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Dissemination and implementation of the *e-MCH Handbook*, UNRWA's newly released maternal and child health mobile application: a cross-sectional study

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ABSTRACT

Objectives In April 2017, the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA) released the electronic *Maternal and Child Health Handbook,* the *e-MCH Handbook* application. One of the first mobile health (m-Health) interventions in a refugee setting, the application gives pregnant women and mothers access to educational information and health records on smartphones. This study investigated factors associated with the dissemination and implementation of m-Health in the refugee setting.

Setting and participants A cross-sectional study was conducted in 9 of 25 UNRWA health centres for Palestine refugees in Jordan. Self-administered questionnaires were distributed for 1 week to pregnant women and mothers with children aged 0–5 years.

Outcome measures The outcomes were whether participants knew about, downloaded or used the application. Multiple regression analyses were conducted to determine factors associated with application download and usage.

Results 1042 participants were included in the analysis. 979 (95.5%) had a mobile phone and 862 (86.9%) had a smartphone. 499 (51.3%) knew about, 235 (23.8%) downloaded and 172 (17.4%) used the application. Having other mobile applications (OR 6.17, p<0.01), staff knowledge of the application (OR 11.82, p<0.01), using the internet as a source of medical information (OR 1.63, p=0.01) and having internet access at home (OR 1.46, p=0.05) were associated with application download. The age of the husband was associated with application usage (OR 1.04, p=0.11).

Conclusions Though m-Health may be a promising means of promoting health in refugees, multiple barriers may exist to its dissemination and implementation. Those who regularly use mobile applications and get medical information from the internet are potential targets of m-Health dissemination. For successful implementation of a m-Health intervention, health staff should have thorough knowledge of the application and users should have access to the internet. Husband-related factors may also play a role.

Strengths and limitations of this study

- This study is one of the first to evaluate factors associated with the dissemination and implementation of mobile health interventions in the refugee setting.
- A limitation of this study is that technical barriers like the unavailability of the mobile application on the iPhone was not taken into account in the regression analysis of application download.
- The questionnaires were distributed only to pregnant women and mothers who attended a health centre during the study period and therefore may not have been fully representative of the study population.

INTRODUCTION

In 2015, over 300 000 women died during or soon after delivery of a child.[1] Wide disparities in maternal mortality rate exist between and within regions and countries, and the risk remains especially high in the developing parts of the world.[2] The United Nations' Sustainable Development Goals (SDGs) has also highlighted the importance of reproductive, maternal, newborn and child health.[3] Adequate access to maternal and child health (MCH) care is pivotal for progress towards the ambitious SDG 2030 target, and one way of achieving this is to incorporate novel technologies in MCH practices.

Examples of such novel technologies are electronic heath (e-Health) and mobile health (m-Health). e-Health serves as a means of strengthening of health systems and has helped reinforce fundamental human rights by promoting increased equity, solidarity, quality of life and quality of care.[4 5] e-Health is also a cost-effective and secure method of communication that supports healthcare services, health education, and research.[6 7] m-Health, whose utilisation has

increased globally in the 21st century, is a component of e-Health that refers to medical or public health practices supported by mobile devices.[8] By providing continuous care through mobile devices, M-Health has been shown to significantly improve health outcomes.[9] With improved access to mobile technologies, m-Health holds considerable potential to provide underserved populations with access to health information and services.[10 11] Though the number of m-Health interventions targeting MCH is limited, MCH is one area where e-Health and m-Health interventions may have particular promise.[12–16]

For Palestine refugees, MCH has been an important health issue: 27.0% of Palestine refugees are women of reproductive age and 7.7% are children up to 5 years of age.[17] The United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA) provides primary healthcare services to 65% of the 5.5 million registered Palestine refugees in 144 health centres across five fields of operation (Jordan, Syria, Lebanon, the West Bank and Gaza), many of whom live in refugee camps and low-resource settings.[17]

UNRWA has been undertaking multiple interventions to improve the lives of Palestine refugees, despite an increasingly volatile environment and a funding crisis.[18] One such example is the *Maternal and Child Health Handbook* (*MCH Handbook*), which was released in 2008 in collaboration with Japan International Cooperation Agency (JICA). The *MCH Handbook* contains basic MCH information and is recommended by the World Medical Association and the World Health Association as a tool for promoting care-seeking behaviours and improving continuum of care.[19 20] The handbook is also known to increase its users' health-related behaviours.[21 22] The handbook was introduced in all five of UNRWA's fields of operation in 2010 and is now used by almost 100 percent of Palestine refugees.[23] Following the success of the MCH Handbook, UNRWA is now aiming to increase access to MCH even further by digitising the handbook.

In 2016, UNRWA and JICA developed an electronic version of the *MCH Handbook* for smartphones (the *e-MCH Handbook* application) to increase refugees' access to MCH care. The *e-MCH Handbook* provides pregnant women and mothers with online and offline access to updated educational information and personal health records of themselves and their children. The *e-MCH Handbook* would also send its users reminders of appointment times and function as a communication tool between patients and UNRWA health centres even outside of the centres. Evidence for the effectiveness of the digital *MCH Handbook* is still lacking, but given that paper *MCH Handbook* has been shown to promote health-seeking behaviours in mothers,[22] the *e-MCH Handbook* is expected to have similar or even more significant effects.

The *e-MCH Handbook* application was released to the Jordan field in April of 2017, supported by two technology platforms: Jordan's comparatively and increasingly high smartphone coverage, which was 51% as of 2015,[24] and UNRWA's electronic medical records system, which transfers data to and from the *e-MCH Handbook*.[25] UNRWA also conducted a small assessment of mobile phone availability on 79 female refugees in two health centres and found that 80% had smartphones (unpublished data).

In order to facilitate the implementation of the application, UNRWA health centres were provided with posters and flyers on how to download the application, and key UNRWA health staff were selected to participate in a training-of-trainers programme on use of the application. Despite these efforts, uptake by the target population was low, with only 927 pregnant women and mothers of over 200 000 eligible individuals having downloaded and activated the application as of July 2017 (unpublished data). Although it is increasingly more important for MCH professionals to report on evidence of m-Health, studies on actual practices, opportunities/challenges and outcomes in dissemination and implementation of m-Health interventions are scarce, especially in low-income and middle-income countries.[26 27]

The objective of this study was to identify factors associated with the download and usage of the *e-MCH Handbook* application among Palestine refugee pregnant women and mothers.

METHODS

Study design

A cross-sectional study was conducted 4 months after the launching of the application. In this study, we distributed self-administered questionnaires to pregnant women and mothers of children aged 0–5 years. We also distributed separate questionnaires to health staff at UNRWA's health centres. We then analysed the data from the questionnaires to identify factors associated with the download and usage of the *e-MCH Handbook* application. We also conducted supplementary focus group discussions (methods and results are available in online supplementary appendix 1) to assess the pregnant women's and mothers' attitudes towards technology and mobile applications.

Participant enrolment

Registered UNRWA refugee pregnant women or mothers of children aged 0–5 years who could read and write in Arabic were eligible for this study. Those who were underage were also included if an adult relative approved of her participation.

We determined the minimum required sample size to achieve a statistical power of 0.8 with a confidence level of 0.05 for a multiple regression model with 10 predictors (discussed in later sections) to be 130, based on an equation for sample size calculation in multiple regressions by Green.[28] We determined that a week of data collection would be sufficient to yield a sample size that is large enough, based on a pilot data collection done at Amman New Camp health centre for 1 day. In the pilot data collection, 50 questionnaires were collected, so we determined that a week of data collection was sufficient to obtain the minimum required sample size based on the following calculation: 50 questionnaires/day * 6 days/week * 1 week

of data collection * nine health centres=2700 questionnaires. Since Amman New Camp health centre is among the larger health centres, we chose to distribute 400 questionnaires to large, 300 questionnaires to medium and 200 questionnaires to small health centres, which would give a total of 2500 questionnaires.

On arrival at an UNRWA health centre, pregnant women and mothers first confirmed their appointment with a clerk. The clerk provided them with a questionnaire as part of the patient's intake paperwork. The questionnaire was to be completed in the waiting room and submitted in designated, secure boxes located inside of each exam room. The questionnaires took about 5 min to complete. Nurses, midwives and physicians were also given questionnaires to distribute to pregnant women and mothers in case they bypassed the clerk without collecting one.

Variables

Exposures

The exposures were the age of pregnant women and mothers, the age of their spouse, the number of their male children, the number of their female children, their educational level, the frequency of their visits to a health centre, their source of medical information, whether they had other mobile applications on their phone and whether they had access to the internet at home. These variables were chosen based on previous literature on dissemination and implementation of e-Health and m-Health interventions.

We included questions on the demographic factors of pregnant women and mothers as well as their accessibility to a health centre, since the m-Health evidence reporting and assessment (mERA) guidelines, developed by the WHO mHealth Technical Evidence Review Group, state that 'challenges to access could relate to socioeconomic status, geographical location, education and literacy, gender norms that limit access to resources and information, as well as other demographic and sociocultural factors'.[27] Particularly, whether the participant was a first-time mother or not was predicted to be an important factor in the dissemination and implementation of the *e-MCH Handbook*, since a previous study has found that first-time mothers are more likely than other mothers to use parent-held health records.[29] We therefore included questions on the pregnancy status and number of children of each participant and defined a first-time mother as a pregnant woman with no children or a non-pregnant mother with only one child.

We hypothesised that if the pregnant women and mothers are not sceptical towards mobile applications, they would be more likely to have mobile applications on their phones and use the e-MCH Handbook application. We therefore included a question on whether pregnant women and mothers had other mobile applications on their phones. Indeed, users' scepticism towards an e-Health technology is often a barrier to its dissemination and implementation, though its effect on m-Health technologies is not yet clear.[30]

We also included a question on access to the internet, since internet connectivity is shown in previous studies to be important in successful implementation of e-Health intervention, which is also stressed in the mERA guidelines.[27 31] Furthermore, internet connectivity is known to be greatly valued by refugees and is hypothesised to affect the utilisation of m-Health interventions.[32]

Qualitative studies have suggested that smartphone owners value the internet as a source of medical information, a quality that may facilitate the utilisation of m-Health interventions.[31 33] Thus, we included a question on the source of medical information used by the pregnant women and mothers.

Staff knowledge score

In addition to the above exposures, we calculated a 'staff knowledge score' for each health centre to assess the health staff's knowledge of and expertise on the mobile application. The staff knowledge score was hypothesised to directly affect the pregnant women's and mothers' knowledge of and eagerness to download and use the *e-MCH Handbook* application, since previous reports have shown that the lack of knowledge of an e-Health intervention can act as a barrier to its implementation.[30] Self-administered questionnaires were distributed to all the health staff members who were present at each of the nine UNRWA health centres during the week of data collection with the exception of Kraymeh health centre because of lack of consent to participate. Each staff member was asked to rate how well he or she knew about the *e-MCH Handbook* application on a scale from 1 to 4. The average of all the answers obtained at each health centre was used as the staff knowledge score.

Outcomes

The primary outcomes were whether the pregnant women or mothers knew about the application, downloaded the application and used the application.

Data collection

We distributed questionnaires in nine UNRWA health centres: Amman New Camp, Jerash, Amman Town, Nuzha, Irbid, Zarqa Camp, Zarqa Town, Talbieh, and Kraymeh. We chose these health centres out of 25 centres based on expert opinion, with the aim of obtaining a sample representative of Jordan's Palestine refugee pregnant women and mothers from geographical, socioeconomic and health standpoints.

The questionnaires were left at each health centre for a chosen week in August 2017, and a representative at each health centre sent the collected questionnaires to the UNRWA Headquarters via mail.

Data analysis

Along with the basic characteristics of all mothers and pregnant women, the characteristics of participants who knew about the application and participants who downloaded the application were compared with the overall study sample using Fisher's exact test for categorical

variables and Wilcoxon rank-sum test for numerical variables. Additionally, we stratified the number of downloads and usage of the application by age group.

We conducted a multiple stepwise logistic regression analysis to assess the relationship between the exposures and whether the pregnant women and mothers downloaded the *e-MCH Handbook* application. Those who knew about the mobile application were included in the analysis. In addition, we conducted a multiple stepwise logistic regression analysis to assess the relationship between the exposures and the use of the mobile application. Those who had downloaded the mobile application were included in the analysis. The stepwise method was chosen for both analyses due to the lack of extensive literature on dissemination and implementation of m-Health. Model selection was performed with the minimisation of the Akaike information criteria in order to account for possible interactions among variables. In the regression analyses, missing data were imputed using random forests, which is a superior method of imputation for non-parametric variables and when there are many variables in the study.[34]

It was found halfway through the questionnaire distribution that the e-MCH Handbook application could not be downloaded on the iPhone due to an error in the mobile application's system. We therefore added a question on the type of smartphone they have (an iPhone or an Android) on questionnaires distributed to Zarqa Town, Zarqa Camp, Talbieh and Kraymeh health centres. However, the proportion of iPhone users in these centres was only 5.8%, and we conducted the analyses as planned without excluding the data collected with the old version of the questionnaire.

Significance level was set at 5%. R version 3.5.2 was used for all data analyses.

Ethics

Only pregnant women and mothers for whom written informed consent were obtained were included in the study. Participation in the study was voluntary, and personal information obtained from the questionnaires were kept confidential.

Patient and public involvement

No participants were involved in the development of the research questions or outcome measures or the design and conduct of this study. The results will be disseminated via this publication.

RESULTS

From the nine health centres chosen, a total of 1047 questionnaires, out of the 2500 questionnaires distributed, were obtained from pregnant women and mothers. The overall response rate was 42% and ranged from 21.7% to 85.7% among individual health centres. The number of questionnaires and the response rate obtained from each health centre is shown in table 1. Only five questionnaires were collected from the Kraymeh Health Center due to a lack of available health centre personnel who could conduct the week-long data collection, and these responses were excluded from the study, since they were determined to be not representative. Thus, we included data from 1042 pregnant women and mothers in the analysis. The number of missing answers were randomly distributed across different questionnaire items. The response rate of the health staff was 67.6% (188 collected/278 distributed; Kraymeh excluded).

Table 1 Response rate of the participating health centres

Location	Number of questionnaires distributed n=2500	Number of questionnaires returned n=1042	Response rate %
Large health centres			
Amman New Camp	400	149	37.3
Irbid	400	161	40.3
Medium health centres			
Jarash	300	65	21.7
Amman Town	300	138	46.0
Nuzha	300	257	85.7
Zarqa Camp	300	127	42.3
Zarqa Town	300	80	26.7
Small health centres			
Talbieh	200	65	32.5

Basic characteristics

The basic characteristics of the pregnant women and mothers are summarised in table 2. The mean age was 28.4 years (SD 6.5). The mean age of the husbands was 34.3 (SD 7.4) and that of mothers at the birth of the first child was 21.9 (SD 4.0). The average numbers of male children and female children were both 1.4 (SD 1.2, for both male and female children).

The most popular source of medical information was the internet, with 36.4% of pregnant women and mothers using it. Other popular sources were mothers or sisters (26.7%) and magazines, newspapers or medical publications (21.9%). More than half of pregnant women and mothers (64.9%) visited the health centre at least once a month. Whereas only half (49.5%) of pregnant women and mothers had access to the internet at home, 84.7% had mobile applications other than the *e-MCH Handbook* application on their phones. The staff knowledge scores calculated for each health centre based on staff questionnaires were 2.46 out of 4 for Amman New Camp, 2.60 for Amman Town, 2.17 for Jerash, 2.48 for Irbid, 2.29 for Nuzha, 2.93 for Zarqa Town, 2.42 for Zarqa Camp and 2.40 for Talbieh.

Factors associated with knowledge and download of the application

As can be seen in table 2, compared with the overall sample, more participants who knew about the application tended to have mobile and smartphone subscriptions, get medical information from the internet, have access to

Table 2 Basic characteristics and comparison between mothers and pregnant women included in each of the regression analyses and the study sample overall

	All mothers and pregnant women	Participants included in the first regression analysis (those who knew about the application)		Participants included in the second regression analysis (those who downloaded the application)	
	n=1042	n=499		n=235	
	Median (IQR)	Median (IQR)	P value	Median (IQR)	P value
Demographic variables					
Age	28.0 (23.0–33.0)	26.0 (22.0–32.0)	0.06	27.0 (22.0–32.3)	0.23
Spouse age	34.0 (29.0–39.0)	33.0 (28.0–38.0)	0.11	33.0 (28.0–38.0)	0.47
Age at first child	21.0 (19.0–24.0)	21.0 (19.0–24.0)	0.77	21.0 (19.0–24.0)	0.99
		% of total	% of total	P value	% of total	P value
First-time mother		25.8	25.4	0.93	26.5	0.85
Mobile phone access						
Mobile phone subscription		95.5	99.6	<0.01		
Smartphone subscription		86.9	95.2	<0.01		
Source of medical information						
Husband		12.3	11.1	0.66	11.0	0.71
Mother or sisters		26.7	23.4	0.32	20.9	0.13
Friends		20.2	21.3	0.80	17.4	1.00
Radio or TV		11.4	6.8	0.05	7.0	0.09
Magazines, newspapers or medical publications		21.9	18.7	0.33	18.6	0.37
Internet		36.4	46.4	<0.01	48.3	<0.01
Visits health centre at least once a month		64.9	71.8	0.05	71.3	0.11
Has access to internet at home		49.5	61.5	<0.01	62.1	<0.01
Has apps on the phone		84.7	97.0	<0.01	97.1	<0.01

the internet at home and have other mobile applications on their phones compared with the overall sample. More participants who downloaded the application tended to get medical information from the internet, have access to the internet at home and have other mobile applications on their phones compared with the overall sample (table 2).

Phone possession and download/usage of the application

979 (95.5%) had a mobile phone subscription and 862 (86.9%) owned a smartphone. 840 (97.4%) of the 862 smartphone users reported that the smartphone was owned by themselves. 499 (51.3%) expressed knowledge of, 235 (23.8%) downloaded and 172 (17.4%) reported using the application.

Comparison of application download/usage of the application by age group

The status of application download and usage by each age group is shown in table 3. The proportions of both download and usage were larger among the younger age groups; Fisher's exact test showed significant differences among groups for neither download (p=0.18) nor usage (p=0.30).

Multiple logistic regression analyses

Four hundred and ninety-nine pregnant women or mothers who knew about the *e-MCH Handbook* application were included in the first analysis, and 235 pregnant women or mothers who knew about the application were included in the second analysis. The results of the regression analyses are shown in table 4, and we included all of the variables listed in table 2 as possible predictors.

Table 3 The number of participants who downloaded or used the application by age group

	Number of responses	Application download	Application usage
Age group	n	n (% of total per age group)	n (% of total per age group)
16–22	195	60 (30.8)	44 (22.6)
23–29	388	87 (22.4)	59 (15.2)
30–36	266	59 (22.2)	47 (17.7)
37–43	118	27 (22.9)	20 (16.9)
44–50	14	2 (14.3)	2 (14.3)

Table 4 Results of the multiple logistic regression analysis of the *e-MCH Handbook* application download and usage

	Predictors of mothers who downloaded the *e-MCH Handbook* application			Predictors of mothers who used the *e-MCH Handbook* application		
	n=499			n=235		
Predictors	OR	95% CI	P value	OR	95% CI	P value
Has other mobile applications on her phone	6.17	(2.73 to 15.27)	<0.01			
Staff knowledge score	11.82	(4.08 to 36.52)	<0.01			
Internet as a source of medical information	1.63	(1.12 to 2.42)	0.01			
Has access to internet at home	1.46	(0.99 to 2.14)	0.05			
Spouse age				1.04	(0.99 to 1.08)	0.11

Among pregnant women and mothers who knew about the application, having other mobile applications on the phone (OR 6.17, 95% CI 2.73 to 15.27, p<0.01), staff knowledge score (OR 11.82, 95% CI 4.08 to 36.52, p<0.01) and using the internet as a source of medical information (OR 1.63, 95% CI 1.12 to 2.42, p=0.01) were associated with their downloading the *e-MCH Handbook* application. Having access to the internet at home (OR 1.46, 95% CI 0.99 to 2.14, p=0.05) was also included in the model, although its association with application download was insignificant.

Among pregnant women and mothers who downloaded the application, we did not find strong evidence for any factors possibly associated with application usage, although spouse age was included in the model (OR 1.04, 95% CI 0.99 to 1.08, p=0.11).

DISCUSSION

Principal findings

Due to problems with application functioning on iPhones, our results applied to Android users only. The results of our study indicated neither dissemination strategies (distributing posters and pamphlets) nor implementation strategies (training of staff members on how to use the application) were enough to promote the uptake of the application.

Having internet access at home, using the internet as an information source and downloading other applications were found to be associated with *e-MCH Handbook* download. This implies that infrastructure and less scepticism towards new technology including e-Health may facilitate the utilisation of the application. This finding agrees with the opinions expressed by mothers and pregnant women in the supplementary focus group discussions (the methods and results are available in online supplementary appendix 1), in which we found that they perceived technology as a useful source of information. Similar findings were reported from previous studies.[30 35] Staff knowledge score was also found to be associated with the download of the application. Having someone who can instruct women on how to use the application may encourage them to download the application.

Meanwhile, more than half of those who were aware of the application did not download it. This is an example of what Rogers named 'passive rejection' (also called non-adoption), which is when people never considered the use of the innovation. However, those who downloaded the application but did not use it is an example of what Rogers terms 'active rejection', which is when people considered the adoption of the innovation but then decided not to adopt it.[36]

Rogers also lists five factors that affect the rate of adoption of innovations: relative advantage, compatibility, complexity, trialability and observability.[36] These factors are helpful when planning strategies to introduce an innovation. Among these, compatibility and relative advantage may be key to the implementation of the application particularly to reduce passive rejection.

Above all, women need to see the advantage of using the *e-MCH Handbook* application over the currently used *MCH Handbook* (relative advantage). New implementation strategies should include showing the benefit of introducing the application. Compatibility is affected by '(1) sociocultural values and beliefs, (2) previously introduced ideas, and/or (3) client needs for the innovation'.[36] As many women seemed to be open to new technology and using a smartphone and applications, the new technology (*e-MCH Handbook*) should be compatible with their values. The content of the application is the same as that of paper *MCH Handbook* and should not have a conflict with each other. Finally, client needs for the innovation are yet to be examined. Some might prefer keeping record electronically and online to using a booklet, but some may not. Currently, the needs are more from the provider (UNRWA) side. The clients in this case (refugee mothers and pregnant women) seem not see the needs. Campaigns to help them realise the needs might accelerate the implementation.

We could not identify factors significantly associated with the usage of the application. The rate of users among those who downloaded the application (73.2%)

suggests that training of staff members was not enough to encourage women to use it. The presence of those who downloaded the application but did not use it may have been an example of active rejection, and complexity might have been one of its causes. Further improvement of the application and training of staff members is required. The aforementioned two factors and implementation strategies may also mitigate active rejection.

Strengths and weaknesses of this study

This study is one of the first to evaluate possible factors associated with the dissemination and implementation of m-Health interventions in a refugee population and one of the first to do so for electronic MCH handbooks. A population living under unstable conditions due to humanitarian conflict,[18] refugees can benefit significantly from a centralised record such as the *e-MCH Handbook* application, which can keep health records secure even in times of crisis. However, no matter how effective a novel m-Health technology may seem, it would be of no use without successful dissemination and implementation.[30] Therefore, studies like this one are of great importance in providing further insight into dissemination and implementation strategies of m-Health technologies.

A limitation of this study is that phone type was not taken into account in the regression analysis of *e-MCH Handbook* application download. iPhone users could not download the application. However, in the three health centres for which phone type was asked, the proportion of iPhone users was low (5.8%), and its effect as a confounder was likely minimal. Another weakness is that staff knowledge score was only calculated for each health centre and not for individual participants, and there likely was variability in how much information the individual participants obtained from the health staff.

We distributed the questionnaires only to pregnant women and mothers who attended a health centre during the study period. Those who do not attend a health centre regularly are more likely to be excluded from the study sample, and therefore our study sample may not have been fully representative of the study population. Furthermore, the health centres were chosen based on expert opinion and therefore were not chosen based on objective data. However, the socioeconomic and health profiles of Palestine refugees attending each health centre were scarce, making relying on expert opinion the most feasible method of sample selection.

Since answering the questionnaire was voluntary, pregnant women and mothers who favoured the application may have been more willing to participate, and therefore the download and use of the application may have been overestimated. In fact, the prevalence of the *e-MCH Handbook* application users found in this study is much higher than that of the total eligible population. Furthermore, though training of faculty was done at each health centre for proper questionnaire distribution, some faculty may have been more collaborative than others and, consequently, more responses may have been obtained in some health centres.

Implications and future research

Our results show that simply having a smartphone is not enough to prompt the usage of m-Health. This study found that the knowledge of the application among the women was still low. To raise awareness, a new dissemination method is necessary. In a setting where funding is limited, it is crucial to replace previous dissemination methods with more cost-effective ones. Healthcare providers who see mothers and pregnant women can directly refer them to the application, or online videos can be used to advertise the application in order to make it spread more quickly and broadly.

Proper education on how to use the technology (ie, health staff education, which is an essential step in educating the potential users) and the adequate condition to download and use the technology (ie, enough cellular data and Wi-Fi) are likely necessary. The guideline for reporting evidence of m-Health interventions recommends to first address infrastructure, which in this case is internet connection and smartphone penetration.[27] The rate of smartphone possession in this study population was higher than that in Jordan in 2015 (82% and 51%, respectively). From this high penetration rate, the platform for a smartphone application looks promising. Given our results, it would be best to increase access to the internet at home. However, access to the internet at home cannot easily be realised, and one alternative is to provide it outside of home. For instance, UNRWA could provide *e-MCH Handbook* download and instruction sessions with better Wi-Fi access at each health centre (the health centres did have free Wi-Fi but was not being effectively used due to slow connection and issues with the Wi-Fi password). The application could not be used on iPhones, indicating the need for further development of the application. This initiative could promote pregnant women and mothers to correctly download and use the application. The important message is that there are things that must be done from the m-Health provider's side to more effectively disseminate and implement a novel m-Health technology, especially in a setting where there are significant barriers to access to m-Health.[37]

The *MCH Handbook* has been proven to effectively promote mothers' health-seeking behaviours in a randomised controlled trial.[22] The e-*MCH Handbook*, then, may also have the potential to do the same while providing even more value to underserved populations.[10–16] However, some parents have focused on the negative effects the increased connectivity of mobile phones poses on parenting, such as getting messages related to work even while at home and not being 'present' with the child when the parents have their phones with them.[38] Many mothers and pregnant women who participated in our supplementary focus group discussions, too, expressed scepticism towards technology, especially mobile phone applications. Therefore, we can speculate that the current

outlook on the effects of the electronic MCH handbook on MCH is equivocal and may depend on the user, and simply allocating an electronic MCH handbook to every pregnancy may not be ideal. Future studies need to evaluate both the beneficial and detrimental aspects of electronic MCH handbooks.

CONCLUSION

Though m-Health has potential to significantly benefit the refugee population, there may be multiple barriers to the dissemination and implementation of m-Health. Those who use other mobile applications are more prone to use m-Health applications and may be potential targets of dissemination of a novel m-Health intervention. For successful implementation of m-Health, it may be necessary to thoroughly educate the health staff on the application and provide an environment for easy utilisation of the application such as access to the internet.

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Competing interests During the study period, SN, RG and SA were interns, AK was the Public Health Specialist/Epidemiologist, GB was the e-Health Project Coordinator, MH was the Chief of Health Protection and Promotion and AS was the Director of Health Programs at the Department of Health, UNRWA HQ, Amman, Jordan. The authors have no other conflicts of interest to declare.

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