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Efficacy of mobile app-based training on health literacy among pregnant women: A randomized controlled trial study

Parisa Farzi Karamolahi[a], Zahra Bostani Khalesi[b,*], Maryam Niknami[b]

[a] Student Research Center, Guilan University of Medical Sciences, Rasht, Iran
[b] Social Determinants of Health Research Center, Guilan University of Medical Sciences, Rasht, Iran

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ABSTRACT

Objective: : Health literacy of mothers during pregnancy shows social and cognitive skills indicating the motivation and ability of mothers to receive and use useful knowledge to maintain and promote the health of themselves and their children. The present study was conducted aimed to determine the effect of mobile app-based training on health literacy among pregnant women.

Study design: A random allocation clinical trial was conducted on 140 eligible mothers. All participants were randomly allocated to the experimental and control groups. Data collection tools included personal information and maternal health literacy questionnaires. The questionnaires were completed and then a mobile app-based training intervention was performed for the experimental group. The participants of the experimental group were asked to read the contents of the software once a week for 8 weeks. The questionnaires were completed again after 8 weeks of the training intervention. The data were analyzed using SPSS software version 21. Independent t-test, Mann-Whitney U, Wilcoxon, Fisher, Chi-square, Kruskal-Wallis, and one-way analysis of variance was used for this purpose.

Results: The participants showed no statistically significant difference in terms of demographic-social information ($p > 0.05$). The mean change in health literacy scores after the intervention was statistically significant between the experimental and control groups ($p < 0.001$). Also, the mean change in health literacy scores before and after the intervention in the experimental group was statistically significant ($p < 0.001$). But this change in the control group was not statistically significant ($p = 0.609$).

Conclusions: For the first time we used mobile app-based training and results showed that it is effective in the health literacy of pregnant women especially in situations like the Corona Virus pandemic. Therefore, it is suggested that health care providers, especially midwives, use this training method to promote the health literacy of pregnant women.

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Introduction

Health literacy is one of the biggest determinants of health that is essential for improving social services and the economic development of individuals [1]. Health literacy is the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions [2]. Today, health literacy is recognized as a vital and important index of health costs and its absence increases the hospitalization rate and the use of medical services [3,4]. According to a study by Dadipour et al., half of the pregnant mothers have inadequate health literacy and inadequate health literacy prevents proper understanding of health messages and information [5].

Improvement in the health literacy of pregnant women is effective in receiving correct and timely care services from health centers [6]. Maternal health literacy is specific knowledge and special social skills to diagnose the risk factors of pregnancy, a healthy lifestyle, and proper nutrition during pregnancy and is effective on improve pregnancy outcomes by improving the quality of pregnancy care [7]. Prenatal care is one of the maternal and child health programs that, if adequately provided, can be an effective intervention to improve pregnancy, including reducing infant mortality, maternal mortality due to pregnancy and childbirth, and especially perinatal mortality [8].

The World Health Organization (WHO) has also emphasized the promotion of health literacy for pregnant women as a primary population [9]. Maternal health literacy is very important in pregnant mothers' understanding of prenatal risks because the

* Corresponding author at: Department of Midwifery, Nursing and Midwifery School of Shahid Dr. Beheshti, Rasht, Guilan, Iran.
E-mail address: z_bostani@yahoo.com (Z. Bostani Khalesi).

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mothers' understanding of risks may affect their desire to follow pregnancy advice [10].In a study by Cho et al., mothers with lower health literacy began prenatal care later and their infants were more prone to low birth weight [11]. The promotion of health literacy requires effective training, planning, and intervention [3]. With the spread of information technology, training methods have changed significantly [12]. One of these changes was the use of new communication tools to facilitate the transfer of information and improve the quality of training and learning [13]. A new training methods that are effective in reducing costs and eliminating barriers to access services such as spatial and temporal factors was training through mobile apps [14]. Learning through mobile apps can be limitless due to the flexibility and high computing power of mobile technologies [15]. Availability of mobile phones and the use of mobile phone reminders have increased health promotion behaviors. This effect insists on the use of new technologies especially mobile phone in health education as the mobile phone is accessible nearly by all populations and can be used to overcome various barriers in health education including access to different social groups, lack of financial resources, and limited physical environment. Furthermore, as mobile health does not require physical participation in health centers, it can be used in educating large populations without the time and geographical limitations [16]. Regarding the high importance of health literacy of pregnant women and the ability of apps with data transfer as well as ease of access to training materials at any time of the day and night, this study was conducted to determine the effect of mobile app training on health literacy in pregnant women.

Materials and methods

This is an randomized controlled trial (RCT) study aimed to determine the effect of mobile app training on health literacy in pregnant women. Among 500 eligible pregnant women, 140 passed inclusion criteria (Iranian citizenship, minimum age 18, maximum age 45, pregnant for the first time, gestational age 6–12 weeks, reading and writing literacy, no underlying and chronic disease, no medical training, a mobile phone with system Android and the ability to install the app, the ability to use and work with the mobile app, lack of experience in participating in a training program of pregnancy care, and interest in participating in the study). Exclusion criteria included: unwillingness to continue participating in the study or not using the training app installed the desired number of times. The number of samples was determined n = 53 in each group, taking into account a 95 % confidence interval and 90 % test power. Taking into account a 25 % drop, the sample size increased to 70 in each group. The sampling method of this study was the random method so that the participants were assigned numbers 1–140, respectively. A Table with 35 rows was designed as a block and each part of it was named with the letters A and B. At the next stage, the numbers were placed in each cell in order, then all the numbers were placed in blocks. 35 quadruple

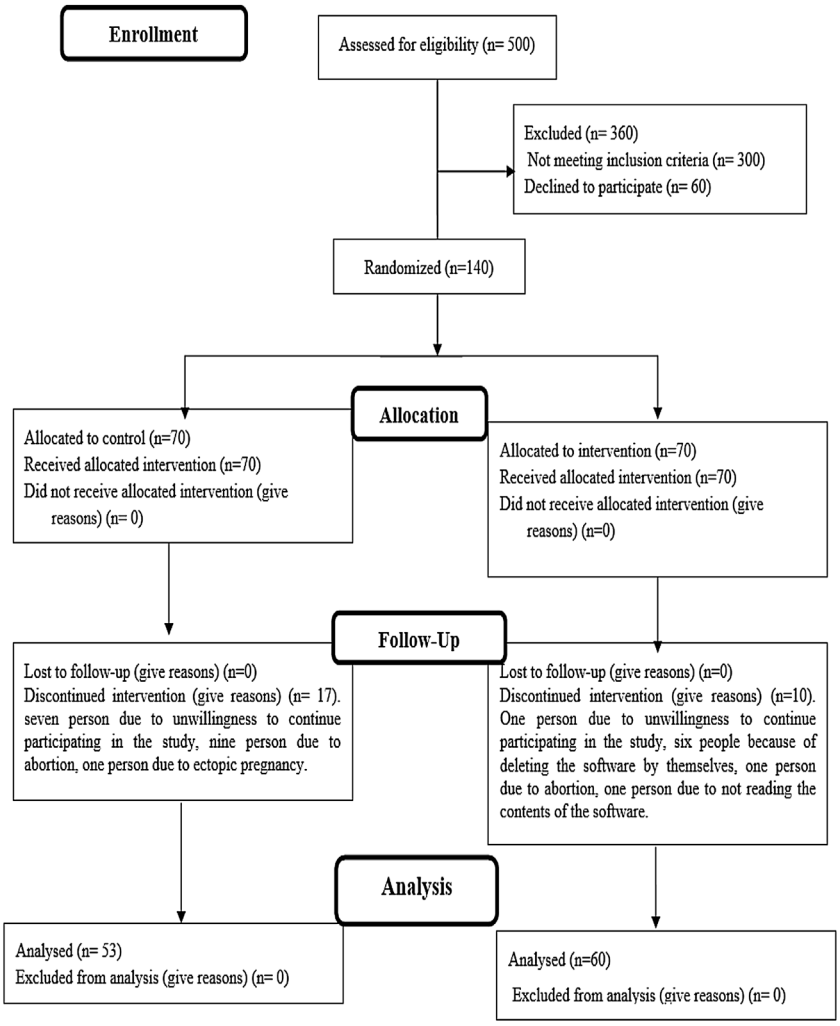

Fig. 1. Consort flow diagram.

blocks were randomly drawn. The blocks were selected daily after the start of the study by a person who did not know the type of blocks. Those in house A were placed in the experimental group and those in house B were placed in the control group.

The blocks were selected daily after the start of the study by a person who did not know the type of blocks. People in house A were placed in the experimental group and people in house B were placed in the control group.

The data collection tool in this study was a questionnaire consisting of two parts. The first part was the demographic information questionnaire (women and spouse age, women and spouse education level, women and spouse's occupation, women's income, and place of residence) and the second part was the Maternal Health Literacy and Pregnancy (MHLAP). The MHLAP has 14 items. The range of maternal health literacy scores is from 14 to 70. The items of this questionnaire are based on a 5-option Likert scale of Totally Agree (Score 5), Agree (Score 4), No idea (Score 3), Disagree (Score 2), and Totally Disagree (Score 1). A higher score shows more health literacy. The Maternal Health Literacy Questionnaire was developed by Mojoyinola (2011) in Nigeria [17], and localized in Iran by Kharazi et al. [18]. The Cronbach's alpha coefficient was 0.89 for health literacy and 0.67 for pregnancy outcome.

The mobile app, based on the items of the MHLAP questionnaire (changes and adaptations of the body during pregnancy, the fetus development, pregnancy care, tests, vaccinations, nutrition, taking supplements, personal hygiene, employment, travel, rest, exercise, sex, addiction, taking medication, pregnancy risk factors, neonatal care, bathing and breastfeeding, neonatal risk factors, vitamin taking, baby position, and coverage) was installed on smartphones in the experimental group and the mother was taught how to use the training app. One week after installing the app on the mobile phone of the mothers of the experimental group, possible questions and problems in using the app were answered during a telephone call. Then, every week, participants were reminded about using the app via SMS, and the researcher's phone number was provided to the participants so that they could contact the researcher if she had any questions about the app. Eight weeks later, MHLAP was completed by the questioner in both groups. The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Statistical analysis

Statistical analysis was performed using descriptive and inferential statistical methods. In order to compare the experimental and control groups before and after the training intervention based on the mobile app, we used statistical tests, including independent t-test, U Mann-Whitney test, and Wilcoxon test by SPSS software version 16. The difference was considered significant at a significant level of $P < 0.05$.

Results

At the end of the study, among 140 pregnant women (70 pregnant women in the experimental group and 70 pregnant women in the control group), 10 women in the experimental group (1 participant due to unwillingness to continue participating in the study, 6 participants due to app deletion by themselves, 1 participant due to abortion and 2 participants due to not reading the app) and 17 participants in the control group (7 participants due to unwillingness to continue participating in the study, 9 participants due to abortion, and 1 participant due to ectopic pregnancy) were excluded from the study (Fig. 1).

The mean age of participants was 30.1 ± 5.66; the majority of participants had a diploma (38.05 %) and were homemakers (84.96 %).

The mean age of the spouses was 33.6 ± 5.7 years. The majority of spouses had a high school education and diplomas (40.71 %), and the majority of spouses were self-employed (76.11 %). The monthly homemaker income of the majority (46.90 %) of the participants had incomes between one to one and a half million.

According to the information in Table 1, before and after the intervention, the changes in the health literacy score are statistically significant. The mean score of health literacy before the intervention in the experimental group was 45.35 ± 6.75 and 42.02 ± 7.41 in the control group. In addition, the mean score of health literacy after the intervention in the experimental group was 58.03 ± 6.57 and 42.23 ± 8.47 in the control group. The change in health literacy score before and after the intervention was 12.68 ± 6.31 in the experimental group and 0.21 ± 4.25 in the control group. In the study of intragroup changes, the changes were significant only in the experimental group based on the Wilcoxon test ($p < 0.001$).

According to the inter-group comparison of the health literacy score before and after the intervention according to the age of the spouse using the Wilcoxon test, a statistically significant difference was observed in the age groups of 30 years and younger and 31 years and older ($p < 0.001$). According to the intragroup comparison of the health literacy score before the intervention in terms of the level of education of the spouse using a one-way analysis of variance test, a statistically significant difference was between the participants ($p = 0.004$). According to the intergroup comparison, health literacy score before and after the intervention in terms of the spouse's education using Wilcoxon test, the score changes before and after the training intervention in the primary school ($p = 0.014$), elementary school ($p = 0.001$), high school and diploma groups ($p < 0.001$), Associate degree ($p = 0.036$) and bachelor and higher ($p = 0.006$) were significantly different.

Table 1
Comparison of health literacy of the two groups: before and after intervention.

Health literacy		Study group		Significance level	Statistical test type
		Experimental(60)	Control (53)		
Before the intervention	M	45.35	42.02	*<0.014	Independent t-test
	SD	6.75	7.41		
	Median	44	42		
After the intervention	M	58.03	42.23	*<0.001	Mann–Whitney U
	SD	6.57	8.47		
	Median	59	42		
Changes of health literacy score before and after the intervention	M	12.68	0.21	*<0.001	
	SD	6.31	4.25		
	Median	13	0.001		
Significance level		*<0.001	0.609		
Statistical test type		Wilcoxon			

* Significance.

Table 2
Intervention effect on changes in health literacy score after controlling the effects of confounding variables.

Variable	Unstandardized Coefficients		Standard error	Significance level	Beta 95 % confidence interval	
	Beta Regression coefficient	Regression coefficient standard error	Beta		Lower bound	Upper bound
(Constant)	−12.268	1.652		0.000	−15.542	−8.995
Intervention	12.476	1.026	0.756	0.000	10.443	14.509
(Constant)	−3.358	3.141		0.287	−9.582	2.865
Intervention	13.243	1.011	0.802	0.000	11.24	15.246
Health literacy scores before the intervention	−0.230	−0.070	−0.201	0.001	−0.369	−0.091
(Constant)	−3.066	3.099		0.325	−9.208	3.077
Intervention	13.421	1	0.813	0.000	11.438	15.403
Health literacy scores before the intervention	−0.181	0.073	−0.158	0.015	−0.326	−0.036
Education of spouse	−0.931	0.455	−0.129	0.043	−1.832	−0.030

[a]Dependent Variable: Health literacy score changes before and after the intervention R Square =) 0.624).

According to the intragroup comparison of the health literacy score before the intervention according to the occupation of the spouse using a one-way analysis of variance test, a statistically significant difference was observed between the participants ($p < 0.001$). According to the intergroup comparison of the health literacy score before and after the intervention in terms of the level of occupation of the spouse using the Wilcoxon test, a significant difference was between the participants in the group of employee ($p = 0.009$), worker ($p = 0.018$) and self-employed ($p < 0.001$).

According to the intragroup comparison of the health literacy score before the intervention in terms of monthly income using a one-way analysis of variance test, a statistically significant difference was observed between the participants ($p = 0.012$).

According to the intergroup comparison of health literacy score before and after the intervention in terms of monthly income using Wilcoxon signed-rank test, a significant difference was between the participants in the group with income less than one million ($p = 0.009$), one to one and a half million ($p < 0.001$), one and a half to two million ($p = 0.003$), and two million and more ($p = 0.005$).

As shown in Table 2, a multiple regression model has been implemented using the step-by-step method, and the effect of training intervention after controlling health literacy score before training intervention, age of women and spouse, education level of women and spouse, occupation of women and spouse, monthly income and place of residence was still significant in the final linear regression model as a predictor variable related to health literacy ($p < 0.001$), so that the training intervention increased health literacy score by 13.4 % ($\beta \pm SE = 13.4 \pm 1$). In addition to the effect of the training intervention, the health literacy score before the intervention also had a significant relationship with higher in health literacy score ($p = 0.015$). With increasing health literacy scores before the intervention, the rate of change in health literacy score reduces ($\beta \pm SE = -0.181 \pm 0.073$).

In addition, spouse's education was another factor related to changes in health literacy score in this study, with increasing spouse education level, health literacy score reduced ($\beta \pm SE = -0.931 \pm 0.455$).

Discussion

Overall, the mobile app-based training was found to lead to improvements in pregnant women's health literacy. The results of the present study were consistent with the study results of Kharazi et al., [19]. In a study by Kharazi, the mean score of health literacy after the intervention in the experimental group was 45.76 ± 5.29 and 39.21 ± 7.03 in the control group.

The study results showed that the mean change in health literacy score before and after the intervention was significantly different in the experimental group, while no significant difference was found in the control group. The significant changes indicate that the implemented training program has been effective in promoting maternal health literacy in the intervention group. The results of the present study were consistent with the study results of Kamali et al. In a study by Kamali in terms of changes in health literacy score before and after the intervention a significant difference was found in the experimental group while no significant difference was found in the control group [20].

According to the intergroup comparison of health literacy scores before and after the intervention in terms of age of the women, a statistically significant difference was observed between the participants. According to the intragroup comparison of health literacy scores before the intervention in terms of education of the mother, a statistically significant difference was observed between the participants. In addition, according to the intragroup comparison of the health literacy score after the intervention in terms of education of the participants, a statistically significant difference was observed between the participants. This finding is consistent with the study results of Kohan et al., [21]. Ghanbari et al., [22], and Safari, et al., [5]. The high level of health literacy in those with higher education confirms the role of education in the level of health literacy. Because general literacy is the basis for the level of health literacy [19].

According to the intergroup comparison of health literacy scores before and after the intervention in terms of age, the level of education of the spouse ($p < 0.001$), the spouse's occupation ($p < 0.001$), monthly income ($p = 0.012$) showed a statistically significant difference between the participants.

The results of the present study showed that the effect of training intervention after controlling health literacy score before training intervention, age of women and spouse, education level of women and spouse, occupation of women and spouse, monthly income, and residence is still significant in the final model of linear regression as a predictor variable related to health literacy ($p < 0.001$) so that on average, training intervention increases the score of health literacy level by 13.4 %.

In addition to the effect of the training intervention, the health literacy score before the intervention had a significant relationship with changes in health literacy score ($p = 0.015$) with increasing health literacy score before the intervention, the rate of score changes reduces. In addition, the education of the spouse was another factor related to the changes in health literacy score in this study, with increasing the level of education of the spouse, the changes in the score reduce.

According to a study by Safari, et al., [5] the most effective factor in predicting health training was education OR = 7.345 and the lowest effect was related to occupation OR = 2.542, which is inconsistent with the results of the present study which is due to the type of study. The present is a clinical trial and a study by Safari was a descriptive-analytical study.

Conclusion

In general, a mobile app was tested in this study and was found to be efficacious in promoting the health literacy of pregnant women. In addition, this study showed that mobile-based interventions can be an option for mass dissemination for improving health in pregnant women.

The results of the study can play an important role in paying attention health care providers to innovative methods for teaching health education. Health providers should be aware of this technology and familiarize themselves with the various features of each app because this method will enable them to instruct women pregnant remotely. On the other hand, health literacy is key for self-care during pregnancy and mobile health offers pregnant women a new option for self-care during pregnancy.

For future studies a mixed method study, should follow that would identify the educational needs to design and build need based application.

Limitations of the study

The major limitation of this study is related to the difficulty to interpret or generalize the results because the studied population is very different from the population treated in normal life.

Ethics committee approval

This paper is taken from the master thesis student of midwifery training with ethics code IR.GUMS.REC.1397.490. This is a RCT study (clinical trial code IRCT20180707040364N1: https://www.irct.ir/search/result?query=IRCT20180707040364N1-2019-03-27). We have obtained consent before the participant enters the research. Participants provided written informed consent prior to the study.

Authors' contributions

Z.B. and P.F participated in the Conceptualization, design, and implementation of the intervention, analysis of the findings, and drafting of the manuscript. M.N. participated in the design of the study and writing—review and editing of the manuscript. All authors read and approved the final manuscript.

Declaration of Competing Interest

All methods were performed in accordance with the relevant guidelines and regulations (Declaration of Helsinki).

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