

# Web and mobile-based technologies for monitoring high-risk pregnancies

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**To cite:** Ayatollahi H, Ghalandar Abadi M, Hemmat M. Web and mobile-based technologies for monitoring high-risk pregnancies. *BMJ Health Care Inform* 2019;**26**:e000025. doi:10.1136/bmjhci-2019-000025

Received 25 March 2019  
Revised 18 March 2019  
Accepted 08 December 2018



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## ABSTRACT

**Introduction** High-risk pregnancy is an illness in which there are severe complications and problems that may cause fetal loss and requires continuous care. It seems that using telemedicine technology is helpful to provide wider access to prenatal care. The aim of this study was to compare the feasibility of using web-based and mobile-based technologies in caring for high-risk pregnancy.

**Materials and methods** This was a cross-sectional study and the participants included midwives and gynaecologists who worked at teaching hospitals. The data were collected by using two five-point Likert scale questionnaires which were designed based on the literature review. The questionnaires included two main sections: demographic questions and questions related to five aspects of a feasibility study. Face and content validity of the questionnaires were confirmed by the experts and the reliability was checked by using the test-retest method. The data were analysed using descriptive and inferential statistics.

**Results** In this study, 79 questionnaires were completed by 50 midwives (63.29%) and 29 gynaecologists (36.71%). Overall, midwives ( $p=0.001$ ) and gynaecologists ( $p=0.003$ ) believed that using mobile-based technologies was more feasible than using web-based technologies in caring for high-risk pregnancies.

**Conclusion** It seems that planning for the future technological direction and providing mobile-based applications should be taken into account and prioritised to improve the quality of prenatal care and to increase access to healthcare services for high-risk pregnancies.

## INTRODUCTION

Improving prenatal and neonatal care is one of the main goals of the third millennium development and is regarded as an important indicator for the WHO.<sup>1 2</sup> However, more than 44 million women have no access to prenatal care in developing countries.<sup>2</sup> Maternal and neonatal care is also one of the essential components of the healthcare services, as getting access to pregnancy information and services is a human right and it is essential for the development of nations. As a result, governmental and non-governmental organisations are required to provide high-quality care for this group of people.<sup>2</sup> Usually, the lack of equal access to healthcare services and problems related to visiting a healthcare provider are among the challenges of

## Summary

### What is already known?

- ▶ High-risk pregnancy may cause fetal loss and requires continuous care.
- ▶ The lack of equal access to health care services is among the challenges of high-risk pregnancies.
- ▶ The goal of using telecare is to improve the outcome of high-risk pregnancies.

### What does this paper add?

- ▶ It seems that applying mobile-based technologies is more feasible than web-based technologies to care for high-risk pregnancies.
- ▶ Mobile phones and mobile-based technologies are popular and accessible to many people.
- ▶ Many mobile-based applications have been developed in the healthcare area and many people are familiar with this type of technology.

prenatal care. In order to overcome these challenges, recent advances in information and communication technology have been employed to improve the quality and speed of care delivery. The use of telemedicine technology is one of the solutions to address these challenges.<sup>3</sup>

Telemedicine has dramatically changed the pattern of healthcare delivery in different areas. This technology aims to improve quality of patient care, increase access to medical care for rural and deprived areas and reduce the cost of patient transfer and treatment.<sup>4</sup> Telecare is considered a subcategory for telemedicine. In the field of pregnancy, telecare can be used to identify problems at the early stages and to provide therapeutic advices to prevent further complications and early delivery. The goal of using telecare is to improve the outcome of high-risk pregnancies, to reduce the number of newborns hospitalised in the neonatal intensive care unit and to reduce the number of hospital visits.<sup>5</sup> For example, a short message service (SMS-based) alert system was used in Rwanda to care for diabetic pregnant women and improved access to maternal and neonatal healthcare services.<sup>6</sup> Similarly, Web and

SMS-based technologies were used in Spain to care for diabetic pregnant women. These technologies facilitated contacting specialists and reduced unnecessary transportation, waiting times and overlaps between the visiting time and the patient's schedule.<sup>7</sup> Overall, remote health management of patients and long term self-management can be performed by using telecare and telemedicine technologies.<sup>8,9</sup> Considering the high prevalence of pregnancy in Iran, the importance of prenatal care and its impact on the health of mothers and children, and the priority of prevention over treatment, it is necessary to pay more attention to the health of this group of people.<sup>2</sup> Thus, the present study aimed to compare the feasibility of using web and mobile-based technologies in high-risk pregnancy care.

## MATERIALS AND METHODS

This was a quantitative study completed in 2018. Before conducting the research, ethics approval was sought from the Institutional Review Board. The potential participants included midwives (n=60) and gynaecologists (n=43) who were working in four different teaching hospitals. All potential participants were invited to take part in the study. In order to collect data, two questionnaires were designed based on the literature review.<sup>10–13</sup> The questionnaires were the same in terms of the number of questions and the content. The only difference was related to the wording of questions and the terms of 'web-based technologies' and 'mobile-based technologies' used in each questionnaire separately. The questionnaires were designed based on a five-point Likert scale and included two main sections: participant's demographic information and questions related to the five aspects of a feasibility study. The second section consisted of five questions for the technical aspect, 16 questions for the operational aspect, five questions for the economic aspect, three questions for the scheduling aspect and seven questions for the ethicolegal aspect.

The content and the face validity of the questionnaire were confirmed by the experts in the field of health informatics and health information management. The reliability of the questionnaires was tested by using the test-retest method and 15 gynaecologists and midwives who worked in other hospitals participated in this phase (r=0.83, r=0.85). Data were analysed by using SPSS software (V.18), Kolmogorov-Smirnov test and t-test.

## RESULTS

In this study, 79 out of 103 distributed questionnaires were completed by 50 midwives (63.2%) and 29 gynaecologists (36.7%), of which only 2 gynaecologists were male. The average age of the participants was 37.7±10.7 years old. As table 1 shows, the highest frequency was related to the age group of 21–30 years old for the midwives (n=28, 35.4%) and the age group of 41–50 years old for the gynaecologists (n=17, 22.5%). In terms of the work experience,

**Table 1** Participants' demographic characteristics

Variables		Participants	
		Midwife N (%)	Gynaecologist N (%)
Hospital	A	8 (16)	6 (20.7)
	B	4 (8)	2 (6.9)
	C	32 (64)	16 (55.2)
	D	6 (12)	5 (17.2)
Age	21–30	28 (56)	0
	31–40	15 (30)	2 (6.9)
	41–50	6 (12)	17 (58.6)
	>50	1 (2)	10 (34.5)
Educational degree	Bachelor	49 (98)	0
	Master	1 (2)	0
	Specialist	0	29 (100)
Work experience	1–5	29 (58)	3 (10.3)
	6–10	10 (20)	12 (41.5)
	11–15	7 (14)	6 (20.7)
	>15	4 (8)	8 (27.5)

the category of 1–5 years had the highest frequency for midwives (n=29, 90.6%), while for most of gynaecologists, it was between 6 and 10 years (n=12, 54.5%).

The results showed that from the participants' perspectives and with respect to the technical aspects, applying mobile-based technology (4.05±5.92) was significantly more feasible than applying web-based technologies (3.69±0.96) for high-risk pregnancies (p=0.001). Among the midwives, the highest mean value (4.52±0.61) was related to 'the availability of hardware and software resources for using mobile-based technologies' and among the gynaecologists, the highest mean value (4.34±0.89) was related to the availability of different mobile-based applications in the market. The lowest mean value for the midwives (3.92±1.01) was related to 'the possibility of applying mobile-based technologies across the country' and the lowest mean value for the gynaecologists (3.69±0.89) was related to 'the possibility of developing mobile-based applications to care for high-risk pregnancies'.

Similarly, the results showed that applying mobile-based technology (4.05±1.03) was significantly more feasible than applying web-based technologies (3.82±1.10) for high-risk pregnancies (p=0.001) in terms of the operational aspect. Among the midwives, the highest mean value (4.66±0.59) belonged to 'improving the quality of care by using mobile-based technologies' and among the gynaecologists, the highest mean value (4.79±0.49) was related to 'the necessity of supervising mobile applications by the Ministry of Health'. In addition, the lowest mean value for the midwives (3.60±1.05) was related to 'reducing the workload for the specialists by using mobile-based technologies' and the lowest mean value for the

gynaecologists ( $3.24\pm 0.91$ ) belonged to 'the availability of appropriate content for mobile-based applications' to improve the quality of care for high-risk pregnancies.

In terms of the ethicolegal aspect, the findings were similar to the results of other mentioned aspects and the feasibility of applying mobile-based technologies ( $4.53\pm 0.92$ ) was significantly more than applying the web-based technologies ( $4.42\pm 0.73$ ,  $p=0.01$ ). Among the midwives, the highest mean value ( $4.56\pm 0.64$ ) belonged to 'the necessity of developing new guidelines to respect the privacy of pregnancies when using mobile-based technologies'. Among the gynaecologists, the highest mean value ( $4.90\pm 0.40$ ) was related to 'the necessity of providing legal supports for the specialists to be able to deliver healthcare services over mobile phones'. Interestingly, this item had the lowest mean value for the midwives ( $4.16\pm 0.76$ ) and the lowest mean value for the gynaecologists ( $4.48\pm 0.57$ ) belonged to 'the necessity of providing legal supports for the patients to be able to receive healthcare services over mobile phones'.

Regarding the economic aspect, no statistically significant difference was found between the feasibility of applying mobile-based technologies ( $3.18\pm 1.06$ ) and web-based technologies ( $3.03\pm 1.03$ ) to care for high-risk pregnancies ( $p=0.07$ ). According to the findings, from the midwives' and gynaecologists' perspectives, the highest mean values  $4.02\pm 0.71$  and  $3.76\pm 0.91$  were related to 'reducing the cost of care for high-risk pregnancies due to the use of mobile-based technologies'. The lowest mean value for the midwives ( $2.98\pm 1.09$ ) belonged to 'the possibility to pay to the technical staff of mobile-based technologies' and the lowest mean value for the gynaecologists ( $2.59\pm 1.01$ ) was related to 'the possibility to pay to specialists'.

In terms of scheduling, the results indicated that there was no statistically significant difference between the feasibility of applying mobile-based technologies ( $3.68\pm 1.33$ ) and web-based technologies ( $3.61\pm 1.38$ ) to care for high-risk pregnancies ( $p=0.5$ ). According to the results, from the midwives' and gynaecologists' perspectives, the

highest mean values  $4.36\pm 0.80$  and  $4.45\pm 0.63$  was related to 'the necessity of setting a schedule for designing and implementing mobile-based technologies' and the lowest mean value for the midwives ( $3.18\pm 1.36$ ) belonged to 'the possibility of implementing mobile-based technologies in a long time' and the lowest mean value for the gynaecologists ( $2.79\pm 1.54$ ) was related to 'the possibility of implementing mobile-based technologies in a short time'.

Overall, the results showed that the feasibility of applying mobile-based technology ( $4.02\pm 1.02$ ) was significantly more than applying web-based technologies ( $3.75\pm 1.07$ ,  $p=0.001$ ). Furthermore, there was a statistically significant difference between the feasibility of applying mobile-based technologies and web-based technologies among the midwives ( $p=0.001$ ) and gynaecologists ( $p=0.003$ ) (table 2).

## DISCUSSION

The results of the study showed that from the participants' perspectives, the technical feasibility of applying mobile-based technologies was more than applying web-based technologies to provide healthcare services for high-risk pregnancies. In fact, in both groups of midwives and gynaecologists, the mean value for the technical feasibility of using mobile-based technologies was higher than using the web-based technologies. Such a result can be attributed to the growth and spread of applying mobile phones and mobile-based applications in the country and around the world. So that, mobile-based technologies are more acceptable for providing healthcare services.<sup>14</sup> The results are in line with the findings of similar studies in which the use of mobile-based technologies for providing education and healthcare services have been highlighted.<sup>14-20</sup> It is notable that web-based technologies have their own advantages and pregnant women can use both web-based and mobile-based technologies to receive healthcare services and information.<sup>20,21</sup> However, the mobile-based technologies have some features, such as ease of use anywhere and anytime that is needed.

**Table 2** Participants' perspectives about the feasibility aspects of applying mobile-based and web-based technologies to care for high-risk pregnancies

Feasibility aspects	Participants				T-test value (P value)
	Midwife		Gynaecologist		
	Mobile-based technologies Mean±SD	Web-based technologies Mean±SD	Mobile-based technologies Mean±SD	Web-based technologies Mean±SD	
Technical aspect	4.16±0.86	3.8±0.93	3.94±0.96	3.43±1.01	5.34 (0.001)*
Operational aspect	4.26±0.81	3.81±1.12	4.01±1.06	3.91±0.96	5.32 (0.001)*
Economic aspect	3.32±1.06	3.07±1.07	2.95±1.02	2.95±0.95	1.82 (0.07)
Scheduling aspect	3.79±1.24	3.59±1.31	3.48±1.45	3.64±1.51	0.54 (0.5)
Ethicolegal aspect	4.48±0.74	4.36±0.75	4.56±0.65	4.67±0.58	2.45 (0.01)*
Total	4.23±0.8	3.76±1.07	3.95±1.04	3.71±1.12	7.25 (0.001)*

\*There was a statistically significant difference at  $\alpha=0.05$ .

Moreover, the availability of technical infrastructure and the possibility of creating diverse applications are among the main reasons for considering mobile-based technologies more feasible than web-based technologies for the high-risk pregnancies.<sup>11 22</sup> Similarly, Pérez-Ferre *et al* showed that both web-based and mobile-based technologies can be used effectively to improve care for pregnant women.<sup>7</sup>

In terms of the operational aspect, the results showed that from the participants' perspectives applying mobile-based technologies was more feasible than applying web-based technologies. The operational aspect includes a number of issues, such as patients' satisfaction and technology acceptance, provision of healthcare services by the specialists, quality of services, speed of care delivery, ease of use, cost of providing healthcare services, the possibility of workload reduction for healthcare providers, women's information literacy, the appropriateness of content and receiving adequate support from the Ministry of Health. It seems that addressing the above mentioned issues is easier by using mobile-based technologies based on the participants' perspectives. The results also showed that there was a statistically significant difference between the feasibility of applying mobile-based technologies and web-based technologies in terms of the operational aspects from the midwives' perspectives and the use of mobile-based technologies was more feasible. However, there was no statistically significant difference between applying these two technologies from the gynaecologists' perspectives. Such a difference between the opinions of gynaecologists and midwives can be attributed to the nature of the tasks and the extent to which they were responsible for caring for a pregnant woman. It seems that midwives can communicate and monitor their patients more easily by using mobile phones or by using mobile-based applications, since they have more contact with pregnant women than gynaecologists.

In terms of the economic aspect, the results showed that although in both groups applying mobile-based technologies was found to be more feasible than applying web-based technologies, overall, no statistically significant difference was found between applying these two technologies in terms of the economic aspect. Similarly, other studies show that there is no significant difference between applying web-based and mobile-based technologies in terms of economic aspect.<sup>28 29</sup> However, in general, telemedicine is expected to reduce costs in high-risk pregnancies.<sup>30 31</sup>

The results of this study also indicated that from the midwives' perspectives considering scheduling aspects was more feasible for mobile-based technologies than for web-based technologies and from the gynaecologists' perspectives, this feasibility was reverse. However, in general, no statistically significant difference was found between scheduling for implementing web-based and mobile-based applications. According to the participants, both technologies needed to be defined as a long or short

term project and adequate time should be spent for any of these projects.

According to the results, the midwives believed that the feasibility of applying ethicolegal aspects was higher by using mobile-based technologies compared with web-based technologies. In contrast, the gynaecologists assumed that web-based technologies were more feasible to be used to address ethicolegal issues. Overall, the results showed that there was a statistically significant difference between these two technologies and applying mobile-based technologies was more feasible than web-based technologies. Avancha *et al* noted that despite the benefits of using mobile-based technology to improve patient care, protecting patient privacy is essential.<sup>32</sup> In fact, the protection of privacy and confidentiality in mobile-based applications is complex, as mobile phones collect patient information continuously and sharing information is much wider and easier. Therefore, developing guidelines to increase patient confidence and privacy should be taken into account before applying telemedicine technologies.<sup>32</sup> Similarly, Kotz *et al* indicated that although mobile-based technologies provide a number of opportunities for improving the quality of life and healthcare services, the security and privacy issues should not be underestimated.<sup>33</sup> Overall, the results showed that applying mobile-based technology was significantly more feasible than applying web-based technologies and both groups of midwives and gynaecologists agreed on that.

### Research limitation

One of the limitations of the current research was related to the limited number of the participants. Although the overall response rate seemed to be good, the number of the gynaecologists who took part in the study was limited. However, the results showed that both groups of the participants had relatively similar ideas regarding different aspects of using both technologies. The second limitation might be related to not including the high risk pregnant in the study. In fact, the current research was a feasibility study which aimed to uncover the strengths and weaknesses, opportunities and threats of a proposed technology, the required resources and ultimately the prospects for success. Therefore, the researchers preferred to include those participants who could assess the possibility, efficiency and effectiveness of applying these technologies with respect to the technical and non-technical aspects. The perception of patients regarding the use of the web or mobile technologies in high-risk pregnancies can be investigated in other future studies.

### CONCLUSION

In this study, a majority of the participants thought that applying mobile-based technologies was more feasible than web-based technologies to care for high-risk pregnancies. As mobile phones and mobile-based technologies are popular and accessible to many people, it seems that such a technology can be more usable to provide

healthcare services for high-risk pregnancies. Moreover, many mobile-based applications have been developed in the healthcare area and many people are familiar with this type of technology. However, apart from the technology development, adequate attention should be paid to different aspects of it to prevent any undesired outcome. Future research is needed to design and implement mobile-based applications and examine the effectiveness of using this technology to monitor high-risk pregnancies versus using the traditional face-to-face visits.

**Acknowledgements** This study was funded and supported by Iran University of Medical Sciences (IUMS/SHMIS\_1394/9211304204).

**Funding** The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

**Competing interests** None declared.

**Patient consent for publication** Not required.

**Provenance and peer review** Not commissioned; externally peer reviewed.

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