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# Lifestyle intervention for gestational diabetes prevention in rural woman of Shoush city

Zahra Karimipour, Nasibeh Sharifi<sup>1</sup>, Hossein Seydkhani<sup>2</sup>, Hojat Sayadi<sup>2</sup>, Mohsen Jalilian

## Abstract:

**BACKGROUND:** Physical activity and nutrition interventions are the most important ways to prevent gestational diabetes. The purpose of the study was to determine the effect of healthy lifestyle intervention to promote preventive behaviors of gestational diabetes in the rural woman of Shoush city.

**MATERIALS AND METHODS:** In an experimental study, 60 pregnant women were selected using simple random sampling and allocate into intervention group ( $n = 30$ ) and nutrition program. The study was conducted from September to June 2018. The data were collected in baseline and 1 month and 3 months of follow-up phase and were analyzed using Chi-square test, repeated-measure test, and generalized linear model (GLM). The  $\alpha = 0.05$  was considered as significance.

**RESULTS:** The mean age in the intervention and control group was  $25.9 \pm 5.6$  and  $27.2 \pm 5.9$ , respectively. The GLM test showed a significant increase in the physical activity level and the mean of nutrition behaviors within the intervention group over time ( $P = 0.013$ ). Further, based on the results of repeated-measure test, the mean of weekly MET-minute was increased in the intervention group in comparison to the control group at 1 month and 3 months of follow-up ( $P < 0.001$ ).

**DISCUSSION AND CONCLUSION:** The lifestyle interventions are appropriate programs to the reduction of the risk of development of gestational diabetes in pregnant women.

## Keywords:

Gestational diabetes, health education, nutrition education, physical activity

## Introduction

Gestational diabetes mellitus (GDM) is defined as any type of diabetes with onset or first recognition during pregnancy.<sup>[1]</sup> The exact mechanism of gestational diabetes is unknown, and its main feature is increased insulin resistance. The GDM occurs when insulin receptors are unable to adequately respond to glucose control due to hormones produced during pregnancy, such as human placental lactogen, which are affected by insulin-sensitive receptors.<sup>[2]</sup> The prevalence of gestational diabetes is increasing throughout the world and affects 9–16% of pregnancies.<sup>[3]</sup> The prevalence of GDM in

Iran has been reported from 18.6–3.3%, and it is predicted that the rate of gestational diabetes will double by 2030.<sup>[1]</sup> GDM is most commonly associated with Type 2 diabetes, which is caused by age, body mass index (BMI), inadequate physical activity, and nutrition behaviors.<sup>[4]</sup> The prevalence of GDM increases due to the increase in age and BMI during pregnancy.<sup>[2,5,6]</sup> GDM is four times more likely in women who are overweight or obese than women who have a normal BMI.<sup>[3]</sup> Therefore, weight management during pregnancy, especially at the beginning of the first trimester, is one of the major strategies for GDM.<sup>[7]</sup>

The risk of gestational diabetes is higher among women who are not physically active

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Department of Public Health, School of Health, Ilam University of Medical Sciences, Ilam, Iran,  
<sup>1</sup>Department of Midwifery, School of Nursing and Midwifery, Ilam University of Medical Sciences, Ilam, Iran, <sup>2</sup>Department of Biostatistics, School of Health, Ilam University of Medical Sciences, Ilam, Iran

## Address for correspondence:

Dr. Mohsen Jalilian,  
Department of Public Health, Faculty of Health, Ilam University of Medical Science, Ilam, Iran.  
E-mail: [jalilian91@yahoo.com](mailto:jalilian91@yahoo.com)

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during pregnancy. Physical activity increases glucose tolerance and insulin sensitivity in pregnant women, thereby improving metabolic control.<sup>[8-10]</sup> Therefore, it is recommended that pregnant women do their daily activities with, at least, moderate intensity to reduce the risk of GDM.<sup>[11]</sup>

Another important risk factors for gestational diabetes is high-fat diets, which increase obesity, abnormal birth weight, and metabolic syndromes.<sup>[12]</sup> High intake of saturated fat and low intake of unsaturated fat in addition to overweight during pregnancy will increase the risk of gestational diabetes.<sup>[9,13]</sup> Moreover, carbohydrates have the greatest impact on raising postprandial blood glucose levels, and it is estimated that this group of foods increases postprandial blood glucose levels by at least 55%.<sup>[14]</sup>

Various strategies have been proposed to GDM prevent gestational diabetes effectively.<sup>[13]</sup> The main intervention strategy is lifestyle changes such as healthy diet, regular physical activity, reducing the BMI, and weight management during pregnancy.<sup>[2]</sup>

Increasing physical activity during pregnancy is one of the best ways to prevent and treat GDM.<sup>[11]</sup> The risk of GDM is higher in pregnant women with less physical activity and prolonged inactivity. Therefore, it is recommended that pregnant women do moderate aerobic exercise and resistance training at least 30–60 min, 3 times a week, to reduce the risk of GDM.<sup>[11]</sup> In addition, it improves insulin sensitivity and glucose control in pregnant with GDM.<sup>[11,15]</sup> Therefore, physical activity interventions are an effective and low-cost approach to increase physical activity in pregnant women.<sup>[16]</sup>

Most previous studies have examined the output evaluation (at the end of the intervention) of lifestyle programs. In this study, we evaluate the effects of the lifestyle intervention in two times of 1 month (output evaluation) and 3 months of follow-up (outcome evaluation).

Hence, the aim of the study was to the effect of lifestyle change intervention on the prevention of GDM in rural women of Shush city, South of Iran.

## Materials and Methods

This study was an experimental study that has been conducted from September to June 2018 on 60 pregnant women attending to rural healthcare centers in Shush, South of Iran. The sample size was determined using the following formula.

$$n = \frac{(Z_{1-\alpha/2} + Z_{1-\beta})^2 (S_1^2 + S_2^2)}{(\mu_1 - \mu_2)^2}$$

The sampling method of the study was simple random sampling. To this end, the rural healthcare centers of Shush (seven centers) were divided into north and south considering the geographical location. Then, using random allocation, four centers in the northern region were designated as the intervention group and three centers in the southern region as the control group. Therefore, pregnant women attending these healthcare centers were examined based on the inclusion criteria, and eligible individuals were identified. Inclusion criteria include age range of 18–40 years, being in the 8<sup>th</sup>–12<sup>th</sup> week of pregnancy, single pregnancy, ability to read and write, BMI of <25, completing informed consent forms by both the pregnant woman and her spouse, no known chronic underlying diseases, or risk factors for obstetrics in the current pregnancy. Exclusion criteria included diabetes mellitus Type 1 or 2, failure to attend at least two counseling sessions, any disorder or illness, or obstetric and midwifery problem that required special intervention and care for the pregnant women who interfered with the interventions in the present study, abortion, or delivery before the end of the study, taking any chemical or herbal medicine other than the recommended nutritional supplements during pregnancy, which interferes with normal gain weight, unwillingness to participate in the study, or simultaneous participation in other research, or similar interventions.

A number of rural pregnant women in the gestational age of 8–12 weeks was extracted from the integrated health system entitled “SIB,” this number was 168 at the time of sampling, including 11 cases twin pregnancies, six cases with a history of GDM, one case of hypertension, 44 cases with BMI >25 before pregnancy, and 19 cases with blood glucose levels >93, in other words, prediabetic or diabetic. Therefore, 81 pregnant women were excluded from all pregnant women, 8–12 weeks, which did not meet the inclusion criteria; and 87 of them had the inclusion criteria, which according to the required sample size, 60 pregnant women were randomly selected and were divided into two intervention groups ( $n = 30$ ) and control groups ( $n = 30$ ).

After selecting and assigning permanent women in the groups, a lifestyle change program, including increasing physical activity and improving nutrition behaviors, was held in eight 60-min training sessions for the intervention group. The sessions’ program included explaining and introducing gestational diabetes, the importance of physical activity and a healthy diet to prevent GDM, physical activity during pregnancy, the food pyramid, and healthy dietary. The educational contents were provided to the intervention group for 1 month, through lectures, role-playing, and group discussions. Moreover, a 5-min telephone consultation for the intervention

group was performed once every 2 weeks, for 2 months, during the follow-up period to maintain the effect of the intervention. It should be noted that while performing a training program, the control group was receiving routine pregnancy care from rural healthcare centers. However, due to the ethical considerations in the research, after collecting the data on the follow-up phase, a 60-min face-to-face training session was held for the control group.

Data collection of this study has been done through three stages of pretest, posttest (1 month), and follow-up (3 months) by interviewing participants. In this study, the short form of the International Physical Activity Questionnaire (IPAQ), as well as permanent women's nutritional scale questionnaire of the Ministry of Health and Medical Education was used to collect data.<sup>[11,17]</sup> The IPAQ consists of seven questions that measure physical activity status in three scales of low, moderate, and high. According to the scoring protocol of the IPAQ, total daily PA in MET-minutes per week was estimated by summing the reported time within each intensity by a MET value specific to each category of physical activity and expressed as a daily average MET score. Vigorous-intensity physical activity was assumed to correspond to 8 METs, moderate-intensity activity to 4 METs, and walking to 3.3 METs. The participants were categorized into three physical activity levels according to the IPAQ scoring criteria: Low: meets lower than 600 MET/minutes/week. Moderate: meets any of combination of walking, moderate-intensity, or vigorous-intensity activities achieving a minimum of at least 600-1500 MET/minutes/week. High intensity was categorized as meets accumulating at least 1500 MET/minutes/week. Hence, the total MET/minutes/week lower than 600 was considered as low-intensity physical activity and it range between 600 and 1500 is categorized as moderate-intensity physical activity. In high-intensity physical activity, the amount of MET/minutes/week is more than 1500.<sup>[18-21]</sup>

The pregnant women's nutrition behaviors questionnaire of the Ministry of Health and Medical Education of Iran has been used to measure nutrition behaviors. This questionnaire is applied in healthcare centers to screening nutrition behaviors of pregnant women and is the main instrument of identifying pregnant women with unhealthy diets. The questionnaire consists of seven five-item, which are scored from 0 to 4 points. The average score for pregnant women is ranged between zero and 28, which a higher score indicating a more desirable state of nutrition behaviors.

It should be noted that the validity and reliability of the IPAQ questionnaire have been confirmed in several studies.<sup>[11,17,22]</sup> Moreover, in this study, the content validity of the nutrition questionnaire of pregnant

women was approved by a panel of experts consisting of eight specialists in health education and health promotion and midwifery. In addition, the reliability of this questionnaire was assessed through a pilot study including 40 pregnant women, and its Cronbach's alpha was calculated to be 0.79.

All collected data were analyzed using SPSS software version 22 (IBM Corp, Armonk, New York) with conducting the Chi-square test, repeated-measure test, and generalized linear model (GLM). All tests were performed at a significance level of 0.05 and a 95% confidence interval.

## Results

The response rate in this study was 100%. The mean age of the participants was  $25.9 \pm 5.6$  and  $27.2 \pm 5.9$  years in the intervention and control groups, respectively and there was no significant difference between them ( $P = 0.37$ ,  $t = -0.903$ ). In terms of education level, in the intervention group, 56.7% of the participants had incomplete education and 43.3% had a diploma or higher education, and this rate was 36.7% and 63.3% in the intervention and control group, respectively. Mean weight of the participants in the intervention group before, a month, and 3 months after the intervention was  $56.9 \pm 8$ ,  $58.85 \pm 8.25$  and  $60.45 \pm 8.34$ , respectively, and these rates in the control group before, a month, and 3 months after the intervention were  $58.3 \pm 7.6$ ,  $60.3 \pm 7.9$ , and  $62.8 \pm 67.01$ , respectively. More details are given in Table 1.

The results of repeated-measure test showed a significant increase in the mean of nutrition behaviors in the intervention group over time ( $P < 0.001$ ). However this increase was not significant in the control group ( $P > 0.05$ ). As shown in Table 2, the increase in the mean of nutrition

**Table 1: Demographic characteristics of the participants**

Group	Frequency (%)	
	Intervention	Control
BMI		
Underweight	0	1 (3.3)
Normal	30 (100)	29 (96.7)
Overweight	0	0
Obese	0	0
Work		
Household	30 (100)	30 (100)
Employed	0	0
Self-employment	0	0
Income (month)		
Low	7 (23.3)	3 (10)
Average	18 (60)	23 (76.7)
High	5 (16.7)	4 (73.3)

BMI=Body mass index

behaviors in the intervention group compared to the control group at 1 month and 3 months after the lifestyle intervention was significant ( $P < 0.001$ ).

Comparison of the mean of MET/minute/week between groups was revealed that in the intervention group, there was a significant increase in the mean of this variable at 1 month and 3 months after the lifestyle intervention ( $P < 0.001$ ). However, in the control group, despite the increase in the mean of the MET/minute/week 1 month and 3 months later, the changes were not significant ( $P > 0.05$ ). Further, repeated-measures analysis has shown an increasing trend with an upward slope and significant in mean of the MET/minute/week in the intervention group ( $P < 0.001$ ). However, this trend was incrementally slow and insignificant for the control group ( $P > 0.05$ ). More details are presented in Table 3.

The findings related to comparing the level of physical activity between groups in pretest and 1 month and 3 months of follow-up are provided in Table 4. According to the GLM analysis, the changes in the level of physical activity within the intervention group is significant by the time ( $P = 0.013$ ). However, the changes were not significant in the intervention group ( $P = 0.074$ ). In addition, the findings related to these changes were significant in the intervention group compared to the control group by the time ( $P = 0.036$ ). The trend of the change in physical activity level in the two groups in the three previous stages and 1 month and 3 months after the intervention is shown in Figure 1.

## Discussion

Considering the fact that gestational diabetes is one of the most common known metabolic disorders during pregnancy, and pregnant women are one of the most vulnerable groups of the society, finding a way to improve their health seems necessary.

There was no significant difference between the intervention and control groups while studying the

nutrition behaviors of pregnant women before the onset of the lifestyle change program. The mean scores of nutrition behaviors in the intervention group have increased a month and 3 months after; however, this increase was not significant in the control group. Continuous nutrition training during the intervention program and subsequent following up have demonstrated the performance of nutrition behaviors. Our findings on the performance of the nutrition behaviors in pregnant women are consistent and coordinated with the findings of Rogozińska *et al.*, on the use of nutritional factors on primary prevention of GDM,<sup>[6]</sup> Davtalab Esmaili *et al.*, on the relationship between fruit and vegetable consumption to prevent diabetes complications,<sup>[23]</sup> and Kzhalili *et al.*, on studying the effect of training intervention on preventive behaviors of GDM in pregnant women.<sup>[24]</sup> Further, Sharifirad *et al.* had been reported that health education intervention based on health belief model is effective in increasing nutrition behaviors in pregnant women.<sup>[25]</sup>

The findings of Donazar-Ezcurra *et al.*, on studying the early prevention of gestational diabetes through nutritional factors, showed that healthy eating patterns before pregnancy reduce the risk of GDM, and the measures taken during pregnancy are ineffective; it is due to the fact that a long time is needed to these interventions to be effective in causing GDM.<sup>[2]</sup> The results of the mentioned study are inconsistent with this study because, according to the results, scheduling training interventions focusing on physical activity and healthy eating behaviors during pregnancy improves lifestyle and modifies the risk factors for GDM. According to many studies and available literature, modifying the risk factors for GDM, before the 24<sup>th</sup> week of pregnancy, plays an important role to prevent GDM.<sup>[26]</sup> For example, Borzouei *et al.* showed that the relatively high prevalence of GDM is dependent on several factors such as the lack of awareness of pregnant women about prevention, as well as regular visits to medical centers, the prevalence of overweight and obesity, poor nutrition,

**Table 2: Mean and standard deviation of nutrition behaviors in intervention and control groups by the time**

Group	Before		1 month		3 months		P
	n	Mean±SD	n	Mean±SD	n	Mean±SD	
Intervention	30	7.4±1.92	30	10.26±1.43	30	10.36±1.47	0.001
Control	30	7.53±1.45	30	7.96±1.73	30	8±1.59	

SD=Standard deviation

**Table 3: Mean and standard deviation of MET/minute/week in intervention and control groups by the time**

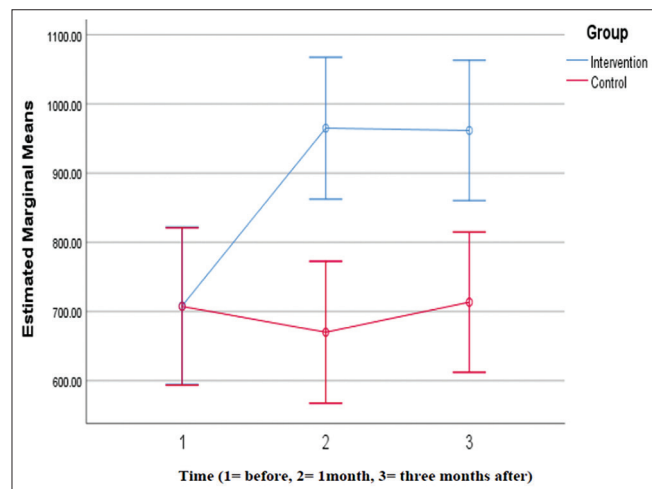
Group	Before		1 month		3 months		P
	n	Mean±SD	n	Mean±SD	n	Mean±SD	
Intervention	30	718.5±373.3	30	972.1±337.1	30	964.3±316.4	0.001
Control	30	696.9±256	30	662.8±218.7	30	710.7±226.3	

SD=Standard deviation



**Table 4: Physical activity level in intervention and control groups by the time**

Physical activity level	Frequency (%)			P
	Low	Moderate	High	
Intervention group				0.001
Before	7 (23.3)	22 (73.3)	1 (3.3)	
1 month	0	28 (93.3)	2 (7.6)	
3 months	0	28 (93.4)	2 (7.6)	
Control group				
Before	8 (26.7)	22 (73.3)	0	
1 month	6 (20)	24 (80)	0	
3 months	0	29 (96.7)	1 (3.3)	

**Figure 1:** Trend of the change in physical activity MET/minute/week in the intervention and control groups by the time

and also the insufficient training to pregnant women.<sup>[27]</sup> Moreover, Khalili *et al.* had reported that controlling glucose metabolism in pregnant women, losing weight before pregnancy, practicing healthy diet, and control of weight during pregnancy are the primary prevention strategies of GDM.<sup>[24]</sup>

Studying the factor of average calories consumed in physical activity in the control group showed an insignificant increase 1 and 3 months after the onset of the lifestyle program, while this amount of increase was significant in the intervention group; moreover, the results of comparing the intensity of physical activity in both groups showed that in baseline, seven pregnant women in the intervention group (23.3%) have had low physical activity, and one of them (3.3%) had vigorous physical activity; in 1 and 3 months after the training intervention, 28 pregnant women (93.3%) and 2 of them (7.6%) have chosen moderate and high physical activity, respectively. However, before the onset of physical activity program, in the control group, 8 pregnant women (26.7%), and 1 month later, 6 of them (20%) had low physical activity, and none of them had vigorous physical activity, and after 3 months of follow-up, 29 pregnant women (96.7%) have chosen moderate physical activity, and only one

of them (3.3%) have chosen vigorous physical activity. Therefore, the results of this study show the positive effect of lifestyle counseling program to improve GDM-preventive behaviors in pregnant women of the intervention group. The results on the performance of pregnant women's physical activity are consistent with the carried out studies by Rönö *et al.*<sup>[28]</sup> and Phelan<sup>[29]</sup> on the interventions of lifestyle to prevent gestational diabetes and Bennett *et al.* on the impact of intervention programs to reduce too weight gain as certain way to reduce the prevalence of GDM.<sup>[3]</sup> Further, these results are consistent with finding of the previous studies which conducted to prevent GDM through lifestyle change and weight management in pregnant women.<sup>[7,9,15,17,30,31]</sup>

In this study, two evaluation stages, 1 month and 3 months of follow-up were performed to identifying the lifestyle intervention influence on improving the physical activity level and developing healthy nutrition behaviors. The telephone counseling was performed to support and encouraging of participants to follow the lifestyle intervention instructions. In addition, intervention was conducted on two main and influential factors of healthy lifestyle to prevention of the development of gestational diabetes were strength of this study.

The study had some weakness. The physical activity program does not include group walking with participation of pregnant women because the group activities could create more willing and motivation to engage in physical activity behaviors. For the monitoring of nutrition behaviors, participants' weighting process should be extracted on a weekly basis during the study and a nutrition program designed for each person. Hence, it is suggested that future studies conduct lifestyle interventions with a 6-month or more follow-up period and evaluate its long-term effects on improving the lifestyle of pregnant women. It is also recommended to follow the incidence of GDM in pregnant women after 28 weeks of pregnancy.

However, the results of the study indicated that regular physical activity and proper nutrition behaviors are the best strategies to prevent gestational diabetes in pregnant women.

## Conclusion

Since a healthy lifestyle is a key factor to prevent GDM and improves the outcomes of mother and baby, the researcher believes that both adequate nutrition behaviors and regular physical activities are effective and low-cost strategies to improve the preventive behaviors of GDM in pregnant women.

In general, this study aimed to determine the effectiveness of lifestyle change program to enhance physical activity

and healthy eating patterns in pregnant women which referring to the rural healthcare centers.

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### Conflicts of interest

There are no conflicts of interest.

### References

- Zareei S, Homayounfar R, Naghizadeh MM, Ehrampoush E, Rahimi M. Dietary pattern in pregnancy and risk of gestational diabetes mellitus (GDM). *Diabetes Metab Syndr* 2018;12:399-404.
- Donazar-Ezcurra M, López-Del Burgo C, Bes-Rastrollo M. Primary prevention of gestational diabetes mellitus through nutritional factors: A systematic review. *BMC Pregnancy Childbirth* 2017;17:30.
- Bennett CJ, Walker RE, Blumfield ML, Gwini SM, Ma J, Wang F, *et al.* Interventions designed to reduce excessive gestational weight gain can reduce the incidence of gestational diabetes mellitus: A systematic review and meta-analysis of randomised controlled trials. *Diabetes Res Clin Pract* 2018;141:69-79.
- Madhuvrata P, Govinden G, Bustani R, Song S, Farrell TA. Prevention of gestational diabetes in pregnant women with risk factors for gestational diabetes: A systematic review and meta-analysis of randomised trials. *Obstet Med* 2015;8:68-85.
- Assaf-Balut C, García de la Torre N, Durán A, Fuentes M, Bordiú E, Del Valle L, *et al.* A Mediterranean diet with additional extra virgin olive oil and pistachios reduces the incidence of gestational diabetes mellitus (GDM): A randomized controlled trial: The St. Carlos GDM prevention study. *PLoS One* 2017;12:e0185873.
- Rogozińska E, Chamillard M, Hitman GA, Khan KS, Thangaratnam S. Nutritional manipulation for the primary prevention of gestational diabetes mellitus: A meta-analysis of randomised studies. *PLoS One* 2015;10:e0115526.
- Wang C, Wei Y, Zhang X, Zhang Y, Xu Q, Sun Y, *et al.* A randomized clinical trial of exercise during pregnancy to prevent gestational diabetes mellitus and improve pregnancy outcome in overweight and obese pregnant women. *Am J Obstet Gynecol* 2017;216:340-51.
- M. n. Renzaho A, Skouteris H, Oldroyd J. Preventing gestational diabetes mellitus among migrant women and reducing obesity and type 2 diabetes in their offspring: A call for culturally competent lifestyle interventions in pregnancy. *J Am Dietetic Assoc* 2010;110(12):1814-7.
- Luoto RM, Kinnunen TI, Aittasalo M, Ojala K, Mansikkamäki K, Toropainen E, *et al.* Prevention of gestational diabetes: Design of a cluster-randomized controlled trial and one-year follow-up. *BMC Pregnancy Childbirth* 2010;10:39.
- Poston L, Briley AL, Barr S, Bell R, Croker H, Coxon K, *et al.* Developing a complex intervention for diet and activity behaviour change in obese pregnant women (the UPBEAT trial); assessment of behavioural change and process evaluation in a pilot randomised controlled trial. *BMC Pregnancy Childbirth* 2013;13:148.
- Mishra S, Kishore S. Effect of physical activity during pregnancy on gestational diabetes mellitus. *Indian J Endocrinol Metab* 2018;22:661-71.
- Hernandez TL, Anderson MA, Chartier-Logan C, Friedman JE, Barbour LA. Strategies in the nutritional management of gestational diabetes. *Clin Obstet Gynecol* 2013;56:803-15.
- Luoto R, Kinnunen TI, Aittasalo M, Kolu P, Raitanen J, Ojala K, *et al.* Primary prevention of gestational diabetes mellitus and large-for-gestational-age newborns by lifestyle counseling: A cluster-randomized controlled trial. *PLoS Med* 2011;8:e1001036.
- Ali HI, Jarrar AH, El Sadig M, B Yeatts K. Diet and carbohydrate food knowledge of multi-ethnic women: A comparative analysis of pregnant women with and without gestational diabetes mellitus. *PLoS One* 2013;8:e73486.
- Chasan-Taber L, Marcus BH, Stanek E, Ciccolo JT, Marquez DX, Solomon CG, *et al.* A randomized controlled trial of prenatal physical activity to prevent gestational diabetes: Design and methods. *J Women's Health* 2009;18(6):851-9.
- Khoram S, Loripoor M, Pirhadi M, Beigi M. The effect of walking on pregnancy blood pressure disorders in women susceptible to pregnancy hypertension: A randomized clinical trial. *J Educ Health Promot* 2019;8:95.
- Nasiri Amiri F, Faramarzi M, Bakhtiari A, Omidvar S. Risk factors for gestational diabetes mellitus: A case-control study. In: *American Journal of Lifestyle Medicine*. Babol, Iran: Health Research Institute, Babol University of Medical Sciences; 2018.
- Jalilian M, Darabi M, Sharifirad G, Kakaei H. Effectiveness of interventional program based on trans-theoretical model to promote regular physical activity in office workers. *Health Syst Res* 2013;9:188-95.
- Moeini B, Hazavehei SM, Jalilian M, Moghimbeigi A, Tarigh Seresht N. Factors affecting physical activity and metabolic control in type 2 diabetic women referred to the diabetes research center of Hamadan: Applying trans-theoretical model. *Avicenna J Clin Med* 2011;18:31-7.
- Lee PH, Macfarlane DJ, Lam TH, Stewart SM. Validity of the international physical activity questionnaire short form (IPAQ-SF): A systematic review. *Int J Behav Nutr Phys Act* 2011;8:115.
- Hagströmer M, Oja P, Sjöström M. The international physical activity questionnaire (IPAQ): A study of concurrent and construct validity. *Public Health Nutr* 2006;9:755-62.
- Akhoondan M, Mirmiran P, Rashidkhani B, Asghari G. The relationship between pregnancy diabetes and dietary patterns. *Iran J Diabetes Lipid* 2011;11:309-20.
- Davtalab Esmaili E, Azizi H, Haghiri L, Soleimani A. The association between fruits and vegetables intake and prevention of diabetes complications in patients with type 2 diabetes. *Med J Tabriz Univ Med Sci Health Serv* 2017;38:18-25.
- Khalili Z, Mobasheri F, Manoochehri M, Khani Jeihooni A. The Impact of Educational Intervention on Preventive Behaviors in Pregnant Women Visiting Fasa Health Centers: Health Belief Model. 6<sup>th</sup> National Conference on Health Promotion and Challenges. Mazandaran University of Medical Sciences and Health Services; 2016.
- Sharifirad GR, Tol A, Mohebi S, Matlabi M, Shahnazi H, Shahsiah M. The effectiveness of nutrition education program based on health belief model compared with traditional training. *J Educ Health Promot* 2013;2:15.
- Hajifaraji M, Dolatkhan N. Gestational diabetes mellitus and associated challenges from the perspective of nutrition science: A review article. *J Mazandaran Univ Med Sci* 2017;27:202-24.
- Borzouei S, Rabiei S, Esna Ashari F, Zareeghane Z, Biglari M. The relationship between gestational diabetes and risk factors in pregnant women in Hamadan. *Pajouhan Sci J* 2018;7:30-6.
- Rönö K, Stach-Lempinen B, Klemetti MM, Kaaja RJ, Pöyhönen-Alho M, Eriksson JG, *et al.* Prevention of gestational

- diabetes through lifestyle intervention: Study design and methods of a Finnish randomized controlled multicenter trial (RADIEL). BMC Pregnancy Childbirth 2014;14:70.
29. Phelan S. Windows of opportunity for lifestyle interventions to prevent gestational diabetes mellitus. Am J Perinatol 2016;33:1291-9.
  30. Vinter CA, Jensen DM, Ovesen P, Beck-Nielsen H, Jørgensen JS. The LiP (Lifestyle in Pregnancy) study: a randomized controlled trial of lifestyle intervention in 360 obese pregnant women. Diabetes Care 2011;34(12):2502-7.
  31. Sun Y, Zhao H. The effectiveness of lifestyle intervention in early pregnancy to prevent gestational diabetes mellitus in Chinese overweight and obese women: A quasi-experimental study. Appl Nurs Res 2016;30:125-30.