with key informants (health care service providers, transport operators) were utilised. In total 193 people took part in the study. The discussion questions centred on travel time, availability of transport, cellular network coverage and perceptions of the RoadMApp application. Data was analysed thematically using Nvivo Pro 12.

Results: Most parts of rural Kwekwe have long distances to health facilities and an inefficient road and telecommunications network. Hence, it is hard to predict if RoadMApp will integrate into the lives of the community - especially those in rural areas. Since these issues are pillars of the design of the RoadMApp application, the implementation is likely to be challenging.

Conclusion: Communities are keen to embrace the RoadMApp application. However, the feasibility of implementing RoadMApp in Kwekwe District will be challenging due to maternal health care barriers such as poor road network, poor phone network and the high cost of transport. There is, therefore, a need to investigate the social determinants of access to maternity services in order to inform the RoadMApp implementation.

Keywords

Pregnancy, Maternal health, Transport; RoadMApp; Barriers to maternal health services; Geographically enabled Mhealth; Mobile health; Kwekwe; Zimbabwe

Background

Several studies have pinpointed the optimal time taken by pregnant women to access maternal care as a predictor of maternal and neonatal health outcomes (1). There is, therefore, a growing need for interventions utilising Geographic Information System (GIS) to apply maps and geospatial analyses to improve birth preparedness and complication readiness (BPCR) (2,3). Definitions of BPCR are normative with very few authors reaching a consensus. Typically, it includes some of the following: (a) knowledge of pregnancy danger signs; (b) shared decision-making before the onset of labour and potential occurrence of obstetric complications (c) planned location for delivery and emergency services; (d) transport plan; and (e) a savings plan, ((4) (5). Consequently, health interventions to improve BPCR that employ GIS can be integrated into online platforms (i.e. web GIS) and mobile devices or telemedicine (i.e. calls and short message services) (6) to reduce health costs (7), and improve health outcomes (8).

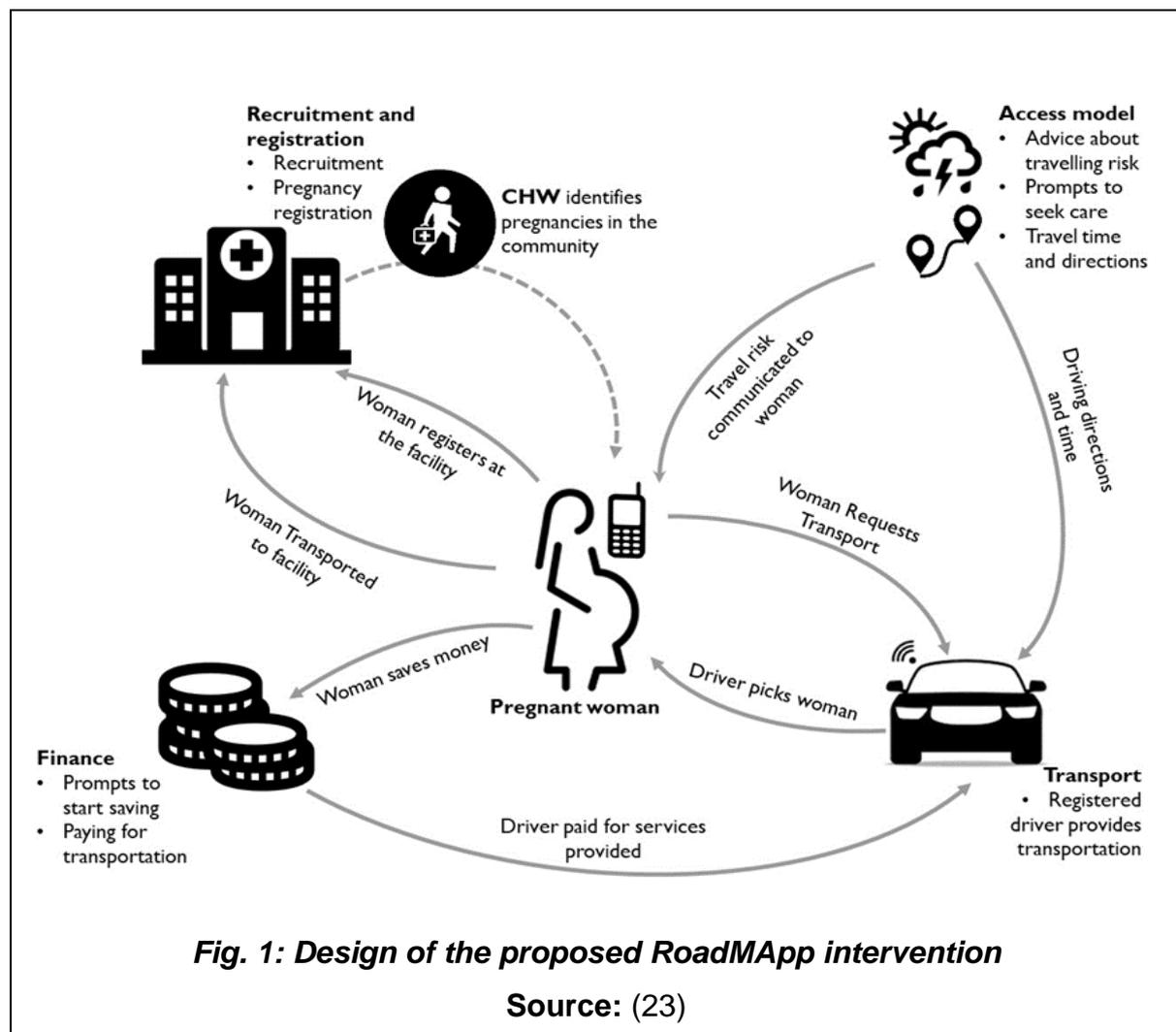
Against this background, a feasibility study was conducted to inform the development of the RoadMApp intervention, a smart travel application that seeks to improve the health of pregnant women and neonates by linking them to locally available transport. The RoadMApp concept, which is an mHealth (mobile health technology) tool, is a disruptive technology because it provides “a simpler and less expensive alternative that meets the essential needs for most consumers and is more accessible, scalable, replicable, and sustainable” (9).

To date, studies conducted on smart travel applications tend to focus on taxis (10) and health or geography warnings for holiday destinations (11). Most mobile health (mHealth) solutions on prenatal and postnatal healthcare focus on sending health-related information related about treatment adherence and disease monitoring (8,12). RoadMApp will not only inform women of their travel risk but will point them to local resources to ease access to health care facilities.

Mobile devices have the potential to reach multiple people at the same time. Mobile technologies have a far-reaching value in healthcare, as these devices are used for diagnostics, health management, and telemedicine. UNICEF (2012) has noted that when mHealth technologies are applied strategically, they can solve problems related to the time, distance travelled and coordination of stakeholders. However, despite the

availability of pregnancy-related mHealth applications, there is a lack of evidence on how these applications integrate into the daily lives of pregnant women and if they influence behaviour change on BPCR amongst pregnant women and their caregivers (14). It is important to note that technology is not neutral, but context-specific – it must be adapted to the needs of people it is designed for (15) to reconfigure that context in ways that it was designed for and some which are unanticipated (16). Therefore, this paper aims to understand how the RoadMApp smart travel mHealth tool fits into the existing strategies and perspectives for mobilizing transport for pregnancy-related care in a low resource setting.

The design of the RoadMApp mHealth tool is based on the assumption of a high mobile phone penetration rate in Zimbabwe (17–19) and long travel times for accessing maternal health care facilities (20,21) resulting in maternal delays (22) (see Fig 1 for the proposed RoadMApp application).



Methods

Research design

This study offers insights into access to transport, travel time and community perspectives about the feasibility of the RoadMApp intervention. Qualitative methods were preferred for their strength in providing information rich data on community experiences and ensuring community voices were heard. The researchers engaged with community members where the RoadMApp application is to be introduced. Two researchers conducted the interviews with the third taking notes of the proceedings.

Participants and Setting

Of the 35 health facilities in Kwekwe, two hospitals (rural and urban), four rural health centers, two peri-urban clinics and two urban clinics were selected. They were purposively selected health facilities provided comprehensive obstetric care services and most of the facilities' clients were travelling long distances to access health care. Registers and maps at the provincial level were used for the selection of study sites. Effort was made to cater for heterogeneous characteristics of the population by purposively looking for representative typical cases and geographical spread. Purposive sampling which bases generalisation on information-rich cases was used (24,25), where the goal was to bring typical cases representative of heterogeneous groups and collect multiple forms of data instead of random samples (26). This is consistent with the goals of qualitative research to achieve credibility and transferability as opposed to validity and generalisation used in quantitative studies (27).

To ensure heterogeneity of the participants, community health workers and health facility managers were asked to assist in snowballing people who could significantly contribute to the study by sharing information on the existing strategies, experiences, as well as suggestions in mobilizing transport and financial resources to facilitate access to antenatal and intrapartum care for women in Kwekwe district. Participants included pregnant women, women of childbearing age, spouses of pregnant women and spouses for women of childbearing age, elderly women (50 years and above), community members and health care providers. Participants provided written/verbal informed consent.

Authors' positionality

The position of the researchers within the research cannot be underplayed as researchers can influence the outcome of the findings as they bring preconceived ideas to the knowledge production and presentation. Data were collected by five females and three males (PTM, LM, YPD, NN, LM LC, ZNJ, ID). The researchers had higher level qualifications in Geographical Information Science, Health Geography, Biostatistics and Epidemiology, Social science, Public health, Development and Information science studies. The researchers were all conversant with the two main languages spoken in the study areas. They were also familiar with the local formal and informal institutional cultures, facilitating easy entry into the community. The female researchers could identify and empathise with the women as they are also mothers. The male interviewers brought in a wealth of information and were instrumental in accessing cultural boundaries. The use of a culturally diverse and multidisciplinary team enhanced the credibility, dependability and transferability of the study findings.

Data Collection

The FGD and IDIs guides were created in English by the qualitative research expert (ZNJ). The other researchers (PTM, LM, NN, YD and ID) reviewed and revised the tools to ensure the objectives of the study were met. A linguist from the Midlands State University translated the tools into both Shona and Ndebele. All tools were back translated to ensure that meaning was preserved. The tools were then pretested at one rural health facility in the study area which was not selected for the main study.

Key informants interviewed were midwives, fire brigade and ambulance personnel, transport owners and operators in the communities. FGDs were convened with pregnant women, women of childbearing age (WoCBA), and other community members. Focus group guides included questions on access to health care facilities for pregnant women, transport options, strategies for mobilizing transport, access to maternal health care services and use of telecommunication networks.

The data saturation rule was applied in making a cut-off of the number of people and sites to collect data from. Data saturation relates to the degree to which new data repeat what was expressed in previous data that would have been collected from the participants (28). To ensure that data saturation had been achieved, the research team constructed a data saturation grid, wherein major topics were listed on the vertical axis

and interviews to be conducted were listed on the horizontal axis (26). Data were collected over four weeks in September 2019 by five female and two male researchers. Each interview or FGD was on average 45 min to 1 hour. The RoadMApp project also engaged the community to ensure buy-in for the proposed project. Community or stakeholder engagement is vital for programming and policy implementation. FGDs and IDIs were tape-recorded with the permission of the participants.

Data analysis

Data from the audio voice recorders were transcribed verbatim and later translated into English. Two translators verified the transcripts for authenticity. The anonymised transcripts were imported into NVIVO Pro 12 to generate codes to aid in the analysis process. The coded data were shared with the rest of the team and the group identified emerging themes. Three authors cross-checked the data with the transcripts and fieldnotes to ensure consistency. Preliminary findings were disseminated to the local authorities and the participants.

Study limitations

The limitation of qualitative research is subjectivity. Being aware of this is the first step towards addressing this bias. The researchers had to go into the study area with as few preconceptions as possible for the qualitative enquiry to be empty of their own experiences and prejudices.

Results

One hundred and ninety-three (193) people took part in the study, through 11 focus group discussions, 14 key informant interviews, and 3 community meetings (*see Table 1 for a break-down*).

Table 1: Study participants

	<i>Rural (N participants)</i>	<i>Peri-urban (N participants)</i>	<i>Urban (N participants)</i>	<i>Totals (N participants)</i>
FGDs				
Pregnant women	14	8	12	34
Women of child bearing age	20	-	15	35
Health staff	17	-	7	24
Spouses	-	-	8	8
Key Informant interviews				
Health staff	5	4	1	10
Transporters	-	1	-	1
Pregnant women	1	-	-	1
Women of child bearing age	-	1	4	5
Spouses	-	-	1	1
Community engagement	74	-	-	74
Total				193

Over two-thirds of the participants were literate, having attained secondary level education. Tertiary education was not prioritised in both the urban and rural settings due to lack of opportunities which have been further compounded by the economic downturn in the country. The major sources of income were mining both formal and artisanal. Incomes ranged between USD \$20 – 250 per month and there were no major differences in the incomes between the urban and the rural dwellers.

The analysis resulted in three main themes and ten subthemes. The superordinate themes were (1) availability of transport, (2) telecommunications and network infrastructure and (3) community perceptions of the feasibility of the RoadMApp application.

Table 2: Themes and sub themes resulting from the data analysis

Superordinate	Subordinate
1. Availability of transport	<i>Quality of transport</i> Safety of the transport Time taken and cost of travel Waiting mothers 'shelters Ambulance system
2. Telecommunication and network systems	<i>Network coverage</i> Mobile phone ownership
3. Community perceptions of feasibility of the RoadMApp	<i>Challenges of RoadMApp</i> <i>Poor economy</i> Poor road infrastructure

Theme 1: Availability of transport

From the transcripts, it was inducted that transport meant available *means of travel, distance to the health facility, the cost of travelling, time taken to reach the facility and the state of the roads*. The urban area had an established road-network as compared to the rural. The main roads in the urban and peri-urban areas were tarred whilst the minor roads were dusty with gravel and potholes. There were some peri-urban places which were hard to access, and most vehicle owners were reluctant to use those routes as they were worried about damage to their vehicles. Hard to access areas negatively affected the waiting time, as shown in the following comment;

“You have to wait for hours before you are picked as transporters would prefer to ferry people from areas where roads are good. One time, I started labour pains at 9.00am and immediately called the transporter but he came 5 hours later. I could have given birth at home”, (An urban postpartum woman within the age range of 18-24).

Discussions with rural participants highlighted the challenges of obtaining transport when a woman went into labour. Women in labour had to walk long distances to access the road network where they could get transport. The following excerpt summarises the ordeal of a woman who went into labour at night;

“I called our local transporter when my daughter got into labour and he told me that he had other errands to make and he would only be available after 3hrs. That was going to be a serious delay as the labour pains had intensified. I asked her siblings to accompany her. They walked in the dark for 2 hours before they got transport to the health facility. They could have been robbed or she could have delivered in the forest”, (An elderly woman within the age range 55-60)

Sub theme 1.1: Quality of transport used for commuting

In urban areas, cheaper modes of transport were available that included the government subsidised Zimbabwe Urban Passenger Corporation (ZUPCO) buses (29). Some pregnant women used Honda Fit vehicles which carry 6-8 passengers (*instead of the standard capacity of 4*) and commuter buses which carried 18 passengers (*instead of 14*), Commuters and the Honda Fit taxis were preferred because of availability and shorter waiting time. The cheaper buses had challenges of long waiting hours and overloading. The following excerpt sums up the women’s experiences on the use of public transport;

“...ZUPCO is cheap but however very hot (because of overloading). Passengers, drivers and conductors seem not to understand or empathise with pregnant women. Even if I am pregnant, they expect me to stand...Sometimes the bus is full and they leave you behind. But smaller vehicles don’t take time to load. However, their design is not ‘pregnant woman-friendly’. The poor road terrain even makes things worse”, (An urban pregnant woman within the age range of 22-26).

A community member from one of the rural sites reiterated the same sentiments.

“Pregnancy is not regarded as an illness and no one bothers to prioritise giving comfortable transport to them. You see them squashed like sardines in public transport”, (Participant within age range 45-50).

Sub theme 1.1.2: Safety of the transport

Despite the availability of public transport in urban areas, most pregnant women mentioned the safety and unaffordability of public transport, especially for routine visits to health facilities. This saw women walking to the clinic/hospital, 5-10 kms. Women would at times use animal driven carts (scotch carts) which were accident prone. Additionally, women did not feel safe to catch a ride in a car whose driver was unknown as they had heard of criminals who were prowling most places. One elderly woman said;

“It is dangerous to board a vehicle from an unknown driver as we have heard reports of people being murdered by unknown assailants”. (FGD participant, age range 55-60)

The participants said pregnant women would leave home at around 0400hrs to catch the queue at the clinic/hospital (*which opened at 0700hrs*). The situation was worse in the rural areas where the pregnant women were reportedly walking more than 20kms. The women’s safety was of major concern both in rural and urban settings due to unavailability or poor lighting. Walking any distance during labour could be problematic during the day and worsened at night. The research team observed that the distance between the drop off points to the maternity wards at most health facilities (rural and urban) was at least a kilometre. Both urban and rural participants cited cases of robberies and muggings of pregnant women which took place close to clinic/hospitals. A participant reiterated;

“A lot of pregnant women have fallen prey to thugs whilst trying to access health care facilities in this district”, (Participant during community engagement, age range 30-35).

Sub theme 1.2: Cost of travel to clinics

Vehicle owners/drivers were reportedly charging high prices because they took advantage of pregnant women and their caregivers who would be (a) panicking, (b) desperate and, (c) with a high need of transport especially during the night. Furthest villages had the highest cost of hiring a car during an emergency with some women asked to pay an equivalent of USD\$100 (Z\$1,000) for a distance of 20km.

Interviews with transport providers revealed that transporting pregnant women was considered risky due to driver’s lack of skills to handle deliveries or emergencies *en route* to the health facilities. One of the transporters commented;

“Seeing a woman delivering is not anything that a male would want to witness. By ferrying a woman in labour to the clinic, you put yourself at risk”, (Male transporter within age range 33-40).

Subtheme 1.2.1: Waiting mothers’ shelter

The non-availability of a mothers’ shelter at some rural clinics/hospitals, presented a need for readily available transport systems to ferry pregnant women in cases of

emergency. Women with complications in rural areas were referred to the next level of care to access additional services and higher level of care in urban areas. In some cases, the women would stay for weeks in the urban areas until they gave birth. The downside to this was the unavailability of accommodation and a support system within urban areas for a successful and comfortable birth in the referral hospital's town. A health care worker commented;

"... rural women are reluctant to be referred to the next level of care because of lack of accommodation and support, particularly in urban settings", (Female participant within age range 40-45).

Subtheme 1.3: Ambulance system

In cases of emergency, an ambulance could be requested from the district or general hospital, depending on the setting. Primary health centres in the urban areas, had at least one ambulance covering several clinics. The standard charge for ambulance usage was USD \$3 (Z\$30). The arrival time of the ambulance depended on its availability. Fuel shortages were rampant in the country which also led to delays.

The following are some of the comments on the complexity of issues surrounding the availability of the ambulance system;

"... we only have one ambulance for all clinics. Imagine if there are complications at the same time. By the way, the ambulance is not for emergencies only. We also use it for duties like the collection of drugs from other health facilities", (A key informant from one of the rural clinics, age range 30-35).

Local authority officials attributed the inefficiency of the ambulance system to an increase in the population with some citing that on a single day they could receive a maximum of 10 calls for a single ambulance.

Due to the unreliability of the ambulance services, some residents with medical aid cover used private ambulances. However, these ambulances attended to emergencies in the urban and peri-urban areas only. There were no private ambulance services in rural areas as most of that population did not have any form of health insurance. A single ambulance in rural communities could cover a radius of over 200km in rough terrain. Pregnant women were also expected to travel in scotch carts and wheelbarrows to accessible places where they could get an ambulance.

Community members in different localities mentioned that ambulance drivers expected to be paid in cash, as they did not accept electronic or mobile fund transfers. Community members expressed concerns about the transparency regarding the cost of ambulances.

Theme 2: Telecommunications and network infrastructure

The telecommunications network providers have tried to ensure that most areas in Zimbabwe have network coverage. The RoadMAApp application will heavily rely on the network accessibility and hence the importance of understanding the network patterns in the study areas.

Subtheme 2.1 Network coverage

Network coverage was reported to be good in urban areas where all telecommunication service providers had a substantial number of base stations. However, network challenges were experienced when there was no electricity due to load shedding. It was noted that the further away rural communities were from the city centres the less the network coverage. At some rural health facilities, despite the low network coverage, people could still receive voice calls and messages and there was no internet connectivity. The communities knew the best spots to pick up signals for communication, but this was a challenge for nurses who had to disrupt their duties to connect to networks. In some rural areas there was no network coverage at all. One participant said the following;

“...At this place we have serious network challenges and it becomes difficult when our wives need emergency assistance. Sometimes you end up going up a tree to access the network”, (Rural male participant age range 28-35).

Subtheme 2.2: Mobile phone ownership

Discussions revealed that most people in urban settings owned mobile phones but this was not always the case in rural areas. Failure to possess a phone in the rural areas was due to the low-income levels and unavailability of electricity, where owning a phone meant that one had to have solar charging equipment. The poor network availability in most rural areas caused communities to rely less on mobile phones and mobile banking applications. People in rural areas were reluctant to utilize mobile money transactions yet at times it was the only medium of exchange. Those without mobile phones utilized phones of friends or family members. The rural communities

mentioned that people were willing to help those without phones as they perceived it as being neighbourly to assist them.

Theme 3: Community perceptions about RoadMApp

Participants in the study perceived the introducing the RoadMApp mHealth intervention as a strategic way of reducing pregnant women's woes of delays in accessing transport and reaching health care facilities in the remote rural communities. Unlike the urban areas, the catchments of some of the clinics or hospitals in the rural areas were as far as 50 km because of the spatial distribution of settlements, landscapes and rivers in between. There were also cases where pregnant women in urban areas accessed health centres far from their homes because of different sociocultural and socio-economic realities. For example, referrals for primigravida and multiparous women and traveling to access scans or a caesarean section specialist. The communities thought the RoadMApp would be a noble idea if it could take into consideration the identified realities.

Subtheme 3.1 Community perceptions on foreseen challenges of RoadMApp

Although communities appreciated the need for preparation to access maternal health care services, there were some obstacles. For example, the issue of obstetric emergencies among women who were not booked for antenatal classes (ANC), regardless of whether they were from rural or urban areas. It was found that women who booked late were aware of pregnancy preparations, but this awareness did not translate to preparedness because of financial constraints. Communities had limited sources of income to enable savings (due to low/unstable incomes and no sources of livelihood) and unstable costs of transport (due to macroeconomic issues). The community argued that RoadMApp would be adversely affected by the lack of savings for pregnancy. One community participant had the following to say;

“There could be cases where a woman is alerted to report to the health facility but she might fail to raise money for transportation as we are all aware that irrespective of the non-user fees for maternal health care, pregnant women are still delaying in accessing health care”, (Rural woman of child bearing age range 26-31).

Subtheme 3.2 Poor economy

Discussions revealed that the economic downturn was taking a toll on pregnant women as most of them had become breadwinners for the household. Partners were

often involved in migratory labour leaving the pregnant women to fend for their families with the assistance of neighbours and relatives. Most husbands were artisanal miners from other districts or miners working underground and inaccessible during emergencies. *“...most of these women’s husbands are illegal miners and they indeed go underground when they are needed the most”*, (Female participant, age range 40-45).

Across all interviews, participants felt strongly that the RoadMApp application would only be successful if there was funding attached to it. Some even suggested that the World Bank, Results Based Financing (RBF) which had introduced free maternity services could be extended to the RoadMApp intervention.

Subtheme 3.3. Poor road infrastructure

The participants cited the bad or non-existent road infrastructure as a challenge that could inhibit the use of the RoadMApp application. Most rural areas were inaccessible such that even if the women got alerts, they would be unable to reach health facilities quickly. The study also found that there were some roads in the urban areas which were not utilized by transporters due to the degradation that has occurred over years.

Discussion

Transport, distance and usage/ non-usage of the RoadMApp mHealth

The findings concerning distances and transport mobilisation are critical for planning mHealth interventions. However, Wilson et al. (2013) proposed that health geography interventions to reduce maternal mortality and morbidity should not solely focus on transport but pay attention to: a) distal factors (terrain and meteorology); b) proximal factors (culture, finance, autonomy, waiting time, transport options) and c) transit factors (support, transport time, ergonomics).

It is debatable if the distance travelled is the only predictor for access to healthcare facilities and subsequent usage of health interventions (31). As a case in point, women travel long distances to access care to seek better quality services (32). This is consistent with the paper’s findings where rural and urban women travel longer distances to access quality care.

The socioeconomic status of pregnant women and their caregivers influences the choice of transport that is used. This is seen through a high preference for low cost transport run by public operators (which is often runs into delays). These results are the same for both urban and rural people.

Birth preparations and community response

It is a common trend for antenatal educators to encourage pregnant women to have a BPCR plan that should be shared with health providers and caregivers (4,33). In some cases where pregnant women and their caregivers had failed to make adequate preparations, the community was used as a safety net in times of emergencies. Therefore, it is plausible to conclude that the socioeconomic status of pregnant women and their spouses could influence BPCR plans and the usefulness of the RoadMApp intervention. Economically disadvantaged families might incur “emergency birthing” and prefer low cost healthcare found in government clinics and hospitals. The community was at times unsupportive to prioritise pregnant women as they did not consider pregnancy as an illness and would not offer their seats in overloaded buses. A study in Ghana found that most expecting women were aware of potential help to reach clinics or hospitals on time but do not make any advance arrangements (34).

The findings suggest that the women’s lack of advance birth arrangements would lead drivers to charge higher rates or refuse to transport pregnant women. Therefore, when implementing the RoadMApp mHealth, the team should take note of predictors of BPCR such as literacy levels of communities, localities, access to information, booking status of the women and affordability (33):

Local studies have attributed late and low ANC registrations amongst Zimbabwean women to transport costs and charges for prenatal services among other factors (21,35). The overall issue which may resound is the macroeconomic environment which made planning during the pregnancy tougher, especially in the rural areas. Therefore, a comprehensive community mobilisation strategy is required to effectively respond to maternal emergencies, rather than sporadic incidents of community mobilisation (36). Hence, the usage of this mHealth initiative may become negatively affected by the lack of birth preparations as RoadMApp relies on regular savings and transport mobilisation to be conducted on time.

The ambulance system

There are a limited number of ambulances in all the study sites resulting in long waiting times for pregnant women. Reports from the media suggest there is a low number of ambulances in Zimbabwe (37). Companies like Econet have in turn launched mHealth related ambulances called “Vaya”. The Vaya transport service is similar to commercial

smart travel applications that use mobile and telecommunications to connect users with available transport (10). In addition, the Insurance Council of Zimbabwe (ICZ) launched a rapid response ambulance (38). To date these ambulances have not expanded to adequately cover the rural areas. This could be a reluctance by the service providers to use bad roads in rural areas. Out of the determinants for using an ambulance in a low resource setting (39), this study could only confirm: distance, nature of the roads, availability of the ambulance and the cost. A limitation of the study was that private ambulance operators were excluded from the data collection, making it difficult for the authors to transfer the findings to their context.

Telecommunications infrastructure

Though Zimbabwe has had one of the world's highest mobile penetration rates since 2014, recent statistics suggest the mobile penetration rate is lessening because of the economic instability in the country (17). This means that there has been a drop in active mobile subscribers, the Internet penetration rate and mobile voice traffic. Perhaps this may explain the low number of people with mobile phones in rural areas.

Other challenges such as the lack of electricity are potential barriers to the implementation of RoadMApp in hard to reach communities. Because rural communities are deprived of mobile and telecommunication infrastructure, they may have developed an apathy for smart mobile technology. Smart mobile travel applications cannot function effectively without telecommunications infrastructure (including Wi-Fi hotspots) and digital literacy (10). The unavailability of these factors in rural settings is a common challenge experienced in low resource settings (10). Yet there are mHealth interventions which have been implemented despite these barriers.

Furthermore, there is a dearth of studies that support the usage of mHealth for smart travel in pregnancy in Zimbabwe. A notable local study conducted by Samusodza (2016) did not evaluate an mHealth intervention currently used in maternal care. Another gap that is not fulfilled in the data are the current uses of mobile phones among the populations to assess their level of digital literacy. Without this sound evidence, it is hard to predict if RoadMApp will integrate into the lives of the community - especially those in rural areas.

The three-delays model

The issues raised above in this discussion can be related to Thaddeus and Maine's three delays model. This model influences the provision of maternal services by looking into factors such as: (a) delay in deciding to seek care if a complication occurs; (b) delay in reaching care, and (c) delay in receiving care (41,42). This paper only touches on the first two delays, as the last delay may be met at the health centre level. The RoadMApp mHealth tool ideally handles the first two delays through strategies for BPCR that cover the woman's choice to be attended by skilled birth attendants, place of delivery, preparation of essential items for delivery and arranging access to funds and means for emergency transport (42). Hence, RoadMApp must be integrated into ANC programmes from clinics/hospitals as measures are put in place to intervene in the three-delay model.

Conclusions

Most parts of rural Kwekwe have long distances to health facilities and an inefficient road and telecommunications network. As a result, pregnant women and their caregivers travel long distances, pay more money for travel and cannot access telecommunications to access healthcare. Despite the community's awareness of these barriers, there is a lack of preparation for child birth and weak support in cases of emergencies. Hence, it is hard to predict if RoadMApp will integrate into the lives of the community - especially those in rural areas. Since all these issues are pillars of in the design of the RoadMApp mHealth intervention in Kwekwe, the implementation is likely to be challenging.

An understanding of the local context where the RoadMApp mHealth intervention will be implemented is fundamental. It will be prudent to factor in all these issues in the later stages of the project as it can impact its results. It is possible that the project may have many positive results, however, the local context where it is being applied has several barriers. Therefore, assessments should move beyond quantitative indicators, and rely more on qualitative indicators such as case studies of people whose lives change through this mHealth intervention. This is because of some of the quantitative indicators (i.e. effect of maternal mortality and reducing morbidity), may take a long time to emerge beyond the project's time.

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Availability of data and materials

The corresponding author can avail the data when requested.

Authors' contribution PTM : conception, development of data collection tools, data analysis and drafting of manuscript, ZNJ, development data collection tools, collection, analysis and drafting the manuscript, LM, development of data collection tools, data analysis and drafting of manuscript, NN; development of data collection tools, data analysis and drafting of manuscript, ID data collection tools, data analysis and drafting of manuscript, LC, data analysis and drafting of manuscript, YD development of data collection tools, data analysis, MV, reviewing of several drafts of the manuscript. All authors have read and approved the final version of the manuscript and they have contributed to its content.

Ethical declarations

Ethics clearance was granted by the Midlands State University Institutional Review Board, Medical Research Council of Zimbabwe (Ref No: MRCZ/A/246) and permission to conduct the study was obtained from Ministry of Health, Provincial and District Medical Directors, Health staff in charge of local health facilities, Local authorities, Chiefs and local leadership and all participants. The purpose of the study was explained to all the participants and informed consent both verbal and written was given by all the participants without coercion. Consent to use an audio recorder to capture proceedings of the discussions was sought by the researchers. Data collected was anonymised to ensure confidentiality. Refreshments were served after the discussions.

Competing interests

The authors declare that they have no competing interests.