ree

ORIGINAL ARTICLE

Development of a mobile application to support the Community Health Workers in assisting the mother-newborn dyad during home visits*

Desenvolvimento de aplicativo móvel para apoio ao Agente Comunitário de Saúde prestar assistência ao binômio mãe-neonato na visita domiciliar

Paolla Furlan Roveri[1] ⓘ, Bianca Machado Cruz Shibukawa[1] ⓘ, Camila Moraes Garollo Piran[1] ⓘ,
Marcela Demitto Furtado[1] ⓘ, Maria de Fátima Garcia Lopes Merino[1] ⓘ, Ieda Harumi Higarashi[1] ⓘ

ABSTRACT

Objective: to develop a mobile application to support the care practice of the community health workers (CHWs) with the mother-newborn dyad. **Methods:** a methodological study was conducted with the CHWs in a city in the countryside of the state of Paraná. The three phases recommended by the Human-Centered Design were used, involving 280 CHWs in the first phase and testing of the pilot application with 73 participants, representing the 74 Family Health Strategy teams. The final evaluation of the application and intervention took place in two focus groups, with the attendance of 21 professionals. **Results:** based on the identification of the professionals' main needs for assistance to the mother-newborn dyad, the archetype of the pilot application was derived and configured in 55 screens, contemplating the guidelines of the Mother Network Program of Paraná (in Portuguese, *Programa da Rede Mãe Paranaense*). The potentialities of the application include feelings of confidence and reassurance of security regarding the information and conduct, through the support offered by the application, and easier illustration of the guidelines to the puerperal woman with the use of the resources provided by the application. **Conclusion:** the study demonstrated the system's feasibility, acceptability, and usability based on mobile health (mHealth) as support for the community health agent's work with the mother-newborn dyad.

Descriptors: Telenursing; mHealth; Community Health Workers; Infant, Newborn; Primary Health Care.

1

Rev. Eletr. Enferm., 2022; 24:70509, 1-12

RESUMO

Objetivo: desenvolver um aplicativo móvel para suporte à prática assistencial do agente comunitário de saúde (ACS) junto ao binômio mãe-neonato. **Métodos:** estudo metodológico, desenvolvido junto aos ACS de um município do interior do estado do Paraná. Foram utilizadas as três fases preconizadas pelo *Human-Centered Design*, envolvendo a população de 280 ACS do município na primeira fase e testagem do aplicativo piloto, com 73 participantes representando as 74 equipes Estratégia Saúde da Familia. A avaliação final do aplicativo e da intervenção se deu em dois grupos focais, com a participação de 21 profissionais. **Resultados:** com base na identificação das principais necessidades dos profissionais para atendimento ao binômio mãe-neonato, derivou-se o arquétipo do aplicativo piloto, configurado em 55 telas, contemplando as diretrizes da Linha Guia da Rede Mãe Paranaense. Dentre as potencialidades do aplicativo se destacaram, o aumento do sentimento de segurança em relação às informações e condutas, por meio do suporte oferecido pelo aplicativo, e a facilidade em ilustrar as orientações à puérpera com uso dos recursos disponibilizados pelo mesmo. **Conclusão:** o estudo demonstrou viabilidade, aceitabilidade e usabilidade do sistema baseado na *mobile health* (*mHealth*) como suporte à atuação do agente comunitário de saúde junto ao binômio mãe-neonato.

Descritores: Telenfermagem; mSaúde; Agentes Comunitários de Saúde; Recém-Nascido; Atenção Primária à Saúde.

INTRODUCTION

The early neonatal period is considered a phase of great vulnerability and risks for newborns. Neonatal deaths, which occur in the first 28 days of life, represent 47% of all mortality of children under five years of age[1]. In Brazil, the avoidable neonatal mortality rate has been decreasing in recent decades, from 10.98 to 6.76 per thousand live births between 2000 and 2018[2]. Despite this improvement, this indicator remains high, demonstrating that it is necessary to further advance the care provided to newborns in this period, as most of these deaths could be avoided with early and quality health care[3].

In this sense, to reduce the number of neonatal deaths from preventable causes and promote humanized and holistic care to the mother-newborn dyad and monitoring in the first days of life, the World Health Organization (WHO) launched, in 2014, the strategy "EVERY NEWBORN - An Action Plan To End Preventable Deaths" [3]. The importance of such a strategy was ratified in 2017, through the report "Reaching the every newborn national 2020 milestones - country progress, plans and moving forward"[4].

The WHO report addresses the low-cost experiences adopted in more than 50 countries with great potential for improving the quality of health care and reducing neonatal mortality. Some suggestions include expanding the competencies of community health workers (CHWs) to meet service and care needs for the survival of newborns; the use of mobile health (mHealth) to support CHWs during postpartum home visits; and home visits to newborns in the first week of life to ensure the early identification of possible aggravations and risk situations[4].

From this perspective, the third edition of the Brazilian National Primary Care Policy (in Portuguese, *Política Nacional de Atenção Básica* - PNAB), also launched in 2017, defined new guidelines for primary care and the expansion of the CHW functions, such as identifying suspected cases of diseases and illnesses, especially in the most vulnerable individuals, as in the case of newborns, and referring them to the reference health unit; recording and notifying the fact to the local health authority; and providing guidelines to the community about symptoms, risks, and disease transmission agents, and individual and collective prevention measures[5].

However, despite the increased responsibilities of CHWs proposed by the WHO report and the PNAB, the care provided by these professionals is often deficient or incomplete due to the lack of knowledge, skills, and sufficient training to offer adequate support to the population. For this reason, in several countries around the world, research has been developed to strengthen and support the care practice of CHWs through the use of mHealth[6]. This term defines the use of mobile devices, such as mobile phones and tablets, with applications installed for health purposes[7]. Most of these technologies comprise an interface between the device and the health professional through the use of installed or downloaded applications (apps) in the devices.

For the creation of these applications, the Human-Centered Design method has been widely disseminated as a guideline, especially in environments with few health resources and low literacy levels, as it involves the participation of the target audience throughout the creation process, from content creation to the final appearance of the application, thus ensuring greater precision regarding the real needs of users[8]. Although this design is used by health care scenarios plagued by a shortage of resources, as in African countries, and international studies reporting such experiences[6], there are limited studies that have focused on the development of applications for CHWs in Primary Health Care (PHC) caring for newborns.

In this regard, the aim of this study was to develop an application using the Human-Centered Design method to strengthen the care practice of community health agents towards the mother-newborn dyad.

2

Rev. Eletr. Enferm., 2022; 24:70509, 1-12

METHOD

Study design

This is a methodological and participatory study involving CHWs in PHC in the scenario of their practice in neonatology.

Site and period of study

The study was conducted in the city of Maringá, Paraná, in the Southern Region of Brazil, from June 2018 to March 2019. The municipality of Maringá, which is the headquarters of the 15th Health Regional Office of Paraná, had an estimated population of 436,472 inhabitants in 2021 (https://cidades.ibge.gov.br/brasil/pr/maringa/panorama), a per capita gross domestic product (GDP) in 2019 of BRL 45,582.78, and an HDI in 2010 of 0.808 (https://cidades.ibge.gov.br/brasil/pr/maringa/panorama). Also, according to the Index of Municipal Management Challenges (IDGM), the basic health care coverage in the city is 80% (https://desafiosdosmunicipios.com.br/resultados.php#section_saude).

Population

The study population consisted of the total number of CHWs in the municipality's PHC at the time of the study, totaling 280 professionals.

Eligibility criteria

Community Health Workers were considered eligible to participate of the study if they were employed as a CHW for at least one year, acting as a member of one of the 74 Family Health Strategy (FHS) teams in the municipality linked to the Municipal Health.

The professionals who were on vacation or leave, or who were not on field work were considered ineligible for participation in the study.

After applying the criteria, all CHWs who fulfilled the inclusion criteria were invited to participate in the study, totaling 280 workers in the phases 1 e 2, and 73 in the phase 3 of the application test.

Methodological approach

The methodological path of this research was outlined according to the Human-Centered Design method, in which the development of an application initially involves identifying and understanding the needs, desires, and behaviors of final users to create a solution that is truly applicable to their reality[9].

The Human-Centered Design method consists of three phases of interaction and iteration with the target audience: inspiration phase, which involves learning directly from the people for whom the application is designed through immersion in their lives/realities and fully understanding their needs; ideation phase, in which previous discoveries are more profoundly understood, thus identifying and creating opportunities for configuring prototypes for testing; and the implementation phase, in which the prototypes are tested to identify the difficulties, potentialities, and feasibility of implementing the solution in reality[9]. In this study, the target audience was represented by the CHWs who provide care to mother-newborn dyad.

Thus, the design process of the application was divided into three phases proposed by the Human-Centered Design.

1) Inspiration Phase

It was developed through "conversation circles" involving 280 CHWs that worked in the 74 FHS units over this study to present the research project and learn about the reality of their work in each team. The "conversation circles" focused on the professional experiences of working with the mother-newborn dyad, which were recorded in a field diary.

2) Ideation Phase

A pilot application was constructed based on the survey of care demands identified in the "conversation circles" during the inspiration phase. In addition to the demands reported by the professionals and considering the concept of the application as a source of consultation and technical-scientific support for care, the assumptions established by the Mother Network Program of Paraná[10] were used as the main guideline for care and source of information. Thus, the research adopted a participatory, constructivist educational perspective based on the realities of the learners (CHWs), based on the current public policies in the specific area of maternal and childcare.

In the end of "conversation circles", each FHS team chose a CHW to represent the team and to participate in the next phase of research. In one of the teams, none of the CHWs were interested in participating in the next phase, which meant that the pilot test phase of the application's prototype was representative of all teams, with exception of this one.

3) Implementation Phase

It was developed in two different moments. The first moment aimed to test the pilot prototype application (app) by CHWs, and the second to present the application usage feedback to them.

The prototype testing involved one representative from each FHS team, totaling 73 (73/74) CHWs, which were indicated by the team itself over the first phase (Inspiration Phase). There was no representation from one of the teams because nobody expressed interest in participating in this phase. The prototype was tested during home visits to newborns (approach from the perspective of the mother-newborn dyad), through non-participant observation. The

3

Rev. Eletr. Enferm., 2022; 24:70509, 1-12

observation process was organized to contemplate facilitators and barriers related to three aspects during the use of the *app*: theoretical and scientific; operational and interface; sequencing of the home visit. Observations were recorded in a field diary.

The feedback on the application's usage included evaluating its final version and the usability and experience of participation in its collective construction. The feedback was gathered through two focus groups (FG), which lasted for an average of two and a half hours at the facilities of the Universidade Estadual de Maringá. All 73 CHWs involved in testing the prototype were invited; however, only 21 attended, separated into two different FGs, one with 16 participants and another with five. During the FG the researchers presented the prototype using a slideshow that highlighted the changes and improvements implemented based on the participants' suggestions during the second phase. Also, they presented the observation results about the use of the prototype listed during home visits listed over home visits, discussing possible necessary modifications to improve the pilot application to finalize the model. The FG sessions were recorded in audio and observations in a field diary by the researcher and two research assistants.

Treatment and analysis of data

All observations produced during the three phases, recorded in a field diary and recorded audios produced during the FGs were transcribed to the Word software (Microsoft Office), version 2010, developed in the United States of America. The descriptive analysis of the whole process were based on the Human-Centered Design theoretical framework[9].

Ethical aspects

The study was developed according to the provisions of Resolution No. 466/12 of the National Health Council and approved by the Standing Committee on Ethics in Research Involving Human Beings of the institution (CAAE: 91236218.6.0000.0104, Report No. 2.751.464).

RESULTS

The results were organized into thematic categories according to the developed methodological phases, as follows:

1) Inspiration Phase - "Conversation circles": getting to know the experiences of Community Health Workers in caring for the mother-newborn dyad and the use of mobile health".

2) Ideation Phase – "Building together: creating an application to assistance to the mother-newborn dyad based on the needs of Community Health Workers".

3) Implementation Phase – "Pilot testing of the prototype application: health care to the mother-newborn binominal in the home visit using the mobile health"; and "Feedback from Community Health Workers to build the final application".

Conversation circle: getting to know the experiences of Community Health Workers in caring for the mother-newborn binominal and the use of mobile health

Each meeting with the FHS teams consisted of two moments: a presentation of the study and conversation circles with the CHWs to know about their experiences in neonatal care and the possible previous use of mHealth. In this phase was possible to outline the daily work routine of the CHWs, with emphasis on home visits to newborns to describe the activities performed during the visit, to identify the existence and completion of any form, as well as its content, to apprehend the guidelines usually accomplish during the home visits and the most frequent doubts of the CHWs in their approach and care for newborns.

During the conversation circles, the use of tablets was identified in the daily work of some FHS teams units of the municipality to facilitate and improve the work of CHWs. The implementation was not successful and the CHWs evaluated the experience as negative. Some points mentioned by CHWs for the failure of the initiative included problems related to the infrastructure of the units, difficulties in handling the tablet, and bureaucratic requirements.

The problems related to infrastructure were mostly lack of network coverage and difficulties in accessing the Wi-Fi signal in some health units. Another obstacle pointed out was the lack of interoperability between the application installed on the tablet and the computer software.

Regarding the difficulties attributed to handling the equipment, the CHWs mentioned that the size and weight of the tablet were inadequate for storing and carrying the device in the bag, generating insecurity about the risk of theft. They also mentioned the low battery life of the device for work, lack of synchronization with the Wi-Fi of the units, requiring upload data using a cable or retyping data into the computer.

Regarding the bureaucratic issues, the CHWs stated the duplicity of records, since the use of the tablet did not eliminate the need for records on paper. Moreover, to prove they had completed the home visits, they needed to collect the signatures of the people they visited, which required them to take other instruments and paper forms since the application did not have a field for signatures. Because of all these barriers, the CHWs eventually stopped using the application on tablets.

A CHW that had experience with another application installed on her mobile phone for the home visits reported that even though the pilot prototype application contained

4

Rev. Eletr. Enferm., 2022; 24:70509, 1-12

all the forms that should be filled out by CHW during visit, it did not include any informative text to clarify doubts. When there were doubts, the CHW consulted the internet pages or protocols of the Ministry of Health that were downloaded to his cell phone. In front of these problems, the CHW commented the following:

It would be great if there was an application that had both things together, the forms that we have to fill out along with some guidelines. CHW 56

Building together: creating an application to assistance to the mother-newborn dyad based on the needs of Community Health Workers

The forms used by the CHWs to collect data during the home visits to newborns were not standardized. Thus, to compose the theoretical content of the application, it was agreed with the CHWs in the conversation circles that the forms used in the visits would be standardized, based on the guidelines of the Mother Network Program of Paraná [10].

This document proposes the following aspect to be addressed by CHWs on the first visit to newborns: accomplishing the home visit up to the fifth day of birth of the newborn; checking the general condition of the child, watching the presence of jaundice and danger signs such as: moaning, vomiting, pain during handling, bulging fontanelle, secretion in the ear or umbilical scar, lethargy, fever (axillary temperature > 37.5ºC), hypothermia (axillary temperature < 35.5ºC), respiratory rate > 60mpm and convulsions; guidance about breastfeeding; guidance about the puerperium consultation and follow-up of the baby, until the 10th day after birth at the Basic Health Unit; guidance about umbilical stump care and hygiene; evaluating the child's screening card and collect data about: a) Apgar score; b) Guthrie test, bloodspot screening test, ear, tongue, and heart screening tests, and Ortolani maneuver; and c) apply vaccines scheduled at birth: BCG (against tuberculosis) and Hepatitis B[10].

These data collected by the CHWs include all the information they need to provide care to newborns, such as the risk classification and the protocol they must follow in situations of risk and problems identified during the visits [10].

Such demands helped determine that an application archetype for CHWs during neonatal care should include the following: a script of questions for data collection related to the newborn, conceptual frameworks and tables, informative texts containing well-founded guidelines, care flowcharts, newborn risk classification, and images of situations commonly found during visits for easier identification by the CHWs. The use of georeferencing as a form of proof of the home visits was discarded, and the CHWs preferred that a digital signature field be adopted. Figure 1 exemplifies some of the 55 screens of the pilot application, covering the 20 guidelines established by the Mother Network Program of Paraná.

The application was developed from the Commcare® online platform[11], which is a customizable open-source mobile platform that allows non-programmers to create applications for mobile devices with open-source operating
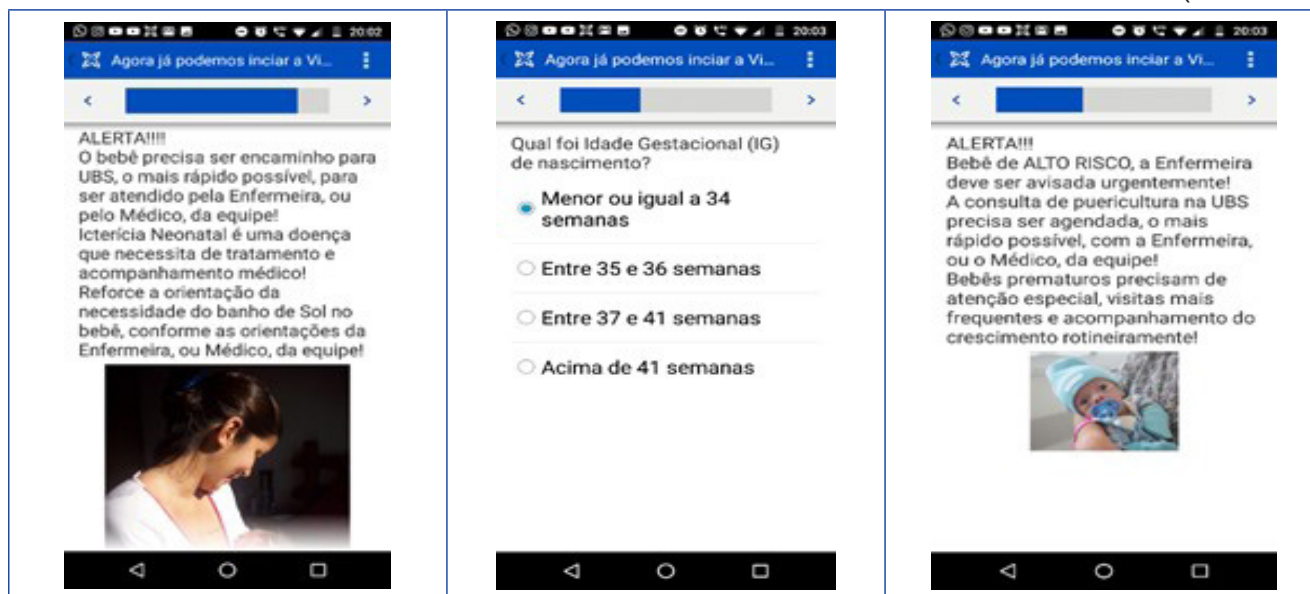
Figure 1. Screenshots of the interface of the pilot application for newborn care by community health workers, Maringá, PR, 2019

5

Rev. Eletr. Enferm., 2022; 24:70509, 1-12
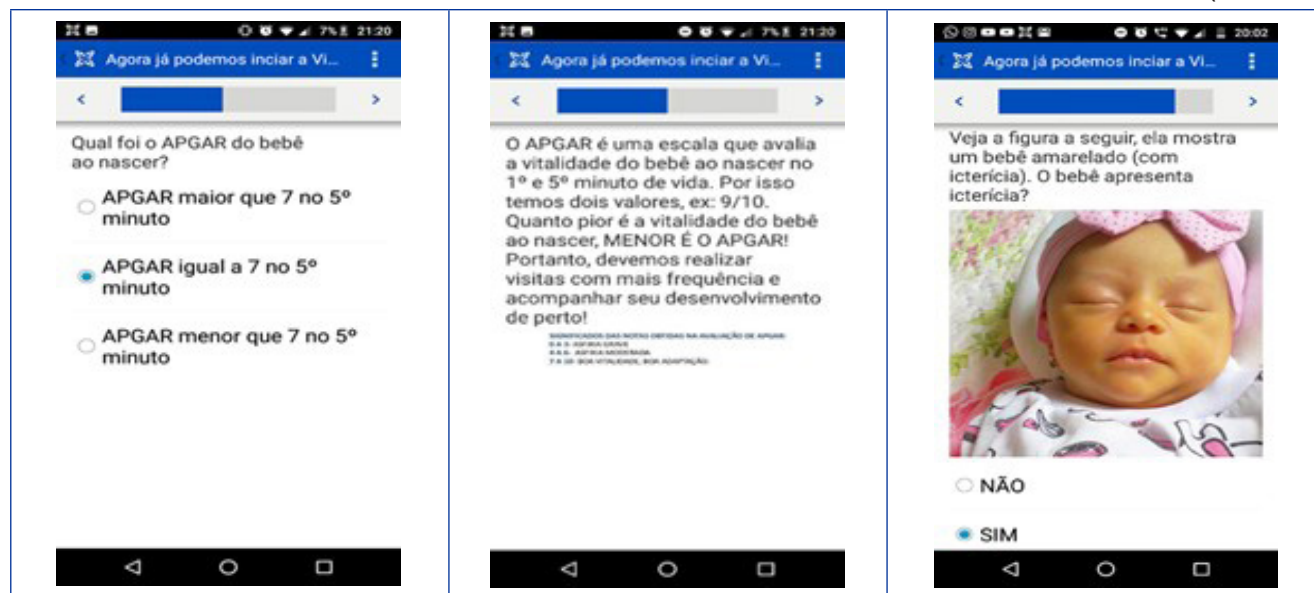
Figure 1. Screenshots of the interface of the pilot application for newborn care by community health workers, Maringá, PR, 2019

(conclusion)

Source: Elaborated by authors.

Note: The app was developed in Portuguese. The translations were presented to favor the reader comprehension in English.

Screen 1 (top left)	*Screen 2 (top center)*	*Screen 3 (top right)*
What was the APGAR level of the baby when he/she was born? ( ) APGAR higher than 7 at the 5th minute/ (x) APGAR equals to 7 at the 5th minute/ ( ) APGAR lower than 7 at the 5th minute.	APGAR is a scale that evaluates the baby's born vitality at the 1st and 5th minutes of life. That is why there are two factors, e.g.: 9/10. The worst the baby's vitality the shortest is the APGAR. Therefore, the home care visits must be frequent to follow the baby's development closer.	Look at the following picture of a yellowish baby (baby with jaundice). Does the baby have jaundice? ( ) No/ (x) Yes.
Screen 4 (bottom left)	*Screen 5 (botton center)*	*Screen 6 (botton right)*
WARNING! The baby must be transported to a health care medical center to be assisted by a nurse or doctor. Newborn jaundice is a disease that requires treatment and doctor follow-up! Reinforce the orientation for the baby sunbath need, under the nurse's or doctor's orientation.	WARNING! The baby is in high risk; the nurse must be immediately notified. The childcare appointment needs to be scheduled as soon as possible. Premature babies need special attention, frequent home care visits and growth follow-up.	What was the birth gestational age (AG)? (x) Equal to or less than 34 weeks ( ) Between 35 and 36 weeks ( ) Between 37 to 41 weeks/ over 41 we

systems, such as Android phones. They can be used for a variety of functions, such as data collection, counseling, promoting behavior change, and other activities.

Pilot testing of the prototype application: health care to the mother-newborn binominal in the home visit using the mobile health

To install the app on the CHWs' mobile phones, as well as upload the data after the home visit, a connection with an internet network was needed. However, internet access was not necessary during the home visit because the app could work in an offline mode. After the installation, a brief training was conducted with the CHWs to familiarize them with the interface, the content, and the commands, and understand overall use.

Of the 73 home visits with each of the 73 participants in this phase of the study, 59% had to be carried out using the researcher's mobile phone. Therefore, some CHWs (18%) reported setbacks with the application interface, such as

6

Rev. Eletr. Enferm., 2022; 24:70509, 1-12

difficulties to type on the buttons and use the touch screen, as well as difficulties to read the questions and informative texts. Most CHWs, 82%, had no problems interacting with the application.

In 66% of home visits performed, the CHWs read the informative texts to the mother to guide and reinforce the correct conduct to be followed in some of the encountered situations, as in the case of breast fissures:

Look, here the application shows you how to treat the fissures [...]. CHW 20

Pictures were used in 52% of the home visits and served to support decision-making when comparing the situation observed during the visit with the situation in the app, as well as to provide examples emphasizing the guidelines provided to the mother. The use of images was extremely useful to demonstrate the care with newborn over sunlight and with the umbilical stump, as stated below:

Leave the breast uncovered when you go sunbathing, it can be right here in the house, just like in the picture, can you see it? CHW 02

Are you bathing the baby every day and cleaning the navel? Look at the picture, is the navel like this? CHW18

In 27% of the visits, the CHWs had difficulties related to the lack of knowledge of scientific concepts and terminology, such as exclusive breastfeeding (EBF) and jaundice. Thus, the information was not sufficient for the CHWs to feel confident when evaluating the newborn and making decisions in the observed situations, as shown below:

If the baby is only breastfed, then is he on EBF? If the baby is only breastfed, then the answer is yes. I don't know what to answer, I think so. CHW 7

The newborn seems to be latching correctly like the baby in the picture, did you see it? I can't tell because he may be choking while feeding. I think that the best thing is to take him to the clinic because then the nurse can see him and guide him better. CHW 12

In summary, this testing phase of pilot application revealed, in addition to the application's operation issues, some obstacles to be overcome for the future implementation of the product in the municipality, such as infrastructure difficulties, which include the availability of an efficient internet network; problems related to interoperability to ensure proper communication and data recording of the provided care; and the lack of regular and continued health care training on neonatal care for CHWs.

Feedback from Community Health Workers to build the final application

In the FGs, the application screens and the aspects or care elements observed during use were shown to the CHWs so they could discuss and give their opinion on each screen/ situation. Therefore, the CHWs' suggestions regarding operational and interface aspects (form) and theoretical elements (content) were organized to support the collective construction of the final application. The following table has a didactic purpose and shows the findings of the feedback *of* the CHWs in two independent columns (Chart 1).

The CHWs reported a feeling of lack of confidence in the mothers regarding the guidelines they provided, which stresses

Chart 1. Suggestions made by the CHWs regarding operational and interface aspects and theoretical-scientific aspects for the construction of the final application "Community Health Worker support guide for care to mo- ther-newborn dyad ", Maringá, PR, Brazil, 2019

(continue)

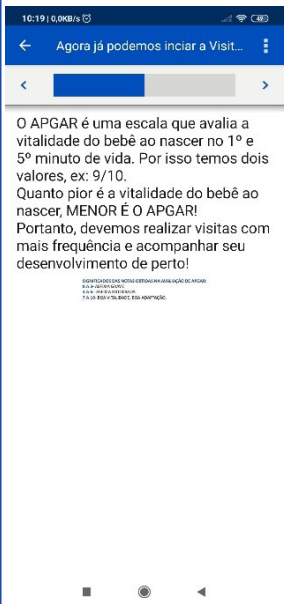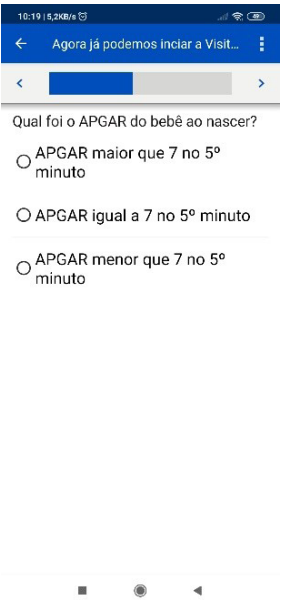| Operation and interface aspects (Form)	Theoretical and scientific aspects (Content)
Installation and availability of Wi-Fi in all health units.	Use simple language rather than scientific terminology, for example, use "yellow baby" rather than "baby with jaundice"
Use of a mobile device that is easy to carry and handle, with long battery life, like a mobile phone.	Use of clearer and more comprehensive supporting texts. They suggested avoiding scientific terminology
Inclusion of the option "others" to allow the CHW to write or add items to the questions.	Inclusion of the note command in the app, "Note this item on the newborn screening card" or "You can find this information on the newborn screening card"
Use of a scroll bar in all input fields that require numbers, replacing calendar or multiple choice questions.	Inclusion of the bibliographic reference or sources in supporting texts, e.g. "the Ministry of Health advises that...".

7

Rev. Eletr. Enferm., 2022; 24:70509, 1-12

Chart 1. Suggestions made by the CHWs regarding operational and interface aspects and theoretical-scientific aspects for the construction of the final application "Community Health Worker support guide for care to mother-newborn dyad ", Maringá, PR, Brazil, 2019

(conclusion)

Operation and interface aspects (Form)	Theoretical and scientific aspects (Content)
Maintain the electronic signature option instead of collecting the fingerprint, photo, or geotagging the patient.	Inclusion of brief explanations and concepts, such as Exclusive Breastfeeding, Newborn Screening, complications of labor, and Ortolani Maneuver.
Keep the white background and buttons in a dark color (preferably blue).	Insertion of short explanations about atypical situations, such as "absence of BCG vaccine scar on baby's arm" or "bath every other day for premature baby or extremely low birth weight ".
Keep questions in dichotomous and multiple-choice questions, avoiding the use of screens with many alternatives.	Change in the wording of some questions, such as, "Have any newborn screening tests been positive?", "Have any newborn screening test results changed?"
Regarding the sequence of screens in the application, change/alter the sequence, for example, first the explanation screen and then the data collection screen, such as in APGAR.	
Before:	After:	

Note: CHWs -Community Health Workers; BCG – Bacillus Calmette-Guérin.

The app was developed in Portuguese. The translations were presented to favor the reader comprehension in English. The text related he first figure means: The APGAR is a scale that assesses the baby's vitality at birth in the 1st and 5th minute of life. Thus, we have two values, for example: 9/10. The worse the baby's vitality at birth, THE LOWER IS THE APGAR. Therefore, we must carry out visits more frequently and monitor its development closely.

Source: Elaborated by authors.

the importance of the application as a source of consultation and support during the provision of care, as described below:

The mother often doubts what we say, because we are CHWs. So, having something that helps us provide these guidelines helps us to have more trust in the mother, especially if we can show her. CHW 14

Another request from the CHWs was the replacement of some figures with "more real" images frequently found in their daily work to draw attention to what was being observed, according to repost below:

8

Rev. Eletr. Enferm., 2022; 24:70509, 1-12

I think this figure had to be changed because we see very damaged breasts, and here the fissure is minimal! In some people, we even see blood on them! CHW 1

After testing the prototype in the care setting as well as surveying the participants' demands and suggestions, it was possible to Implement all the changes related to the theoretical-scientific aspects (content). Regarding the operational and interface changes (form), all aspects related to the configuration of the application were adequate. However, suggestions related to the structural aspects of the service, concerning the availability of an adequate Wi-Fi network in the Basic Health Units, as well as smartphones for the CHWs, and the guarantee of interoperability (application and network information system of the health secretariat) depend on the availability of resources and infrastructure by the municipal management.

DISCUSSION

The various phases of the study initially provided insight into the demands or needs of CHWs when providing care to mother-newborn dyad. This was supported by the participatory construction of the prototype and its testing and evaluation in the care scenario. The previous experience of health workers with mHealth in tablets also provided elements for the development of more effective strategies for the considered reality.

The method adopted in this research project confirms the idea that, when starting a mHealth implementation project, developers should plan together with its end-users, to avoid investments and public expenses with very low chances of adherence and success. The election of the mobile phone as the most viable technological device, for example, was based on studies that describe the CHWs' preference for the use of mobile phones[12-14].

Decision-making based on scientific evidence and each specific reality is a determining element for the success of the implementation of mHealth, justified by the choice of a device with a longer-lasting battery, which is lighter and easier to carry, and which enables access to the internet, making calls and sending messages[15].

As well as the considerations regarding the mobile device to be used, it is essential to consider the characteristics and content of the application that will be installed, which would ensure it is adapted to the context for which it is being created and relevant to the users. The application developer will need to rely on user participation, become familiar with their reality, understand their needs, and discover the potentialities and weaknesses of the device from the evaluation and previous experience of these users[16].

The application creation phase with the involvement of the end-user is essential to ensure individuals can develop a greater affinity with the device and a sense of co-responsibility and commitment to what is being created[17]. Moreover, they can view themselves as participants in this construction process, which will impact adherence and future use of the application in their daily work[18].

In a multinational study conducted in Africa, CHWs reported feelings of appreciation and increased self-esteem when they could talk and be heard by their supervisors[19]. The operational and interface aspects that transcended the possibility of adjustments to the application, such as the availability of adequate Wi-Fi network in the Basic Health Units, smartphone devices for the CHWs, and the interoperability of the application with the information system used in the health secretariat, stress the importance of management in the implementation of any proposals for the innovation and qualification of care.

In this regard, interoperability, a term often discussed by developers, means the ability of various systems, organizations, and software to communicate and work together (interoperate), and has been a major obstacle in the implementation of mHealth projects[20]. Interoperability issues often arise when software does not "dialog" with another, as observed in this study. The electronic medical record of users installed on the computers of the municipality's health units did not allow the pilot application to access the system, making it impossible to upload the collected data, which eventually generated the need to copy and paste the information from the application to the electronic medical record. The problem related to interoperability has been discussed worldwide and alternatives are being studied to try to solve this issue [21-22].

Regarding the need for regular training of CHWs, it should be noted that this observation reiterates the premise that any technological device is never a final or definitive solution to the difficulties of care. They are innovative elements with a supporting role in the qualification of care and may greatly facilitate the provision of care. However, education must always be provided together with the use of applications, jointly with the continued evaluation of these initiatives.

Continuing education is especially justified in PHC when considering the workforce represented by CHWs who, as individuals who establish a close link with users and are often from the same community, also present important learning needs due to the lack of specific training in health care[23]. Thus, it is necessary to associate the implementation and use of mHealth with regular training and periodic supervision to improve the care provided by CHWs to mothers and newborns.[24]

Based on the FG feedback from the CHWs and the observations made in the field, it was found that the use of

9

Rev. Eletr. Enferm., 2022; 24:70509, 1-12

this application, "Community health worker support guide for care to mothers and newborns", based on the premise of mHealth, increased the self-confidence of the CHWs during decision-making and interaction with mothers. Similarly, the mothers felt more confident regarding the guidelines and demonstrations. These improvements were also observed in a study conducted in Tanzania, where mothers assumed that the guidance on the app had been sent from an authorized medical source, which led them to believe that the messages provided by the CHWs were more legitimate and reliable[25]. The practical implications of this support for the work of CHWs are that it contributes to the continuing education of these professionals and optimizes decision-making for referral of assistance situations.

The steps proposed by Human-Centered Design method revealed the items the CHWs would like to find in the application, based on a diagnosis of the care scenario of these workers. In this way, joint planning based on the real demands of the end-users should be supported and would increase the chances of success and adherence to the proposal[9].

Due to financial limitations, lack of support from the developer team, and time restrictions, the application was tested with only one CHW from each FHS. The concession of the Commcare® platform by the owners for extended use (release for use in 73 devices), free of charge, during the two years of the research, was essential for a more comprehensive diagnosis of the reality of care in the municipality. From this perspective, the collective construction process of the pilot application (or application archetype) and the participatory field research now serve as a starting point for the implementation of the final application, with the possibility of reformulations and modifications according to the emerging needs of care. In the field of health informatics, an application archetype is a model or set of screens with the complete developed content, and which enables its replication in other bases, in addition to the Commcare® platform (https://www. commcarehq.org/accounts/login/), in which it was designed. The complete content of the application, as well as the description of its functionalities, are included in the full version of the master's thesis, from which the present study was derived.

The small participation of CHWs in the final evaluation phase of the pilot application may be a limitation for the generalization of results to other healthcare realities in other regions.

The granting of free use of the Commcare® platform up to a maximum of five mobile devices may represent a hindrance to more extended use due to the implication of costs to the health system. However, release for research and non-profit purposes can be requested and obtained, as occurred in the present study. Finally, operational and cost aspects, especially regarding the guarantee of infrastructure (Wi-Fi network and devices) and interoperability, depend exclusively on a closer look at the management and its interest in investing in technological innovation as a strategy for quality care.

Although this proposal attracted great interest from the manager at the time of its development, a positive evaluation, as well as the surveying of scientific evidence regarding the usability of this apparatus, is essential to raise awareness of the municipal management and enable its large-scale implementation in the municipality's PHC network.

CONCLUSION

The study demonstrated the feasibility, acceptability, and usability of a model or application archetype based on mHealth as a tool to support CHWs in caring for mothers and newborns, considering that the participatory construction of the pilot comprised almost all (98.6%) of the FHS teams of the municipality in question. This is an innovative resource in the learning process of CHWs in practice, aimed at the qualification of maternal, newborn, and child care in PHC.

The Human-Centered Design method ensured the protagonism of the end-user, represented by the CHW in the construction of the technological solution, from the diagnosis of learning needs for the specific practice and testing and reformulating the application, to the presentation of a final product model for use on a larger scale.

The construction of a technological application based on the guidelines of the Mother Network Program of Parana as support for the CHWs in their care and assistance in the neonatal period is an important resource for the constant qualification of care.

REFERENCES

1. Muhe L M, McClure EM, Nigussie AK, Mekasha A, Worku B, Worku A, et al. Major causes of death in preterm infants in selected hospitals in Ethiopia (SIP): a prospective, cross-sectional, observational study. Lancet Glob Health [Internet]. 2019 [cited 2022 Dec 28];7(8):e1130-8. Available from: https://doi.org/10.1016/S2214-109X(19)30220-7

2. Prezotto KH, Oliveira RR, Pelloso SM, Fernandes CAM. Trend of preventable neonatal mortality in the States of Brazil. Rev. Bras. Saude Mater. Infant. [Internet]. 2021 [cited 2022 Dec 28];21(1):291-9. Available from: https://doi.org/10.1590/1806-93042021000100015

3. World Health Organization. Every Newborn: an action plan to end preventable deaths [Internet]. Geneva: World Health Organization, 2014 [cited 2022 Dec 28]. Available from: https://apps.who.int/iris/bitstream/handle/10665/127938/9789241507448_eng.pdf

10

Rev. Eletr. Enferm., 2022; 24:70509, 1-12

4. World Health Organization. Reaching the every newborn national 2020 milestones: country progress, plans and moving forward. Geneva: World Health Organization, 2017 [cited 2022 Dec 28]. Available from: https://apps.who.int/iris/bitstream/handle/10665/255719/9789241512619-eng.pdf

5. Portaria nº 2.436, de 21 de setembro de 2017 (BR) [Internet]. Aprova a Política Nacional de Atenção Básica, estabelecendo a revisão de diretrizes para a organização da Atenção Básica, no âmbito do Sistema Único de Saúde (SUS). Diário Oficial da União. 22 set. 2017 [cited 2022 Dec 28];183(seção 1):68. Available from: http://www.in.gov.br/materia/-/asset_publisher/Kujrw0TZC2Mb/content/id/19308123/do1-2017-09-22-portaria-n-2-436-de-21-de-setembro-de-2017-19308031.

6. Tran NT, Portela A, Bernis L, Beek K. Developing capacities of community health workers in sexual and reproductive, maternal, newborn, child, and adolescent health: mapping and review of training resources. PLoS One [Internet]. 2014 [cited 2022 Dec 28];9(4):e94948. Available from: https://doi.org/10.1371/journal.pone.0094948

7. Agência dos Estados Unidos para o Desenvolvimento Internacional. Compêndio mHEALTH. Edição especial 2016: em grande escala [Internet]. Arlington: USAID, 2016 [cited 2022 Dec 28]. Available from: http://www.africanstrategies4health.org/uploads/1/3/5/3/13538666/2016_mhealth_final_cs6_pt_web_version.pdf

8. Holeman I, Kane D. Human-centered design for global health equity. Inf Technol Dev [Internet]. 2020 [cited 2022 Dec 28];26(3):477-505. Available from: https://doi.org/10.1080/02681102.2019.1667289

9. IDEO. The Field Guide to Human-Centered Design. Canadá: IDEO; 2015.

10. Secretaria de Estado da Saúde do Paraná. Linha Guia Rede Mãe Paranaense. 7ªed. Curitiba, PR: SESA; 2018.

11. Fry-Harris H, Beard BJ, Harrison T, Paudel P, Shrestha N, Jha S, et al. Smartphone tool to collect repeated 24 h dietary recall data in Nepal. Public Health Nutr [Internet]. 2018 [cited 2022 Dec 28];21(2):260-72. Available from: https://doi.org/10.1017/S136898001700204X

12. Zakus D, Moussa M, Ezechiel M, Yimbesalu JP, Orkar P, Damecour C, et al. Clinical evaluation of the use of an mhealth intervention on quality of care provided by Community Health Workers in southwest Niger. J Glob Health [Internet]. 2019 [cited 2022 Dec 28];9(1):010812. Available from: https://doi.org/10.7189/jogh.09.010812

13. Hanrieder T, Maray EM. Digitalzing community health work: a struggle over the values of global health policy. Historical Social Research [Internet]. 2021 [cited 2022 Dec 28];46(1):136-59. Available from: https://doi.org/10.12759/hsr.46.2021.1.136-159

14. Odendaal WA, Anstey Watkins J, Leon N, Goudge J, Griffiths F, Tomlinson M, et al. Health workers' perceptions and experiences of using mHealth technologies to deliver primary healthcare services: a qualitative evidence synthesis. Cochrane Effective Practice and Organisation of Care Group, editor. Cochrane Database of Systematic Reviews [Internet]. 2020 Mar 26 [cited 2022 Dec 28]; Available from: https://doi.wiley.com/10.1002/14651858.CD011942.pub2

15. Diese M, Kalonji A, Izale B, Villeneuve S, Kintaudi NM, Clarysse G, et al. Community- based maternal, newborn, and child health surveillance: perceptions and attitudes of local stakeholders towards using mobile phone by village health volunteers in the Kenge Health Zone, Democratic Republic of Congo. BMC Public Health [Internet]. 2018 [cited 2022 Dec 28];18(1): 316. Available from: https://doi.org/10.1186/s12889-018-5186-2

16. Quandt M, Beinke T, Freitag M. User-Centered Evaluation of an Augmented Reality-based Assistance System for Maintenance. Procedia CIRP [Internet]. 2020 [cited 2022 Dec 28];93:921-6. Available from: https://doi.org/10.1016/j.procir.2020.03.053

17. Ferreira MNF, Pinheiro FDC, von Wangenheim CG, Missfeldt Filho R, Hauck JCR. Ensinando Design de Interface de Usuário de Aplicativos Móveis no Ensino Fundamental. Revista Brasileira de Informática na Educação [Internet]. 2020 [cited 2022 Dec 28];28:48-72. Available from: https://doi.org/10.5753/rbie.2020.28.0.48

18. McBride B, O'Neil JD, Trinh TH, Eni R, Nguyen CV, Nguyen LT. Improving health equity for ethnic minority women in Thai Nguyen, Vietnam: qualitative results from an mHealth intervention targeting maternal and infant health service access. J Public Health (Oxf) [Internet]. 2018 [cited 2022 Dec 28];40(suppl_2):ii32–41. Available from: https://doi.org/10.1093/pubmed/fdy165

19. Sanou AK, Jegede AS, Nsungwa-Sabiiti J, Siribié M, Ajayi IO, Turinde A, et al. Motivation of Community Health Workers in Diagnosing, Treating, and Referring Sick Young Children in a Multicountry Study. Clin Infect Dis [Internet]. 2016 [cited 2022 Dec 28];63(Suppl 5):S270-5. Available from: https://doi.org/10.1093/cid/ciw625

20. Satti FA, Ali T, Hussain J, Khan WA, Khattak AM, Lee S. Ubiquitous Health Profile (UHPr): a big data curation platform for supporting health data interoperability. Computing [Internet]. 2020 [cited 2022 Dec 28];102:2409-44. Available from: https://doi.org/10.1007/s00607-020-00837-2

21. Hategeka C, Ruton H, Law MR Effect of a community health worker mHealth monitoring system on uptake of maternal and newborn health services in Rwanda. glob health res policy [Internet]. 2019 [cited 2022 Dec 28];4:8. Available from: https://doi.org/10.1186/s41256-019-0098-y

22. Lee SH, Nurmatov UB, Nwaru BI, Mukherjee M, Grant L, Pagliari C. Effectiveness of mHealth interventions for maternal, newborn and child health in low- and middle-income countries: Systematic review and meta-analysis. J Glob Health [Internet]. 2016 [cited 2022 Dec 28];6(1):010401. Available from: https://doi.org/10.7189/jogh.06.010401

23. Chou VB, Friberg IK, Christian M, Walker N, Perry HB. Expanding the population coverage of evidence-based interventions with community health workers to save the lives of mothers and children: an analysis of potential global impact using the Lives Saved Tool (LiST). J Glob Health [Internet]. 2017 [cited 2022 Dec 28];7(2):020401. Available from: https://doi.org/10.7189/jogh.07.020401

24. Musabyimana A, Ruton H, Gaju E, Berhe A, Grépin KA, Ngenzi J, et al. Assessing the perspectives of users and beneficiaries of a community health worker mHealth tracking system for mothers and children in Rwanda. PLoS ONE [Internet]. 2018 [cited 2022 Dec 28];13(6):e0198725. Available from: https://doi.org/10.1371/journal.pone.0198725

25. Hackett K, Kazemi M, Lafleur C, Nyella P, Godfrey L, Sellen D. 'It makes you someone who changes with the times': health worker and client perspectives on a smartphone-based counselling application deployed in rural Tanzania. Health Policy Plan [Internet]. 2019 [cited 2022 Dec 28];34(4):307-15. Available from: https://doi.org/10.1093/heapol/czz036

12

Rev. Eletr. Enferm., 2022; 24:70509, 1-12