

# Mobile-application Intervention on Physical Activity of Pregnant Women in Iran During the COVID-19 Epidemic in 2020

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## Research article

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# Abstract

**Background:** Considering the low level of physical activity in pregnant women in the COVID-19 pandemic period and on the other hand the benefits of mobile app learning, we decided to conduct a study to determine the impact of educational intervention based on mobile app on physical activity in pregnant women.

**Methods:** The present study was quasi-experimental and examined 93 pregnant women aged 16 to 20 weeks of gestation. Sampling was done on pregnant women participating in the childbirth preparation classes in Isfahan. We used the validated and reliable questionnaire including perceived benefits, perceived barriers, perceived enjoyment, perceived social support and Pregnancy Physical Activity Questionnaire (PPAQ). The intervention was based on mobile app and the content of the application contained 12 main domains such as : description of physical activity and benefits and barriers of exercise in the pregnancy, different types of proper pregnancy exercise , planning for exercise, different types of exercise. Finally, data were analyzed using SPSS20 and the Chi-square test, independent t-test Paired t-test were employed. The significance level was considered to be less than 0.05.

**Results:** The results showed that after the intervention based on mobile app, the mean score of perceived benefits and enjoyment were significantly higher than before the intervention in the intervention group. Finally total mean score of physical activity significantly increased in the intervention group, while the change decreased in the control group.

**Conclusion:** The results indicated that the use of mobile app can be used to promote physical activity in pregnant women. Therefore, it is recommended that mobile app education should apply with face-to-face classes in health centers for physical activity in pregnant women in pandemic situation.

## Background

Pregnancy is an important sensitive stage of a women's life, and regular physical activity improves the quality of life and physical conditions in pregnant women (1). Studies on physical activity during pregnancy in the United States indicate that only 15.1% of pregnant women engage in physical activity at the recommended levels (2). According to the report of the Deputy of Women's Sports in Iran, about 30% of women play sports of which 5–7% are during pregnancy (3, 4). Other studies on the lack of physical inactivity during pregnancy in Iran also indicated that 52% of pregnant women in the first half of pregnancy and 70.7% in the second half of pregnancy did not do any exercise (5, 6).

Pregnant women have expressed various barriers in this regard, including the lack of a suitable place and time for exercise, lack of adequate equipment, and the lack of a suitable vehicle and even a regular exercise program (7, 8). About cognitive factors, several studies have reported the lack of knowledge, lack of self-confidence, and positive attitudes towards physical activity during pregnancy, and even the lack of attention to psychosocial factors such as cultural norms and criteria as well as social support (7, 9, 10). Due to the coronavirus (COVID-19) pandemic, these barriers have become more prominent, and even

pregnant women have fewer out-of-home visits to the gym or walking. According to a study on the Spanish pregnant women with an aimed to analyze the impact of staying home due to COVID-19 on the pregnant women's lifestyles, there was a significant reduction in the level of physical activity in the pregnant women and even more than half of them could not participate in childbirth preparation sessions (11). Even though several studies have recommended the health care providers' roles in performing effective interventions to promote exercise in pregnant women (12, 13), inadequate education by health care providers about the benefits of physical activity and safe activities during pregnancy are also other factors affecting the lack of physical activity (3).

Given the determinants of the lack of physical activity behavior in pregnant women, as mentioned above, and the positive role of physical activity in the physical and mental health of pregnant mothers, we sought to use the education that somewhat reduced these barriers and used capabilities such as time-and-place-independent service (14), high recovery and processing speed (15), better efficiency and cost-effectiveness than printed media (16), multimedia and sending multiple messages (17). Therefore, we chose mobile application education as a modern method of health education that caused behavioral changes (18). For instance, a review study by Free on the use of mobile phones and communication technology in the field of health care indicated the effectiveness of mobile technology interventions to improve the results of health services worldwide. (19) Knight et al. studied mobile applications (apps) on physical activity in 2015 indicating the effectiveness of apps in this field (20). However, there are few studies on the use of applications in the field of behavior changes in physical activity, but other studies have been conducted using the apps to change behavior, for instance, Amini et al. found that web-based educational interventions and e-learning could increase physical activity in female employees (21). Pirzadeh et al. found that the web-based study was effective in increasing physical activity (22).

Considering the low level of physical activity in pregnant women and its determinants as well as the impact of this behavior in the COVID-19 conditions and on the other hand the benefits of electronic and app-based learning, we decided to conduct a study to determine the impact of educational intervention based on mobile app on physical activity of pregnant women.

## Methods

The present study was quasi-experimental and examined 93 pregnant women aged 16 to 20 weeks of gestation. Sampling was done on pregnant women participating in the childbirth preparation classes in Isfahan (Falavarjan County). Among the three centers of childbirth preparation classes, we accidentally considered a center as an intervention and another center as the control group. Inclusion criteria: willingness to participate, permission to participate in the childbirth preparation classes by a gynecologist, no disability and physical diseases, bone and joint problems, and no underlying diseases such as diabetes, hypertension, respiratory diseases, and no history of first abortion and pregnancy. Exclusion criteria: unwillingness to continue studying, migration or transfer from the county, not using the application during the intervention, obstruction of physical activity in terms of midwifery (cervical

cerclage, placenta previa, rupture of membrane, preeclampsia, bleeding in the second and third trimesters of pregnancy, etc.)

After approving the proposal in the faculty and adopting the code of ethics, the researcher visited the center, and sampling was performed after explaining the research purpose to the head of the center according to the previous coordination with the researcher who attended the first session of childbirth preparation classes, and the pregnant women received training in both intervention and control groups in terms of the research purpose and the way of responding to the questionnaire. At the beginning of the study, we included 110 individuals in the study according to the inclusion criteria. Among whom 58 were put in the intervention group and 52 in the control group and 9 ones in the intervention group and 8 in the control group were excluded from the study due to migration, cancellation of the study, earlier delivery, and the lack of use of the application during pregnancy (in the intervention group), and finally the study continued with 49 individuals in the intervention group and 44 ones in the control group. All individuals in both groups completed the informed consent form. We did not mention the individuals' names in the questionnaire and the whole information was kept confidential.

In the study, we used the questionnaire to collect data before the intervention and three months after the intervention in both groups including the first part for the demographic information including: age, education level, and job.

The second part included the following constructs, including the perceived benefits (13 questions), perceived barriers (14 questions), perceived enjoyment (6 questions), perceived social support (14 questions) that were measured on a Likert scale (very agree with a score of 5, agree: 4, no idea: 3, disagree: 2, and strongly disagree: 1). Solhi et al. used the questionnaire and confirmed its validity and reliability (23).

We used the standard Pregnancy Physical Activity Questionnaire (PPAQ) to assess physical activity and Chasan Taber et al. approved its validity (24), and Abbasi et al. also evaluated and confirmed the validity of its Persian version and its reliability with a Cronbach's alpha of 0.81 (25), and Ahmadi et al. evaluated and approved its validity using the opinions of some faculty members at Isfahan University of Medical Sciences, and evaluated and confirmed its reliability with a Cronbach's alpha of 0.8 (26). In the present study, the reliability of the questionnaire was above 0.8. The questionnaire measured the levels of physical activity by questions about four different fields: 1- household/caregiving (13 questions) among which we eliminated three questions about lawn mowing, care, and playing with pets for localization; 2- transportation (3 questions); 3- occupational activity (5 questions); and 4- sports/exercise activity (8 questions) and we evaluated a total of 29 questions. Respondents were asked to report the duration of participation in each activity and select a category for each activity that best approximated the amount of time spent in the activity during a day of the current quarter of the year. We calculated the activity intensity based on MET as a unit for estimating metabolic expenditure in physical activity (a MET is equivalent to 3.5 ml of oxygen per kilogram of body weight). To calculate the intensity of activity, we multiplied the amount of MET of each activity by the time spent in a day. An activity with a MET of less

than 1.5 refers to sedentary activity, MET of 1.5- 3 is light activity, MET of 3–6 is moderate activity, and MET of higher than 6 is intense activity (24).

For designing the educational content, we first performed the need assessment on three groups of pregnant mothers, teachers of childbirth preparation classes, health education specialists, and experienced midwives, and then prepared the appropriate educational content covering their needs under the supervision of health education specialists, a senior midwife, and a sports medicine specialist in text, photos, videos, and gifs from the ministry's reputable sources such as Pregnancy and Childbirth Preparation Books and other reliable sources, and then the content was reviewed by the research team. After confirming the content, an IT expert and we performed software programming and application development. In the content, we sought to focus on the perceived benefits and barriers, social support, and perceived enjoyment.

The content of the application contained 12 main domains: 1. Description of physical activity, 2. Physical and mental benefits of exercise in the pregnancy, 3. Different types of proper pregnancy exercise (walking, swimming, tennis, yoga, cycling, mountaineering, and water sports) (for the intervention of perceived benefits), 4. The way of doing daily activities (ways of correct stance, lifting objects, sleeping, and sitting properly, doing properly the rest of house affairs like ironing, sweeping, and driving; and all of the educational principles were with a photo display), 5. Planning for exercise, 6. Time to stop exercising and cases of the absolute prohibition of exercise (to intervene on the perceived barriers), 7. Massage (including massage of the head, back, abdomen, shoulders, perineum with photo display) (explaining the massage that could be done by spouse, colleague, parents, to intervention on the perceived social support), 8. Stretching exercises (exercises in cross-legged sitting, in lying-down position, pelvic floor and groin exercises along with photo display), 9. Relaxation, 10. Reminding important points while doing exercises, 11- Exercise demonstration movements (showing a few short sports movements), and 12. Educational videos (eight videos including videos of standing exercise movements, Stretching exercises, exercises for preventing constipation and strengthening the pelvis, and doing simple exercises for better delivery), and as a whole, playing music, proper training along with sports photos and gifs, colorful background and marginal content, and making the content attractive to intervene on the perceived enjoyment construct.

After creating the application and final checking, the app was given to the intervention group for use, and the account in the app was given to specialists to contact the pregnant mothers. In the intervention group, the necessary training was provided by the researcher about the way of using the application and everyone was encouraged to use the application during the week through the national messenger on cyberspace. It should be noted that the information was completed by the above-mentioned questionnaire before and three months after the intervention in both groups and the data were analyzed using SPSS20. The descriptive statistics (frequency, percentage, mean, and standard deviation) and the Chi-square test was used for the qualitative variables. We also used the statistical analysis including t-test to compare the mean scores of physical activity and constructs before the intervention and three months after the intervention between the intervention and control groups, and compared the mean

scores of physical activity and constructs before and after the intervention in both groups using the Paired t-test. The significance level was considered to be less than 0.05.

## Results

The mean age of women was 26.69 in the intervention group, and the mean age of women was 25.15 in the control group. The independent t-test ( $P = 0.114$ ) indicated that the mean age did not differ significantly between the two groups.

About the constructs of the model, the mean score of perceived benefits was  $22.38 \pm 6.75$  in the intervention group before the intervention and  $59.20 \pm 5.57$  three months after the intervention. Even though there was an increase in the control group, the independent t-test indicated a significant difference between the intervention and control groups after the intervention. ( $p < 0.001$ ).

Before the intervention, the mean score of perceived barriers was  $46.10 \pm 9.02$  in the intervention group, and  $35.28 \pm 7.12$  after three months of the intervention; and the statistical test indicated the significant difference between the two groups after the intervention. ( $p < 0.001$ ).

The mean score of perceived enjoyment was  $24.61 \pm 2.89$  in the intervention group before the intervention and  $26.61 \pm 2.81$  three months after the intervention. Even though a slight increase was seen in the control group, the difference was significant in the intervention group after training.

The mean score of social support was  $51.67 \pm 6.24$  in the intervention group and  $56.48 \pm 5.81$  three months after the intervention, and  $51.04 \pm 6.38$  in the control group, and  $53.53 \pm 6.53$  three months after the intervention, indicating a significant difference between the intervention and control groups after the intervention. ( $P = 0.045$ )

As shown in Table 2, the mean scores of benefits, social support, and enjoyment in the intervention group were significantly higher before the intervention in comparison with after the intervention. Also, the score of perceived barriers was significantly different in the intervention group before and after the intervention ( $p < 0.001$ ).

Table 1  
Comparison of demographic information between intervention and control groups

<b>Variable</b>	<b>intervention groups</b>		<b>control groups</b>		<b>p-value*</b>
	Number	Percentage	Number	Percentage	
<b>Education level</b>					
High school	16	32.7	5	11.4	0.526
Diploma	22	44.9	30	68.2	
Bachelor	10	20.4	9	20.5	
MA	1	2	0	0	
<b>Job status</b>					
Employee	1	2	0	0	0.655
housewife	46	93.9	43	97.7	
Home Jobs	1	2	0	0	
Student	1	2	1	2.3	
* Chi-square test result was used.					

Table 2

Mean scores of perceived benefits, perceived barriers, perceived social support, and perceived enjoyment in both groups in 2 times

Variable	before the intervention	three months after the intervention	Paired t-test result P-value
<b>perceived benefit</b>			
intervention groups	22.38 ± 6.75	59.20 ± 5.57	≤ 0.001
control groups	23.90 ± 7.16	54.27 ± 6.09	≤ 0.001
<b>T test</b>	0.295	≤ 0.001	
<b>perceived barriers</b>			
intervention groups	46.10 ± 9.02	35.28 ± 7.12	≤ 0.001
control groups	47.29 ± 8.89	46.18 ± 10.16	0.533
<b>T test</b>	0.523	≤ 0.001	
<b>perceived enjoyment</b>			
intervention groups	24.61 ± 2.89	26.61 ± 2.81	≤ 0.001
control groups	23.84 ± 3.59	24.54 ± 2.68	0.170
<b>T test</b>	0.256	≤ 0.001	
<b>perceived social support</b>			
intervention groups	5167 ± 6.24	56.48 ± 5.81	≤ 0.001
control groups	51.04 ± 6.38	53.88 ± 6.53	0.005
<b>T test</b>	0.633	0.045	
<b>physical activity (Mets)</b>			
intervention groups	1570.00 ± 754.11	1872.44 ± 653.86	0.014
control groups	1637.27 ± 812.65	1413.29 ± 758.74	0.084
<b>T test</b>	0.680	0.002	

In the control group, the mean scores of social support and benefits were significantly higher after the intervention in comparison with before the intervention, but there was no significant difference in mean scores of perceived barriers and enjoyment and their physical activity scores before and after the intervention. The independent t-test indicated that the mean scores of benefits, enjoyment, and social

support in the intervention group were significantly higher than the control group, and the mean score of perceived barriers was lower than the control group.

Table 2 presents changes resulting from education in the intervention group so that the total mean score of physical activity significantly increased in the intervention group, while the change decreased in the control group, and the difference between mean scores was significant in the intervention and control groups after the intervention.

## Discussion

The present study aimed to determine the effect of application-based educational intervention (mobile application) on the physical activity of pregnant women. The results indicated that application-based education in childbirth preparation classes made changes in perceived benefits, barriers, enjoyment, and social support in the intervention group.

Given the constructs, there was no significant difference between mean scores of perceived benefits in the two groups before the intervention, but a significant difference was seen after the intervention, and it was consistent with a study by Mousavi et al. who aimed to determine the effect of educational interventions on awareness of benefits of physical activity in pregnant women in the Tehran health centers (27). It was also consistent with a study by Solhi et al. who aimed to examine the effect of educational intervention on the adoption of appropriate physical activity in pregnant women (23). Even though changes in perceived benefits in the control group existed after the intervention, changes in the intervention group were significant because there were perceived benefits in the app along with motivational content and images that emphasized both physical and psychological benefits.

The results of the present study indicated that the mean score of perceived barriers decreased significantly only in the intervention group after the intervention because the perceived barriers were identified after assessing the needs of pregnant women, including lack of time, lack of access to reliable educational resources, and the impossibility of visiting the health centers that were solved by an application for doing the physical activity. Reducing barriers is an effective factor in changing behavior, especially physical activity and it has been proven in various studies (23, 28)

The present study indicated that the mean scores of social support significantly increased in both intervention and control groups after the intervention in comparison with before the intervention because there were different sections in the app for increasing the social support. In the control group, there was a significant increase after the intervention ( $p$ -value = 0.005), but it was not as much as the intervention group ( $p$ -value < 0.001) because the pregnancy preparation classes or the routine training provided training about the effect of social support on physical activity for the control group. The effect of social support on physical activity has been proven in various studies, including Garshasbi et al. (29) and Mohammadian et al. and we should seek to emphasize the way of encouraging the pregnant women's husbands and their close acquaintances for physical activity in the application (30).

The research results indicated that the mean score of perceived enjoyment increased in the intervention group after the intervention and there was no significant difference between the intervention and control groups before the intervention, but there was a significant difference after the intervention. The main reason for the continuity of physical activity is the enjoyment of understanding that behavior. In the study, uploading attractive images, fluent text with colored borders, relaxation, and massage with music in the content of the app increased the desire, motivation to do exercise, and understand its positive points, and increased enjoyment in the participants. The results of the present study were consistent with a study by Rezaei who indicated the effect of lifestyle educational intervention on mean scores of perceived enjoyment in the intervention group (31).

The present study indicated that the mean score of physical activity increased significantly in the intervention group after the intervention, and there was also a significant difference between the mean scores of physical activity in the control and intervention groups after the intervention probably due to the impact of the application on various constructs such as perceived barriers, perceived benefits, perceived social support, and perceived enjoyment. Other studies, which examined the above-mentioned constructs, pointed out the effectiveness of investigating the physical activity in women, such as studies by Solhi et al. (23) and Pirzadeh et al. (32) who found that the score of physical activity improved significantly in the intervention group after the educational intervention. Cohen et al. (2013) conducted a study inconsistent with the present study and in the absence of constructs affecting the behavioral change and noted that educational interventions about physical activity during pregnancy did not make any significant change in the physical activity of the intervention group (33). Furthermore, a review study by Caragh Flannery also indicated that education caused very little changes in levels of physical activity in pregnant women (34) probably because the educational intervention was as the face-to-face classes in most studies but the content based on the audience's needs in the present study existed in the app so that most limitations and barriers to physical activity were solved. Furthermore, the whole educational content was prepared by an expert team with motivational multimedia with photos and videos as important motivating factors. On the other hand, pregnant women could use educational videos and content easily at any time and place without the need for a special device. The videos contained simple, safe, and doable movements for pregnant women that were included in various sections of the app along with relaxation programs such as massage, reducing fatigue, and exercise for pregnant women, and they could use the app easily in coronavirus epidemic when leaving home was forbidden.

## Conclusion

The research results indicated that the use of mobile applications increased scores of perceived benefits, perceived barriers, perceived social support, and perceived enjoyment and improved the levels of physical activity in pregnant women, and the use of videos, photos, gifs, and music in the applications could help facilitate learning and acquisition of physical activity skills and motivation to do them.

## Limitations

A main limitation of the study was the exclusion of women from the study for various reasons such as migration or the existence of medical barriers to physical activity. Another limitation was the pregnant women's belief in the harmful effects of Wi-Fi waves on the fetus during pregnancy. Therefore, we made an attempt to design the app in a way that did not require an Internet connection. Lack of monitoring the women's behavior and self-reporting data collection were other barriers in the present study.

## Abbreviations

Mobile App: Mobile Application

## Declarations

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### Funding

No financial support was received for this research.

### Availability of data and materials

Upon request, we can offer onsite access to external researchers to the data analyzed at Isfahan University of Medical Sciences, Iran.

### Authors' contributions

The authors' responsibilities were as follows: AP was supervisor of the study. NK designed the study and also drafted the manuscript. All authors contributed the design and data analysis and assisted in the preparation of the final version of the manuscript. All authors approved the final version of the manuscript.

### Authors' information

NK is MSc student in Health Education at Isfahan University of Medical Sciences, Isfahan, Iran. AP is an Assistant professor of Health Education and Promotion at Isfahan University of Medical Sciences, Isfahan, Iran.

### Ethics approval and consent to participate

All participants were informed about the study and confidentiality protocols.

Informed consent was obtained from all the participants; The Ethics

Committee of Isfahan University of Medical Sciences confirmed the study.

## **Consent for publication**

Not applicable.

## **Competing interests**

The authors declare that they have no competing interests.

## **References**

1. Taheri M IK. The effects of physical activity in pregnant depressed women on post-term development indexes Journal of shahid sadoughi university of medical sciences and health services 2017;24(11):868-75.
2. Evenson KR, Savitz A, Huston SL. Leisure-time physical activity among pregnant women in the US. Paediatric and perinatal epidemiology. 2004;18(6):400-7.doi:10.1111/j.1365-3016.2004.00595.x.
3. Akbari Z, Tol A, Shojaeizadeh D, Aazam K. Assessing of physical activity self-efficacy and knowledge about benefits and safety during pregnancy among women. Razi Journal of Medical Sciences. 2016;22(139):76-87.
4. Ghaderpanah N, Mohaddesi H, Vahabzadeh D, Khalkhali H. The effect of 5A model on behavior change of physical activity in overweight pregnant women. The Iranian Journal of Obstetrics, Gynecology and Infertility. 2017;20(9):101-14.
5. Taavoni S, Ahmadi Z, Haghani H. Trend of exercise before, During, and after Pregnancy. Iran Journal of Nursing. 2008;21(54):135-41.
6. SE S. Trend of exercise before, during and after pregnancy. 2008;21(54):135-141
7. Ouji Z, Barati M, Bashirian S. Application of BASNEF model to predict postpartum physical activity in mothers visiting health centers in Kermanshah. J Educ Community Health. 2014;1(3):54-62.
8. Aghamolaei T, Zare F, Ghanbarnejad A, Haji-Alizadeh K. Relationship of Exercise Benefits/Barriers and self efficacy with stages of change for physical activity in Abu Musa Island employees, Iran. Journal of Preventive Medicine. 2014;1(1):31-8.
9. Ibrahim S, Karim NA, Oon NL, Ngah WZW. Perceived physical activity barriers related to body weight status and sociodemographic factors among Malaysian men in Klang Valley. BMC public health. 2013;13(1):275. doi:10.1186/1471-2458-13-275
10. Nishida Y, Suzuki H, Wang D-H, Kira S. Psychological determinants of physical activity in Japanese female employees. Journal of occupational health. 2003;45(1):15-22.doi: 10.1539/joh.45.15
11. Biviá-Roig G, La Rosa VL, Gómez-Tébar M, Serrano-Raya L, Amer-Cuenca JJ, Caruso S, et al. Analysis of the impact of the confinement resulting from COVID-19 on the lifestyle and psychological wellbeing of Spanish pregnant women: an internet-based cross-sectional survey. International Journal of Environmental Research and Public Health. 2020;17(16):5933.doi:10.3390/ijerph17165933

12. Downs DS, Hausenblas HA. Women's exercise beliefs and behaviors during their pregnancy and postpartum. *Journal of midwifery & women's health*. 2004;49(2):138-44.doi: 10.1016/j.jmwh.2003.11.009
13. Clarke PE, Gross H. Women's behaviour, beliefs and information sources about physical exercise in pregnancy. *Midwifery*. 2004;20(2):133-41.doi:10.1016/j.midw.2003.11.003
14. shahmohammad M tM. The role of the telephone in promoting the educational system and its related services. *jep*. 2011;6(19):138-49.
15. Shirvani ZG, Ghofranipour F, Gharakhanlou R, Yaghmaei F. The effectiveness of theory-based multimedia software on exercise behavior and physical activity among women: The Women and Active Life Study. *Payesh (Health Monitor)*. 2016;15(5):549-58.
16. Tehrani H, Kabootarkhani MH, Peyman N, Vahedian-Shahroodi M. The impact of new communications technology on promoting women's physical activity. *Payesh (Health Monitor)*. 2016;15(3):293-300.
17. Zhao J, Freeman B, Li M. Can mobile phone apps influence people's health behavior change? An evidence review. *Journal of medical Internet research*. 2016;18(11):e287.doi: [10.2196/jmir.5692](https://doi.org/10.2196/jmir.5692)
18. Torkian S, Mostafavi F, Pirzadeh A. Effect of a Mobile Application intervention on Knowledge, Attitude and Practice Related to Healthy Marriage among Youth in Iran. 2020.doi: [10.21203/rs.2.22698/v1](https://doi.org/10.21203/rs.2.22698/v1)
19. Free C, Phillips G, Felix L, Galli L, Patel V, Edwards P. The effectiveness of M-health technologies for improving health and health services: a systematic review protocol. *BMC research notes*. 2010;3(1):250.doi: [10.1186/1756-0500-3-250](https://doi.org/10.1186/1756-0500-3-250)
20. Knight E, Stuckey MI, Prapavessis H, Petrella RJ. Public health guidelines for physical activity: is there an app for that? A review of android and apple app stores. *JMIR mHealth and uHealth*. 2015;3(2):43.doi: 10.2196/mhealth.4003
21. Amini N, Shojaeezadeh D, Saffari M. The study of the effect of e-education on physical activity and body mass index of female employees. *Journal of School of Public Health and Institute of Public Health Research*. 2014;11(3):95-106.
22. Pirzadeh A, Zamani F, Khoshali M, Kelishadi R. Web-based intervention on the promotion of physical activity among Iranian youth using the transtheoretical model. *Journal of education and health promotion*. 2020;9(1):118.doi: 10.4103/jehp.jehp\_36\_20
23. Solhi M, Ahmadi L, Taghdisi MH, Haghani H. The Effect of Trans Theoretical Model (TTM) on exercise behavior in pregnant women referred to dehghan rural health center in. *Iranian Journal of Medical Education*. 2012;11(8):942-50.
24. Chasan-Taber, L, Schmidt, MD , Roberts, DE, Hosmer D, Markenson G, freedson PS. Development and validation of a pregnancy physical activity questionnaire. *Medicine & Science in Sports & Exercise*. 2004;36(10):1750-60.doi: [10.1249/01.MSS.0000142303.49306.0D](https://doi.org/10.1249/01.MSS.0000142303.49306.0D)

25. Abbasi S, Moazami M, Bijeh N, Mirmajidi SR. Investigation of the relationship between physical activity levels, maternal weight (before delivery) and serum cortisol level (during labor) in nulliparous women. *The Iranian Journal of Obstetrics, Gynecology and Infertility*. 2015;18(151):12-9.
26. Ahmadi P KA. Relationship between physical activity during the first 20 weeks of gestation and hypertension in pregnancy. *Journal of Shahrekord University of Medical Sciences*. 2007;9(2):20-7.
27. Mousavi A, Shakibazadeh E, Sadeghi R, Tol A, Foroshani AR, Mohebbi B. The effect of educational intervention on self-efficacy, knowledge of benefits and safety tips of physical activity among pregnant women. *2020;26(11)98-111*
28. Duncombe D, Wertheim EH, Skouteris H, Paxton SJ, Kelly L. Factors related to exercise over the course of pregnancy including women's beliefs about the safety of exercise during pregnancy. *Midwifery*. 2009;25(4):430-8.doi: 10.1016/j.midw.2007.03.002
29. Garshasbi A MM, Rafiey M, GHazanfari Z Evaluation of womens exercise and physical activity beliefs and behaviors during their pregnancy and postpartum based on planned behavior theory *Daneshvar medicine*. 2015;22(115):7-16.
30. Keshavarz Mohammadian S, Farmanbar R, Mohtasham-Amiri Z, Atrkar Roushan Z. Factors associated with physical activity based on the stages of change model among health volunteers in Rasht. *Iranian Journal of Health Education and Health Promotion*. 2015;3(3):253-65.
31. rezaei Z, esmaeili M, tabaeian SR. The influence of group training of health promoting life style on vitality, pleasure and social adjustment among women with type II diabetic in isfahan city. 2016;15(5):581-590
32. Pirzadeh A, Mostafavi F, Ghofranipour F, Feizi A. Applying transtheoretical model to promote physical activities among women. *Iranian journal of psychiatry and behavioral sciences*. 2015;9(4):e1580.doi: 10.17795/ijpbs-1580
33. Cohen TR, Koski KG. Limiting excess weight gain in healthy pregnant women: importance of energy intakes, physical activity, and adherence to gestational weight gain guidelines. *Journal of pregnancy*. 2013;2013.doi: 10.1155/2013/787032
34. Flannery C, Fredrix M, Olander EK, McAuliffe FM, Byrne M, Kearney PM. Effectiveness of physical activity interventions for overweight and obesity during pregnancy: a systematic review of the content of behaviour change interventions. *International Journal of Behavioral Nutrition and Physical Activity*. 2019;16(1):97.doi: 10.1186/s12966-019-0859-5