



RESEARCH ARTICLE

REVISED Effectiveness of a mobile health intervention on infant and young child feeding among children ≤ 24 months of age in rural Islamabad over six months duration [version 3; peer review: 1 approved, 2 approved with reservations]

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Abstract

Background: Childhood development is highly influenced by feeding practices at infancy and young age of the children. Unfortunately, according to the National Nutrition Survey (2011), the prevalence of exclusive breastfeeding in Pakistan was 21% at four months, and 13% at six months of age with 51.3% of mothers initiating semisolid foods to their children at the recommended 6-8 months of age. Pakistan Demographic & Health Survey (PDHS 2018) however; indicates that only 48% of infants are exclusively breastfed which has been improved from 38% as reported in the past five years but still more improvement is envisaged.

Methods: A quasi-experimental study design was employed for this post-intervention survey assessing effectiveness of mobile health (mhealth) regarding infant & young child feeding (IYCF) among pregnant and lactating mothers in Tarlai, Islamabad from May to June 2018. A total of 135 mothers who were earlier included in the intervention phase were recruited after obtaining verbal & written consent. The data was entered in EpiData (3.1) and analyzed in SPSS version 21.

Results: The mean age of these pregnant and lactating mothers was 30.5 years ± 4.5 SD with the majority of mothers in the age group of 25 to 29 years. After intervention, the overall knowledge of mothers regarding IYCF nutrition was raised among 94 mothers (69.6%) as compared to 74 (54.8%) mothers prior to the intervention. Overall attitude regarding IYCF was found to be positive among 86 (63.7%) of the mothers, whereas 88 (65.2%) of the

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mothers had good IYCF related practices.

Conclusion: Our post-intervention survey signifies the effectiveness of mhealth in raising knowledge, attitude, and practices of mothers regarding IYCF in rural Islamabad. However, implementation of mhealth in masses requires future research specifically to address cost-effectiveness of such interventions in maternal & child health programmes.

Keywords

Mobile health, mhealth, IYCF nutrition, Operational research, Islamabad, Pakistan

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Any reports and responses or comments on the article can be found at the end of the article.



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REVISED Amendments from Version 2

The reviewers recommended to cite references and add the limitation of quasi-experimental studies. The manuscript has been revised as per the suggestions.

Any further responses from the reviewers can be found at the end of the article

Introduction

Childhood under-nutrition is a major public health problem which has been contributing extensively to childhood mortality and morbidity¹. Globally; 45% of child mortality results from ‘*undernutrition*’ which highlights the right of every child to good nutrition. According to [World Health Organization](#) (2018), globally more than 100 million children were found to be stunted, and nearly 52 million were found to be wasted in 2016 alone. Adequate nutrition is required for optimal growth and development of children². Evidence indicates that under-nutrition leads to severe cognitive and behavioural disabilities throughout life if not managed in early infancy³⁻⁵. The magnitude of malnutrition is extensive in the South Asian region leading to high rates of stunting, wasting, and disease burden⁵. One of the major causes of these high indicators of undernutrition is poor infant and young child feeding (IYCF) practices. The WHO and United Nations International Children’s Emergency Fund (UNICEF) recommends early initiation of breastfeeding within an hour after birth, and exclusive breastfeeding for the first 6 months during infancy with timely and appropriate initiation of complementary feeding⁶. Despite this recommendation, the recognized adverse effects of malnutrition and undernutrition among infants and children have been significantly reported in various studies⁷⁻⁹.

Regarding infant and young child feeding practices, around 40% of infants from 0–6 months of age had been exclusively breastfed, worldwide⁶. Whereas, only a few children acquire adequate nutrition along with proper complementary feeding which is appropriate for their age group they belong to⁶. In low-and middle-income countries (LMICs), these sub-optimal feeding practices of infants and young children contribute to the prevailing burden of malnourishment. According to the Pakistan Demographic Health Survey (PDHS, 2018), 38% of children under five years of age are stunted and 17% are severely stunted. However; the national findings also indicate an improved nutritional status of children which has resulted in the decline of stunting from 45% to 38% among children as reported by previous findings of PDHS 2012–2013^{2,10,11}. Lack of knowledge, lower socio-economic status, and relatively low levels of education of mothers or caregivers can be attributed to suboptimal IYCF practices¹².

Emphasis has been laid on implementing effective innovative interventions to improve nutrition among children particularly in poor resource countries. One of the most effective strategies laid down by WHO to improve IYCF practices is effective counseling on proper nutritional practices through community health workers^{13,14}. In Pakistan, these community health workers

are referred to as Lady Health Workers (LHWs), recruited under the National Program for Family Planning and Primary Health Care¹⁵. With support from WHO, the government of Pakistan launched the ‘Lady Health Workers Programme’ in 1994, which was mainly aimed to provide an effective grassroot level system for accessing primary health care¹⁵. This program was aspired to bridge the communities for accessing primary healthcare through LHWs. Moreover; among the various roles and responsibilities under this program, the LHWs are also expected to provide nutritional counseling. However, the deliverables by LHWs somehow are affected due to being overburdened¹⁶.

Thus, it is imperative that a facilitating system if is provided to these LHWs will help to reduce their workload. Among some of the innovative strategies of providing health service, mobile health or mhealth, is gaining momentum in low- and middle-income countries. As defined by WHO mhealth is the “provision of health services and information via mobile and wireless technologies”¹⁷. The innovation and use of information and technology through mhealth has been vastly employed to address access, resource utilization, and coverage gaps. Many LMICs including those in South Asia have been employing mhealth approach through the Community Health Workers or peer counselors to improve healthcare as an innovative strategy^{18,19}. A study conducted in Bangladesh demonstrated gaps in IYCF related service delivery which prompted the need of healthcare messages, including information related to emergency and medical care, to be delivered through mobile phones. The potential benefits and necessity of mhealth led the technology to embrace community-based nutrition services to improve the service delivery and coverage related to IYCF nutrition. Mass-scale behavioural interventions that actively included social mobilization at the community-level, media campaigns, and counseling by trained workers have also been found useful¹⁹⁻²¹. Evidence from India suggests that IYCF related nutrition among children can be improved using counseling strategies aimed at the parents²². Limited evidence is available from Pakistan indicating effectiveness of mhealth related to IYCF nutrition as mhealth has not been extensively opted for IYCF nutrition solely. Although there lies significant opportunities including use of mhealth in masses, advocacy, intersectoral collaboration and training of community health workers regarding IYCF nutrition²³. Therefore, considering the current situation in Pakistan, we planned to pilot mhealth technology with counseling through LHWs. For this intervention we first conducted a formative study in collaboration with Lady Health Worker (LHW) programme, which helped in the development and implementation of a mhealth based program to counsel women on proper nutritional practices related to infant and young children (IYCF) in a rural periphery located in Islamabad.

Our mhealth intervention was deployed on pregnant and lactating mothers from July 2016 to December 2016 in rural Islamabad. The aim was to test the feasibility and acceptance of mhealth intervention among the target population. A pre-intervention survey was conducted one month prior to the intervention in June 2016 followed by a post intervention survey conducted in May to June 2018 to determine the

effectiveness of mhealth intervention in improving infant and young child feeding (IYCF) nutrition related knowledge, attitude and practices among pregnant and lactating mothers in rural Islamabad (Both surveys are available as Extended data²⁴). The specific objective of this post-intervention study was to compare the pre and post mhealth intervention related knowledge, attitude & practices of pregnant and lactating mothers regarding IYCF.

Methods

Study design

A quasi-experimental study design was employed to determine the effectiveness of mhealth in improving knowledge, attitude, and practices of pregnant and lactating mothers regarding IYCF in rural Islamabad.

Study setting

Islamabad is the federal capital territory of Pakistan. According to census conducted in 2017, the total population of Islamabad is more than 2 million²⁵. The rural population of Islamabad comprises of 991,747 individuals with approximately 165,490 number of households²⁶. This study was conducted in Tarlai Kalan which is a rural union council in Islamabad which comprises of around 37,500 households.

Study population

As mentioned, our intervention was deployed to pregnant and lactating women residing in Tarlai, Islamabad (See [Figure 1](#)). The study area is covered by the Lady Health Workers (LHWs) who are considered as the first level healthcare providers in this community. Upon availability and approval from the district health office, 10 LHWs were randomly selected and trained on IYCF. Out of these 10 LHWs, 05 were selected on basis of their best performance during the IYCF training. The sampling frame was based on these five selected LHW-wise households where pregnant or lactating mothers residing within the catchment area of Tarlai, Islamabad and have children of ≤ 2 years of age who were willing to participate in the study were recruited and registered. Their husbands were also invited to participate and after obtaining consent the post-intervention study was conducted. Non-residents, non-consenting cases and mothers with serious co-morbidities were excluded from the study.

Intervention

A user-friendly audio-visual android based mobile application was developed for LHWs who were then trained and supervised on its use which contained the formulated messages related to IYCF. The content of messages was prepared in English language after extensive review by experts, which were mainly based on WHO and UNICEF guidelines^{14,27}. It was translated into local language 'Urdu' and was then back translated into English language.

Intervention Design: On the basis of results of pre-intervention survey (phase one), it was decided that biweekly voice and text messages on appropriate IYCF practices will be disseminated

to the recruited pregnant and lactating mothers as well as the messages will be sent to their mothers in law and husbands. The project team was then trained by a mobile application developer to create their application on the content of voice and text messages to be disseminated.

Messages: A team of public health professionals, paediatricians, health informatics professionals, academicians and program managers formulated the messages based on WHO and UNICEF guidelines. These messages were initially drafted in English, then translated into Urdu and back translated into English. The target audience was pregnant women in their third trimester and lactating mothers of children between 0–24 months of age. The age of child and stage model was employed so that the messages could be sent according to the trimester of the pregnant women or age of the child as the case may be. After these messages were created, they were incorporated into a specialized message scheduling system whereby separate audio and text based message libraries were created to be sent to recipients.

Mobile Application: The application was created over a period of 03 months with testing to optimise the user's experience. The application had two modules which were registration and follow up. Each module further included two sections, one for the pregnant women from their third trimester and one for children 0–12 months. The questions within each module were drafted in Urdu and included logical checks and errors based on the responses to avoid errors in data entry. The LHWs were to first register pregnant women or mothers of children of 0–12 months of age using the registration form. The included data consisted of name of the mother and the child, age, gender of the child, date of birth, last menstrual period (in case of pregnant women), address, phone number and dietary habits. From the next visit onwards, they were instructed to use the follow up forms to collect monthly data on their dietary intake, supplement intake (in case of pregnant women) and any associated illnesses or problems. A laptop/desktop-based dashboard was also created to import data collected in the field by the LHWs. The same dashboard also had the capacity to monitor the LHW activity through display activity times, number of forms sent, and time spent with each mother. Through the same dashboard the project manager had the capacity to create mobile application users. After creation of the mhealth application, it was installed into android phones and following pretesting by the team members it was then modified.

Once the application was ready and the message library was created, the project team sought written permission from the Federal District Health Office (DHO) to recruit the LHWs of Union Council of Tarlai Kalan for the intervention. The DHO assigned an assistant district coordinator who assisted the project team in recruiting the LHWs. Upon availability of the LHWs, a three-day training workshop was scheduled in a health house. A health house is a household of LHWs. The agenda of the training was to first educate the LHWs on IYCF, explain the objective of the intervention and train them on using the application by providing them application installed smart phones

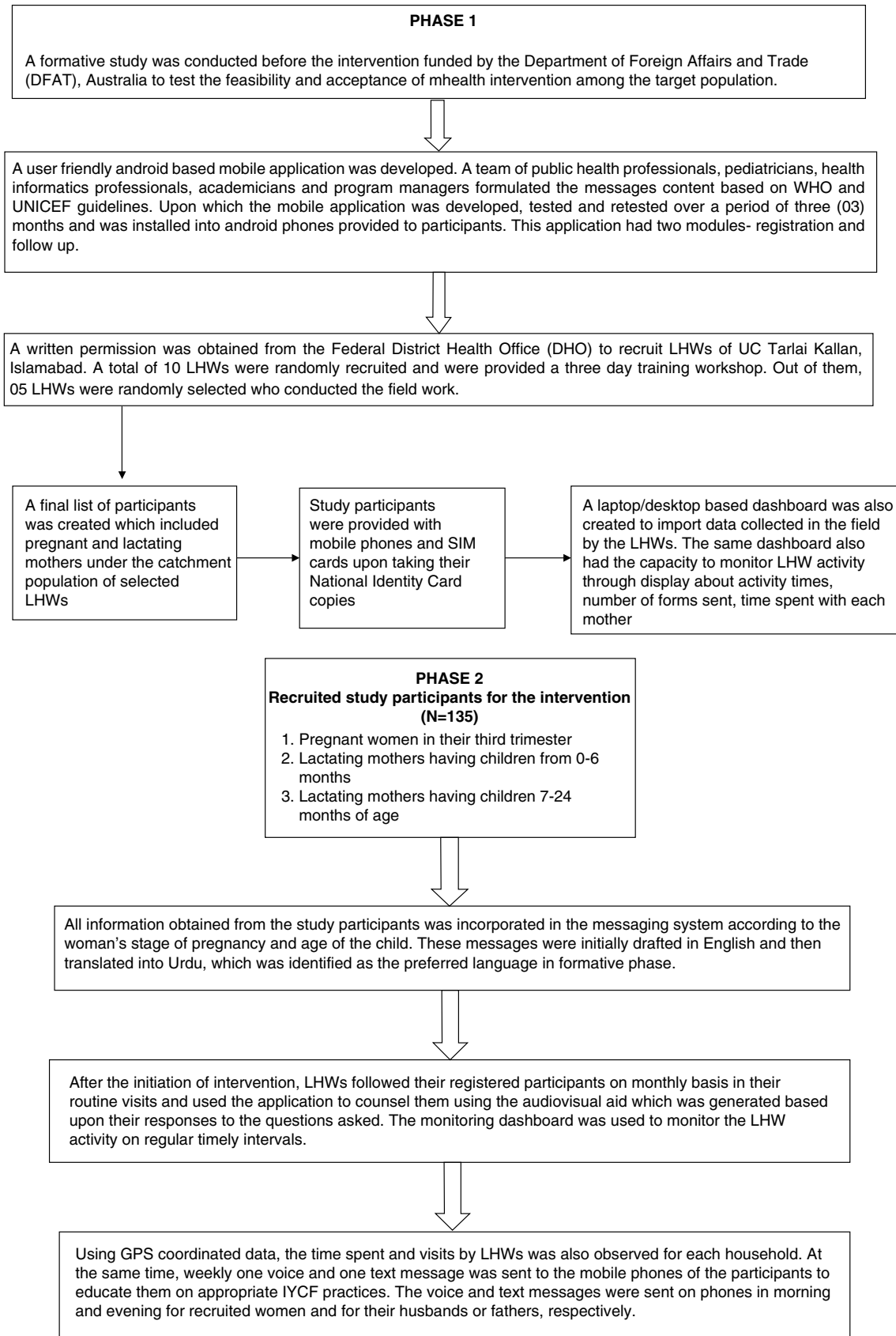


Figure 1. Intervention Phase among pregnant & lactating mothers in rural Islamabad from July to December 2016.

and tablets. A pre- and post-test regarding knowledge on IYCF was also conducted during the training. This was followed by a field visit to test the use of the application in the field. After obtaining the national identity card copies of the selected LHWs, they were then provided with android-based smart phones along with the SIMS and mhealth application installed. Consent to be a part of the study was also obtained for participating in the project, along with their National Identity card copies (this is required by the Pakistan Telecommunication Authority (PTA) for provision of sim cards).

Upon selection, the participating LHWs were then requested to provide a list of eligible pregnant and lactating mothers for the project within their catchment area. These comprised of three groups including all pregnant women in their third trimester, children from 0–6 months of age and those mothers who had children of 7–12 months of age. Before including their names in the study, the LHWs were advised to describe the purpose of the mhealth project to the respondents or the caretakers (which were assumed as those individuals who were responsible for the care of infant or the child at their homes). Only those individuals or caretakers who had consented to be a part of the intervention were included. On average, around 10–15 individuals' names were provided under each group by each LHW. Once the lists were provided, three individuals under each group for each LHW were selected and assigned to be included in the intervention through a lottery / draw method. These respondents were randomly picked out of all the recruited participants whose names were included in a draw box to receive the mhealth intervention. The participants consisted of primary participants who were pregnant women and mothers of children of 0–12 months of age followed by secondary participants who were mothers in law/grandmothers and husbands/fathers of the primary participants. The purpose of including the other family members was sociocultural. As in the first phase of the project; it was indicated that for a successful delivery of mhealth intervention, involving husbands and mothers in law will be very important. This was so that the participants would own the intervention and consider themselves as participants in the study.

Once the final list of participants was created, a one-day inaugural session was organized for them near to their place of their residence so as to brief them about the intervention. A pre-intervention survey was conducted after which they were provided with mobile phones along with SIM cards upon obtaining their National Identity Card copies and their written consent for participating in the study. Once all the information was obtained from the participants, it was then incorporated in the messaging system according to the stage of pregnancy and age of the child for the purpose of dissemination of IYCF nutrition related knowledge. From the next day, mhealth intervention was initiated as all the LHWs registered their participants and they were then followed up every month in their routine visits. They were also counseled and provided with information on using the mobile application and an audio-visual aid which was generated based upon their responses to the questions being asked regarding IYCF.

At the same time, a weekly voice and text message was sent to the mobile phones of the participant to educate them on appropriate IYCF practices. The voice message was sent on Tuesday mornings to the phones of the females and evenings for the husbands/fathers, whereas the text message was sent on Thursday at the same time. The content of both the voice and text messages was the same to avoid confusion. Every month the pregnant women and mothers of children were also called up through our call centre to inquire about the routine LHW visit, whereby they were asked about the visit and whether if they had received the voice and text messages. They were also asked about the content of sent messages which they had received. A monitoring dashboard was used to monitor the LHW activity, whereby the project manager observed whether the visits were actually made using GPS coordinated data. Similarly, the time when the visit was made was also noted along with the time spent in each household. This intervention lasted for six months starting from July to December 2016 followed by a short post intervention research consisting of a focus group discussion with the mothers.

Data collection instrument

A structured, post intervention questionnaire was used for data collection which was developed on the same lines as that of the pre-intervention survey. The initial version of questionnaire was developed through extensive review of literature and experts' review^{20,27}. The questionnaire's Part A comprised of socio-demographic characteristics of the study participants which included age and education level of the women, number of children, family size, place of birth, and mode of delivery. Part B and C contained questions related to breastfeeding, exclusive breastfeeding, and complementary feeding.

The study variables related to knowledge, attitude and practices regarding IYCF were timely initiation of breastfeeding after birth, advisable duration of breastfeeding and exclusive breastfeeding, complementary feeding initiation and continuation, and practices related to prelacteal feeding. The data was collected through telephonic interviews which were indicated as a preference in our formative study. Only if the woman was unreachable via the phone were they then visited at their house for the interview which was facilitated by the respective LHW of the respondents' catchment area.

Statistics analysis

The collected data was double-entered in *EpiData* software version 3.1. It was analyzed using *SPSS* version 21. The total sample size was 135 eligible women which were recruited based on the sampling frame created earlier for the intervention phase. Both descriptive and inferential statistics are reported in frequencies and percentages, including the percentage difference for pre and post knowledge, attitude, and practices related to IYCF nutrition.

Ethical consideration

Ethical clearance was obtained from Hospital Ethics Committee of Pakistan Institute of Medical Sciences (PIMS), Islamabad²⁸. Informed consent (both written and verbal) was

obtained from all study participants prior to their recruitment in the study. These women and their husbands were approached and were explained about the study purpose. Their queries to the study were addressed and they were provided with necessary information to contact in case of withdrawing from the study. They were also ensured about their privacy and confidentiality to be protected.

Results

Table 1 shows baseline characteristics of the 135 mothers, out of which 49 (36.3%) women belong to the age group of 25 to 29 years of age. The mean age of these pregnant and lactating mothers was 30.5 years \pm 4.5 SD. Out of 135 women, 71 (52.6%) had 3 children and on average had 7 family members. Most women i.e. 59 (43.7%) had their education up to Matriculation and Intermediate followed by primary level of education for 48 (35.6%) of the women. The occupation status of 128 (94.8%) of these women was 'unemployed'. The birth place of children as reported by 77 (57.3%) of women was a government facility, and the mode of delivery of 86 (63.7%) women was reported as 'normal'. The common source of water was 'tap water' in the households according to 50 (37%) of women.

The overall pre-intervention knowledge of 34 pregnant mothers regarding breastfeeding, exclusive breastfeeding and complementary feeding was 75.6% which decreased to 46.7% among 21 of these women even after the mhealth intervention. This emphasizes the need of increasing awareness among pregnant women, in particular (**Table 2**). Overall, findings of our survey elucidated that the mhealth intervention was effective in improving the overall knowledge of mothers regarding IYCF from 74 (54.8%) in 2016 to 94 (69.6%) in 2018 after the intervention (**Table 4**).

The overall attitude regarding IYCF among 59 (43.7%) of the mothers before intervention, and among 86 (63.7%) of the mothers after intervention, was found to be positive. Whereas; overall practices of 22 (16.3%) mothers before intervention and 88 (65.2%) of the mothers after intervention were found adherent to good practices (**Table 3**). A noticeable percentage increase in knowledge related to pre-lacteal feeding considered as harmful and the benefits of colostrum was 28.2% and 23%, respectively (**Table 2**).

A percentage difference of 46.4 was observed in attitude of mothers towards consistency of food consumed by their children, which was 12.1% before intervention, and was found to be adequate among 58.5% of the mothers after intervention. Furthermore, practices regarding complementary feeding and additional foods during the first six months of infancy were 0.0% before the intervention which was significantly raised to 66.7% among these mothers (**Table 4**). In addition, 55 (40.7%) of the mothers reported to be visited 'once' by LHW, followed by 49 (36.3%) of the mothers who were visited 'twice' on a monthly basis (**Table 1**). Pre- and post-intervention findings are available as Underlying data²⁴.

Discussion

For child survival, growth and development, a key strategy is to improve IYCF related practices which is becoming

Table 1. Socio-Demographic characteristics of pregnant & lactating mothers in rural Islamabad, during 2016–2018 (n=135).

Characteristics	Frequency	Percentage (%)
Age in years (30.5\pm 4.5)		
15–19	01	0.7
20–24	10	7.4
25–29	49	36.3
30–34	44	32.6
35–39	31	23.0
Number of Children (alive)		
01	05	3.7
02	32	23.7
03	71	52.6
04	14	10.4
05	13	9.6
Family Size		
Average	6.56	-
Minimum	03	2.2
Maximum	13	0.7
Education		
Illiterate*	13	9.6
Primary	48	35.6
Matric/Intermediate	59	43.7
Graduation	15	11.1
Occupation		
Employed	07	5.2
Unemployed	128	94.8
Place of Birth		
Government Facility	77	57.3
Private Facility	58	43.0
Mode of Delivery		
Normal Delivery	86	63.7
C-Section	49	36.3
Monthly LHW Visits		
Once	55	40.7
Twice or more	49	36.3
Never	22	16.3
Don't Know/Don't Remember	09	6.7
Source of Water		
Tap Water	50	37.0
Well Water	46	34.1
Boiled Water	16	11.9
Mineral Water	08	5.9
Tube Well	15	11.9

* No Formal Education, LHW=Lady Health Worker

Table 2. Knowledge regarding infant and young child feeding (IYCF) nutrition among pregnant & lactating women in rural Islamabad, during 2016–2018 (n=135).

Knowledge Questions	Correct Responses	Before (%)	After (%)	Percentage Difference
Breastfeeding initiation after birth	Within one hour of birth	80.2	74.8	-5.4
Prelacteal feed for baby	Harmful	38.5	66.7	28.2
Benefits of Colostrum	Rich in nutrients & provides immunity	58.5	81.5	23
Advisable duration of Breastfeeding	1–2 year	94.5	81.5	-13.0
Understanding about exclusive breastfeeding	Exclusively giving mother's milk for first 6 months and nothing else	80.2	79.3	-0.9
Complementary food initiation	At 7 months	7.7	5.9	-1.8

Table 3. Overall knowledge, attitude & practices regarding infant and young child feeding (IYCF) nutrition among pregnant & lactating women in rural Islamabad, during 2016–2018 (n=135).

	Pre-Intervention (2016)		Post-Intervention (2018)	
	N	(%)	N	(%)
Knowledge	74	54.8%	94	69.6%
Attitude	59	43.7%	86	63.7%
Practice	22	16.3%	88	65.2%

Table 4. Attitude & practices regarding infant and young child feeding (IYCF) nutrition among pregnant & lactating women in rural Islamabad, during 2016–2018 (n=135).

Attitude Questions	Correct Response	Before (%)	After (%)	Percentage Difference
Prelacteal feed be given to born baby	No	62.9	63.7	0.8
A mother should breastfeed when she is ill	Should breastfed	73.6	78.5	4.9
Consistency of complementary food	Thick and sticky	12.1	58.5	46.4
Practice Questions				
Breastfeed baby within 1 hour of birth	Yes	51.6	74.8	23.2
Complementary feeding	3 Times	41.8	40.7	-1.1
Additional food during first 6 months	Nothing	0.0	66.7	66.7

an essential component of child health programs in various countries²⁹. The results of our post-mhealth intervention survey regarding IYCF conducted in a rural territory in Islamabad yielded to be effective in improving the knowledge, attitude, and practices of pregnant and lactating mothers. Based on findings of our earlier research conducted on the same study population we found that community-based nutritional intervention such as 'mhealth' offer new opportunities for effective and efficient service delivery, resource utilization, and improving access to healthcare³⁰.

Improving IYCF practices in poor resource setting can be effectively contextualized through information technology involving mhealth. Specific socio-cultural and socio-economic barriers hindering access of mothers for acquiring information related to IYCF must be overcome in order to reduce the prevailing burden of preventable malnutrition³¹. Studies suggest that maternal literacy plays important role whereas healthcare services can be augmented through the use of mobile phone-based technology such as mhealth^{31,32}. It offers enormous opportunities for improving health indicators related to maternal, new born and child

health specifically in rural settings. It was found in one study that mhealth or SMS-based health education could provide an essential chance to educate pregnant and lactating mothers about antenatal care (ANC) visits, child birth, and education related to family planning³². This indicates that there is a potential capacity to implement mhealth based IYCF which may render opportunities for scaling up the intervention in rural Islamabad. The findings of our survey elucidate that specific focus should be placed on the components of knowledge related to breastfeeding and exclusive breastfeeding during early infancy. However; relevance and quality of mhealth to other components of maternal and child health must be rigorously studied to promote the proliferation of mobile phones as a source of acquiring health information in LMICs.

Despite the improvement in overall knowledge, attitude and practices of women related to IYCF in our study, certain important components related to breastfeeding showed steady findings. The knowledge of women regarding advisable duration of breastfeeding, early initiation of breastfeeding after birth, and timely complementary feeding initiation with additional food to be given to in early 6 months of infancy showed no significant change after mhealth intervention. This could be attributed to a prolonged washout period after the deployment of mhealth intervention among the mothers or it can possibly be subject to recall bias. Despite this more than a quarter of women in our study still practised and considered prelacteal feed such as honey and water as advantageous for the infant. This was found to be consistent to the findings of research studies conducted in Myanmar, Ethiopia & India where prelacteal feeding was perceived as a cultural practice and was related to maternal beliefs^{33–36}.

There seems to be a paucity of relevant available literature on assessing the effectiveness of mhealth, particularly in the context of infant and young child nutrition particularly in Pakistan³⁰, which signifies its importance in implementing such interventions in poor resource settings. In contrast to our earlier research findings on testing the acceptance of mhealth among women residing in Tarlai Kalan Islamabad, a study from Sri Lanka demonstrated that women preferred to interact with healthcare providers on their maternity and child health needs³⁷. Contrary to it, in our study majority of women favoured the use of mobile phones to access information related to infant and young child feeding. On the basis of which, we therefore recommend scaling up of the health intervention in poor resource settings for the purpose of providing knowledge and increasing awareness regarding IYCF. Our study findings reflect that extensive mobile coverage has emerged as an innovative tool in rural Islamabad, and has acted as a facilitator which can effectively reach the underserved communities for providing health as well as education regarding infant and young child nutrition.

Strengths and limitations

- Overall, the strength of the deployed intervention lies in an increase in the practices of mothers related to IYCF nutrition
- This was a novel intervention, the first of its kind in Pakistan

- We have managed to incorporate the intervention within the existing LHW program rather integrating a new intervention so as to enable the intervention to be scaled up feasibly
- One of our study limitations is that we conducted telephonic interviews which can introduce potential biases in responses of the mothers unlike in face-face interview approach.
- Quasi-experimental designs have limitations as compared to experimental designs since it includes no randomization

Conclusion

Our study indicates that community-based nutritional interventions using mhealth are innovative and effective in increasing IYCF related knowledge, attitude and practices among mothers. Cost-effectiveness of such behaviour change approaches and interventions should be assessed for future implementation in maternal and child health related programmes. Further experimental studies must be explored to validate the findings in Pakistani context.

Software availability

The source code of android phone-based application developed for the Lady Health Workers (LHWs) under the project “Sehatmnd KI” is the property of Maternal, Neonatal and Child Health Research Network (MNCHRN) and cannot be made public.

All content used in the app to provide information to the recruited mothers is available as Extended data²⁴.

Data availability

Underlying data

Open Science Framework: Effectiveness of mhealth on IYCF. <https://doi.org/10.17605/OSF.IO/VRHA5>²⁴

This project contains the following underlying data:

- Data Set Epi Data.zip (Data entry sheet on Epi Data 3.1)
- Post Analysis.sav (Output file of data analysis on SPSS version 21)
- Pre & Post Scoring _Pregnant.sav (SPSS file of pre & post entered data)

Extended data

Open Science Framework: Effectiveness of mhealth on IYCF. <https://doi.org/10.17605/OSF.IO/VRHA5>²⁴

This project contains the following extended data:

- Finalized__0-6__months[1].pdf (Pre-intervention survey for 0–6 month infants)
- Finalized__7-12__months[1].pdf (Pre-intervention survey for 0–6 month infants)
- Finalized_Pregnancy_survey[1].pdf (Pre-intervention survey for mothers in final trimester)
- Intervention Application.zip (content from Android app)

Acknowledgement

We would like to thank the South Asian Infant Feeding Research Network and the University of Sydney for supporting the development of this mHealth intervention. We also would like to

acknowledge Dr. Baseer Achakzai from Ministry of National Health Services, Regulations & Coordination, Pakistan as well as the LHWs, District Health Officer and Assistant District Coordinator from Islamabad. Also, we would like to acknowledge International Research Force for facilitation in data collection process.

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Open Peer Review

Current Peer Review Status: ? ? ✓

Version 3

Reviewer Report 28 October 2019

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Alexandre Delamou 

Department of Public Health, Gamal Abdel Nasser University of Conakry, Conakry, Guinea

I thank the authors for their efforts to address all my comments in their new version. I have no additional comments.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Public Health

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Version 2

Reviewer Report 19 August 2019

<https://doi.org/10.5256/f1000research.22004.r51735>

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Zohra Lassi 

The Robinson Research Institute, The University of Adelaide, Adelaide, SA, Australia

I feel the reference should be cited at the end of the sentence. My comment #2 and #5 needs to be addressed.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Maternal and child health

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 08 Oct 2019

Subhana Khan Akber, Maternal, Neonatal and Child Health Research Network, Islamabad, Pakistan

References have been cited at the end of the sentences mentioned in comment number 2 and 5.

Competing Interests: All authors declare no conflict of interest.

Author Response 08 Oct 2019

Subhana Khan Akber, Maternal, Neonatal and Child Health Research Network, Islamabad, Pakistan

References have been updated.

Competing Interests: All authors declare no conflict of interest.

Reviewer Report 29 July 2019

<https://doi.org/10.5256/f1000research.22004.r51736>

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Alexandre Delamou 

Department of Public Health, Gamal Abdel Nasser University of Conakry, Conakry, Guinea

I thank the authors for their efforts to address the comments made on the first version. Most of my comments have been addressed but still, I think they omitted one:

1. In the limitations section, it is important to acknowledge the fact that the quasi-experimental design bears some limitations as compared to experimental designs. In the conclusion section, I would say that we need experimental designs to confirm/validate their results in the Pakistani context.

Thank you.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Public Health

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 08 Oct 2019

Subhana Khan Akber, Maternal, Neonatal and Child Health Research Network, Islamabad, Pakistan

Revised as per kind suggestion.

Competing Interests: We declare no conflict of interest.

Author Response 08 Oct 2019

Subhana Khan Akber, Maternal, Neonatal and Child Health Research Network, Islamabad, Pakistan

Revised as per kind suggestions.

Competing Interests: All authors declare no conflict of interest.

Version 1

Reviewer Report 23 May 2019

<https://doi.org/10.5256/f1000research.18626.r47681>

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Alexandre Delamou

Department of Public Health, Gamal Abdel Nasser University of Conakry, Conakry, Guinea

I have provided my comments directly in a [PDF document](#) because the manuscript pages are not numbered to facilitate the reviewer's work.

My main comments are:

- The intent of the authors is good. They made a lot of effort to well describe the intervention and conduct pre- and post-intervention surveys.

However:

- The design does not optimistic conclusions. I think the authors should be very modest and discuss some key limitations: the selection was not randomly done, there was no comparator to your study (cluster randomized trial). Also, the questionnaire was quantitative and you did not capture the qualitative aspect of the intervention (feasibility, acceptability, sustainability, etc).
- The introduction is long but the authors did not use the space to justify the study in Pakistan. Just saying that "there is insufficient information" is not the good justification.
- There are many typos in the text, I have flagged some but the text needs some corrections.

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Public Health

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 21 Jul 2019

Subhana Khan Akber, Maternal, Neonatal and Child Health Research Network, Islamabad, Pakistan

Reviewer 3: Alexandre Delamou, Department of Public Health, Gamal Abdel Nasser University of Conakry, Conakry, Guinea

I have provided my comments directly in a PDF document because the manuscript pages are not numbered to facilitate the reviewer's work.

Suggested changes revised in the manuscript. PDF file is sent for review comments.

My main comments are:

The intent of the authors is good. They made a lot of effort to well describe the intervention and conduct pre- and post-intervention surveys.

However: The design does not optimistic conclusions. I think the authors should be very modest and discuss some key limitations: the selection was not randomly done, there was no comparator to your study (cluster randomized trial). Also, the questionnaire was quantitative and you did not capture the qualitative aspect of the intervention (feasibility, acceptability, sustainability, etc).

We opted for quasi-experimental (pre-post) design and convenience-based sampling was done for the selection of participants form the sampling frame. The qualitative component, we covered in the formative study where we tested the acceptance of the intervention mentioned in the introduction section, last paragraph.

The introduction is long but the authors did not use the space to justify the study in Pakistan. Just saying that "there is insufficient information" is not the good justification.

Revised in the introduction.

There are many typos in the text, I have flagged some but the text needs some corrections.

Corrections have been made in the text.

Competing Interests: None.

Reviewer Report 21 May 2019

<https://doi.org/10.5256/f1000research.18626.r47677>

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Ejaz Ahmad Khan

Department of Epidemiology and Biostatistics, Health Services Academy (HSA), Islamabad, Pakistan

General comments:

This is a good effort by the authors to introduce mHealth in overcoming the barriers to achieving optimum IYCF. The article is not written very well. There are numerous English language comprehension and spelling (perhaps typo) mistakes. The authors leave the reader confused about their sampling frame at several places, and text is some times extremely haphazard. The tables are cited irrespective of their order as they appear in the article. Discussion lacks critical points from results discussed. There is an element of publication bias and misinterpretation of technical terms such as Recall Bias (contrary to how it is defined in text books of epidemiology). About 30% of the references are more than five years old.

Specific comments:

Abstract:

- The abstract reports only the positive findings without highlighting the negative findings. It also concludes for effectiveness, whereas, no test of significance was applied, and just uses the difference in percentages as proof of significant effectiveness.

Methods:

- Ten can be written as 10, as numbers below 10 are written in words only.
- For intervention part, the authors had messages translated to Urdu from English just once. However, the standard is to back translate it in English so that they are exactly the same as they were before the initial translation.
- The paragraph on "intervention design" needs rephrasing as the text is confusing. Similarly, the paragraph on "messages" also needs rephrasing, so that the reader easily understand what the authors wanted them to know.
- Sampling frame creates big confusion. In the start it is 0-24 months of age children. But then it changes to 0-12 months in the later text (mobile application part). Further, in the flow diagram, this age group is further subdivided into 0-6 and 7-24 months of age. It is unclear how the application designed only for 0-12 months of age could have catered for age group beyond 12 months. The flow diagram has repeatedly wrong spellings of "participants". In paragraph three, following the heading "mobile application" again contradicts the 7-24 months of age and states 7-12 months of age.
- age 6, paragraph two, the text has not been able to explain to the reader whether the SIM and mobile were acquired for the LHWs or for all the participants. This should be clearly stated and differentiated.

Additional points for methods:

- For practices, why were there non-direct or indirect observations? The acquired knowledge of the participants during the intervention can lead to over reporting of good practices to please the researchers (Hawthorne effect). Furthermore, did the researchers take into an account the effect of other sources of knowledge (confounders), which could supplement or negatively impact their intervention, and how did they take care of them and controlled those factors?

Results:

- Results are divided into descriptive and inferential statistics. However, no test of significance was applied for the inferential statistics. Just on the bases of difference of percentages in pre- and post- is insufficient to claim significant effectiveness.
- The results should be written in order of the objectives of the study as they were achieved.
- The tables are cited without proper and ascending sequence.

Discussion:

- Instead of discussing the mHealth intervention in length, depicting their inclination towards supporting their positive results only, the authors should do impartial and unbiased discussion. They should also discuss the implication of negative results, why some practices also increased while a few declined, what could be the underlying factors (supported by literature), claiming that the women favored the use of mobile phone to access information was not supported by any result given in the text.

References:

- About 30% of references were of more than five years old.

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Epidemiology, systematic analyses, environmental health, nutrition, immunization, communicable and non-communicable disease, injuries, research methods

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 21 Jul 2019

Subhana Khan Akber, Maternal, Neonatal and Child Health Research Network, Islamabad, Pakistan

Reviewer 2: Ejaz Ahmad Khan, Department of Epidemiology and Biostatistics, Health Services Academy (HSA), Islamabad, Pakistan

General comments:

This is a good effort by the authors to introduce mHealth in overcoming the barriers to achieving optimum IYCF. The article is not written very well. There are numerous English language comprehension and spelling (perhaps typo) mistakes. The authors leave the reader confused about their sampling frame at several places, and text is sometimes extremely haphazard. The tables are cited irrespective of their order as they appear in the article. Discussion lacks critical points from results discussed. There is an element of publication bias and misinterpretation of technical terms such as Recall Bias (contrary to how it is defined in text books of epidemiology). About 30% of the references are more than five years old.

The comprehension mistakes have been corrected. Sentences regarding sampling frame have been rephrased. Tables have been cited correctly and in ascending order. We mentioned that we were handicapped on finding useful literature related to mhealth in our context for the discussion section. Recall bias is a systematic error introduced in the study due to providing inaccurate answers to questions, similarly mothers who were interviewed were found indecisive to answer the questions at some points which can be attributed to long wash out period after intervention. There are 12 references that are more than five years old, due to limited available data so we searched literature that is available in past 10 years.

Specific comments:

Abstract:

The abstract reports only the positive findings without highlighting the negative findings. It also concludes for effectiveness, whereas, no test of significance was applied, and just uses the difference in percentages as proof of significant effectiveness.

Negative findings have been reported in the results and tables. Since it was not a trial therefore by effectiveness we mean the success of deploying mhealth intervention for IYCF. Hence, differences were calculated pre-post to assess the increase in knowledge, attitude and practices among the study participants.

Methods:

Ten can be written as 10, as numbers below 10 are written in words only.

Revised

For intervention part, the authors had messages translated to Urdu from English just once. However, the standard is to back translate it in English so that they are exactly the same as they were before the initial translation.

The messages were back translated into English language, the text has been revised.

The paragraph on "intervention design" needs rephrasing as the text is confusing. Similarly, the paragraph on "messages" also needs rephrasing, so that the reader easily understand what the authors wanted them to know.

Rephrased

Sampling frame creates big confusion. In the start it is 0-24 months of age children. But then it changes to 0-12 months in the later text (mobile application part). Further, in the flow diagram, this age group is further subdivided into 0-6 and 7-24 months of age. It is unclear how the application designed only for 0-12 months of age could have catered for age group beyond 12 months. The flow diagram has repeatedly wrong spellings of "participants". In paragraph three, following the heading "mobile application" again contradicts the 7-24 months of age and states 7-12 months of age.

The mobile application part is the intervention phase where mothers having children of 0-12 months of age were recruited in 2016 but messages were sent according to the age groups defined which were from 0-6 months and 7-12 months. Later on in the post-intervention survey which was conducted in 2018, we included the same population but the age of the children was set 0-24 months so to match the ages of children. Spelling errors have been corrected. In the paragraph three, the age group refers to the pre-intervention phase.

Age 6, paragraph two, the text has not been able to explain to the reader whether the SIM and mobile were acquired for the LHWs or for all the participants. This should be clearly stated and differentiated.

Revised. The text has been mentioned in paragraph two, line number 11.

Additional points for methods:

For practices, why were there non-direct or indirect observations? The acquired knowledge of the participants during the intervention can lead to over reporting of good practices to please the researchers (Hawthorne effect). Furthermore, did the researchers take into an account the effect of

other sources of knowledge (confounders), which could supplement or negatively impact their intervention, and how did they take care of them and controlled those factors?

Practice-based knowledge questions were asked from the study participants without observation. We did not take into account Hawthorne effect or other confounding factors though we have mentioned that this evaluation was conducted after 2016 in 2018 and have mentioned in limitations about potential biases.

Results:

Results are divided into descriptive and inferential statistics. However, no test of significance was applied for the inferential statistics. Just on the basis of difference of percentages in pre- and post-is insufficient to claim significant effectiveness.

For effectiveness we referred to it the success of using mhealth for dissemination of knowledge regarding IYCF.

The results should be written in order of the objectives of the study as they were achieved.

The tables are cited without proper and ascending sequence.

Revised and table have cited correctly in ascending order.

Discussion:

Instead of discussing the mHealth intervention in length, depicting their inclination towards supporting their positive results only, the authors should do impartial and unbiased discussion. They should also discuss the implication of negative results, why some practices also increased while a few declined, what could be the underlying factors (supported by literature), claiming that the women favored the use of mobile phone to access information was not supported by any result given in the text.

Decrease of some practices has been ascribed to prolong wash period mentioned in the text paragraph 3 line number 6. The discussion might be read as narrow due to limited evidence on use of mhealth for IYCF knowledge and quality of mhealth for MNCH programs. But negative results have been discussed and supported by literature in paragraph two line numbers 3 & 5, paragraph three line number 10. The use of mobile phone to access information was been demonstrated by the results of our formative study.

References:

About 30% of references were of more than five years old.

There are 12 references that are more than five years old, due to limited available data so we searched literature that is available in past 10 years.

Competing Interests: None.

Reviewer Report 08 May 2019

<https://doi.org/10.5256/f1000research.18626.r47680>

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Zohra Lassi 

The Robinson Research Institute, The University of Adelaide, Adelaide, SA, Australia

Comments:

- Abstract-Results: After the intervention, the overall knowledge of mothers regarding IYCF nutrition was raised to 69.6% among 94 mothers as compared to 74 (54.8%). Please complete the sentence, 74 (54.8%) in the comparison group?
- Introduction - Second Paragraph - first line: Needs a reference.
- Introduction - Second Paragraph - third line: Reference 6 should be hyper-script.
- Introduction - Second Paragraph: Developing countries should be replaced with low- and middle-income countries.
- Introduction - Second Paragraph: The sentence "According to the Pakistan Demographic Health Survey (PDHS, 2018), almost 38% of children under five years of age are stunted, 23% are underweight, and 7% are wasted" needs a reference.
- The words developing countries and LMICs should be used consistently. In the current form, both have been used interchangeably.
- The IYCF acronym was introduced in the first paragraph of the Introduction, and still used in full several times in the Introduction.
- Abstract - methods: The date of study mentioned was May to June 2018. However in the Introduction, it was mentioned that it was piloted in 2016 and evaluated between April to June 2018. Please check the dates and provide the correct one.
- Under mobile applications - Second Paragraph: Please add "study" in the sentence: "Consent to be a part of the was also obtained for participating in the project,"
- Please provide the name of the smart phone application that was created?
- It would be more informative, if the interface of the application is attached to the paper and the type of options available for the participants to receive information on IYCF.
- Discussion: Please indicate if there is agreement of the results with the earlier studies?

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Partly

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Partly

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Maternal and child health

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 21 Jul 2019

Subhana Khan Akber, Maternal, Neonatal and Child Health Research Network, Islamabad, Pakistan

Responses to Reviewers

Reviewer 1: Zohra Lassi, The Robinson Research Institute, The University of Adelaide, Adelaide, SA, Australia

- Abstract-Results: After the intervention, the overall knowledge of mothers regarding IYCF nutrition was raised to 69.6% among 94 mothers as compared to 74 (54.8%). Please complete the sentence, 74 (54.8%) in the comparison group?

Added as suggested

- Introduction - Second Paragraph - first line: Needs a reference.

Provided at the end of completing the sentences at line 4

- Introduction - Second Paragraph - third line: Reference 6 should be hyper-script.

Revised as suggested

- Introduction - Second Paragraph: Developing countries should be replaced with low- and middle-income countries.

Revised as suggested

- Introduction - Second Paragraph: The sentence "According to the Pakistan Demographic Health Survey (PDHS, 2018), almost 38% of children under five years of age are stunted, 23% are underweight, and 7% are wasted" needs a reference.

Reference number 10 is provided at line number 10.

- The words developing countries and LMICs should be used consistently. In the current form, both have been used interchangeably.

Revised as suggested

- The IYCF acronym was introduced in the first paragraph of the Introduction, and still used in full several times in the Introduction.

Revised as suggested

- Abstract - methods: The date of study mentioned was May to June 2018. However in the Introduction, it was mentioned that it was piloted in 2016 and evaluated between April to June 2018. Please check the dates and provide the correct one.

Revised as suggested

- Under mobile applications - Second Paragraph: Please add "study" in the sentence: "Consent to be a part of the was also obtained for participating in the project,"

Added as suggested

- Please provide the name of the smartphone application that was created?

The name of application was "mhealth" and is mentioned in the text.

- It would be more informative, if the interface of the application is attached to the paper and the type of options available for the participants to receive information on IYCF.

Regarding the interface of the application, we have mentioned under heading of software availability that “the source code of android phone-based application developed for the Lady Health Workers (LHWs) under the project “Sehatmnd KI” is the property of Maternal, Neonatal and Child Health Research Network (MNCHRN) and cannot be made public.”

- Discussion: Please indicate if there is agreement of the results with the earlier studies?
The text has been highlighted under the heading of discussion.

Competing Interests: None.

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