Orginal Article Open Access
Iranian Journal of Diabetes and Obesity (IJDO)

The Effect of Physical Activity with Different Intensity on Anxiety, Blood Pressure and Blood Glucose in Pregnant Women Aged 20-30

Ghazal Radfar[1], Aliakbar Alizadeh[2*], Mohammad Rami[2], Abdolhamid Habibi[3]

[1]Master of Sports Physiology, Department of Sports Physiology, Faculty of Sports Sciences, Shahid Chamran University of Ahvaz, Ahvaz, Iran.
[2]Assistant Professor, Department of Sports Physiology, Faculty of Sports Sciences, Shahid Chamran University of Ahvaz, Ahvaz, Iran.
[3]Professor, Department of Sports Physiology, Faculty of Sports Sciences, Shahid Chamran University of Ahvaz, Ahvaz, Iran.

Abstract

Objective: This study aimed to examine the effect of physical activity at varying intensities on anxiety, blood pressure, and blood glucose levels in primiparous women aged 20-30 years.

Materials and Methods: The study population comprised 200 primiparous pregnant women. Data were collected using the Spielberger Anxiety Questionnaire and a physical activity questionnaire. Pearson's correlation test was employed to analyze the relationships between physical activity, blood pressure, blood glucose, and anxiety levels. Analysis of covariance (ANCOVA) was used to evaluate the effects of different physical activity intensities on these variables, with statistical significance set at $P< 0.05$.

Results: The Pearson correlation test revealed a significant inverse relationship between physical activity and blood glucose ($P= 0.011$, r= -0.55) as well as between physical activity and blood pressure ($P= 0.003$, r= -0.62) in primiparous women. Similarly, an inverse and significant relationship was observed between physical activity and anxiety levels ($P= 0.021$, r= -0.47 for state anxiety; $P= 0.001$, r= -0.78 for trait anxiety). The ANCOVA results demonstrated significant differences in blood pressure and blood glucose levels among pregnant women across three levels of physical activity intensity ($P= 0.001$ for both).

Conclusion: The findings suggest that increased physical activity is associated with reductions in blood glucose levels, blood pressure, and anxiety in pregnant women. These results highlight the potential benefits of regular physical activity for managing these health indicators during pregnancy.

Keywords: Physical activity, Anxiety, Blood pressure, Blood glucose, Pregnant women

QR Code:

Citation: Radfar G, Alizadeh A, Rami M, Habibi A. The Effect of Physical Activity with Different Intensity on Anxiety, Blood Pressure and Blood Glucose in Pregnant Women Aged 20-30. IJDO 2024; 16 (4) :231-239

URL: https://ijdo.ssu.ac.ir/article-1-909-en.html

10.18502/ijdo.v16i4.17289

Article info:

Received: 17 June 2024

Accepted: 05 July 2024

Published in December 2024

Corresponding Author:

Aliakbar Alizadeh, Department of Sports Physiology, Faculty of Sports Sciences, Shahid Chamran University of Ahvaz, Ahvaz, Iran.

Tel: (98) 918 143 6507

Email: A.alizadeh@scu.ac.ir

Orcid ID: 0000-0001-7846-6503

[DOI: 10.18502/ijdo.v16i4.17289]

Introduction

Regular physical activity improves physical and psychological health. Adverse consequences of inactivity may be important problem among pregnant women (1). Up to 60% of pregnant women are inactive during pregnancy. There is much consistent evidence that physical activity is reduced during pregnancy; however, few investigators have sought to quantify physical activity patterns among pregnant women using well validated measures (2). Some barriers to physical activity during pregnancy, such as depression, anxiety and fatigue, changes in blood pressure and blood glucose, have been shown to be reduced by regular exercise in non-pregnant samples. There is a need to better understand the relationships between these factors and physical activity during pregnancy (3). Available retrospective and prospective results suggest that both leisure time and work-related physical activities are decreased during pregnancy. Intensity and duration decrease both during pregnancy compared with pre-pregnancy and in the third trimester compared with the first. There is a need for well-designed longitudinal investigations that document pregnancy-related changes in physical activity at frequent intervals during pregnancy using validated and more precise measures of physical activity (4). Nevertheless, in both medical and non-medical environments, there are often uncertainties and fears regarding the intensity and frequency of physical activity or exercise that would be most advisable for individual women. These worries lead to doubt among pregnant individuals, resulting in elevated levels of physical inactivity, especially in the third trimester (5).

Antenatal anxiety in pregnant women is a public health issue worldwide due to its high prevalence and the heavy burden it places not only on pregnant women themselves but also on their families. Previous studies have shown that 14-54% of pregnant women experience anxiety (6). Due to lack of experience, primiparous women unconsciously experience unusual emotions, which, if not controlled, will have multiple consequences. In other words, this type of mood disorder during pregnancy is associated with adverse effects on mother and fetus (7).

Today, the effect of physical activity on the health of pregnant women has become a hot topic in pregnancy health care, however, this view is still controversial on the duration and intensity of exercise. Some studies supported that healthy pregnant women should be encouraged to carry out regular physical exercise (8). The American College of Obstetricians and Gynecologists encourage pregnant women to get at least 30 minutes of moderate physical exercise a day (9). Conversely, there is also a view that pregnant women should exercise cautiously, especially at moderate or vigorous levels (8). Excessive physical exercise during pregnancy can lead to chronic fatigue, hypoglycemia, and an increased risk of injury (i.e., low back pain or musculoskeletal injury). Significant changes in posture and shifts in center of gravity alter maternal balance and coordination. In the past, Physical exercise was not recommended for women with high blood pressure during pregnancy because of concerns about the safety of the fetus and the pregnant woman, however, recent studies have showed that proper exercise is associated with a significantly reduced risk of gestational hypertensive disorders overall, either structured exercise or yoga have a beneficial effect in prevention of pregnancy-induced hypertension (PIH) (10,11). The effect of exercise training on the cardiovascular system of pregnant women according to their different protocols and the main criteria of exercise prescription, i.e. duration, intensity and especially the type of exercise, degrees, and especially in our country, has not been investigated sufficiently and with appropriate methodology. Also, in previous limited researches, conflicting results have been

[DOI: 10.18502/ijdo.v16i4.17289]

reported regarding cardiovascular hemodynamic changes and changeable parameters such as blood pressure and blood glucose in pregnant women following exercise (12). Therefore, important factors such as intensity, frequency and type of exercise should be considered in exercise training to prevent and treat pregnancy-related complications (13). However, the effects of different intensities of activity with the same volume and frequency have not yet been determined. Ashrafi et al. (2012) observed that physical activity had no significant effect on blood sugar in diabetic women (14). This study aims to investigate the effect of physical activity with different intensity on anxiety, blood pressure, and blood glucose in primiparous pregnant women aged 20-30 in Shushtar city.

Material and methods

This semi-experimental study was conducted in pregnant women aged between 20 and 30 years. The blood pressure and blood glucose were measured in the third week of pregnancy and immediately after delivery. Also, the anxiety questionnaire was completed by the subjects in the third week and immediately after delivery. The statistical population of this research consists of 20-30 year old pregnant women of Shushtar city. For this purpose, 200 pregnant women of Shushtar city (between 20 and 30 years old and (Mean weight: 66.42) were voluntarily selected. The subjects first got acquainted with the way of conducting the research. Then the personal and health information questionnaire was distributed among the volunteers.

Inclusion criteria were**;** Education at least diploma, age 20 to 30 years, pregnant women with primiparous births, medical examination during pregnancy and appropriate pregnancy status, complete physical and mental preparation and willingness to cooperate with the researcher, no blood pressure and diabetes medication.

Exclusion criteria

Low score of anxiety behavior disorder through questionnaire, doing sports activities professionally, heart disease.

After filling the consent form, the volunteers were assured that their information will not be shared with the organization or a specific person. According to the ethical principles of working with human samples, the subjects were told that they have the right to withdraw from the research at any time.

A mercury sphygmomanometer was used to measure blood pressure (Riester mercury blood pressure device made in Germany). Glucometer (Performa Accu-Chek Glucometer made in America) was also used to measure blood glucose. In order to check the anxiety level of the subject, the Spielberger questionnaire consists of 40 questions and measures the two dimensions of anxiety state (20 questions) and anxiety streak (20 questions).

Subjects' answers to this questionnaire are determined by a 5-point scoring spectrum (not at all, to some extent, moderate, much, and very much). The reliability and validity coefficient of this questionnaire has been determined as 0.98 and 0.92 respectively.

Physical activity questionnaire: The questionnaire contains 7 questions. In this questionnaire, activity is divided into three categories: intense activity (questions 1 and 2 of the questionnaire), moderate activity (questions 3 and 4 of the questionnaire) and walking or light (questions 5 and 6 of the questionnaire). After determining the coefficients, the duration of time devoted to each type of activity (according to the intensity) in each day, as well as the number of days per week devoted to that activity, are considered (15). These are then multiplied together. For example, for a person who did not have intense activity in the last week and had an average of 15 minutes of activity on 3 days of the week and an average of 30 minutes of walking one day a week, it is calculated as follows:

0+ 4 (1 ×3× 3.3)+ (3× 15 ×4)= 288

[DOI: 10.18502/ijdo.v16i4.17289]

According to the physical activity questionnaire, the activity levels were divided into three levels: low to light, moderate, and intense. The average obtained from the physical activity questionnaire determined these three activity levels, and the variables of blood sugar and blood pressure in these three activity levels of women. Primates were examined.

Statistical analysis

All data were analyzed using SPSS version 26 software. Descriptive statistics were used to check the mean and standard deviation. Shapiro-Wilk method was also used for the normality of the data. Pearson correlation test was used to check the assumptions and correlation of the indicators and the significance level was considered $P< 0.05$ for all statistical analyses. Analysis of covariance test was used to check blood sugar and blood pressure at different levels of physical activity.

Ethical considerations

This study was approved by the Ethics Committee of Shahid Chamran University of Ahvaz with code IR.SCU.REC.1403.046. All information collected was kept confidential and anonymous.

Results

The results of descriptive statistics (mean± standard deviation) of this research include: variables of age, weight before and after pregnancy, body mass index before and after pregnancy, weight gain, baby weight, systolic and diastolic blood pressure, blood glucose, physical activity, state of distress and streak of anxiety are reported in Table 1.

Also, the results related to inferential statistics are reported in Table 2. The results of the Pearson correlation test showed that there is a significant relationship between physical activity and blood sugar in 20-30-year-old primiparous women of Shushtar city (P= 0.011 and r= -0.55); According to the correlation coefficient, this relationship is inverse. That is, by increasing the amount of physical activity, the blood glucose level in pregnant women decreases and approaches the normal level. Also, the results of Pearson correlation test showed that there was a significant relationship between physical activity and the state of anxiety of primiparous women aged 20 to 30 in Shushtar city (P= 0.021 and r= -0.47), by increasing the level of

Table 1. Descriptive statistics of research variables

Variable	Mean	Standard deviation
Age (years)	26.68	3.76
Height (cm)	159	8.28
Pre-pregnancy weight (kg)	66.42	12.52
BMI before pregnancy (kg/m^2)	26.06	81.11
BMI after pregnancy (kg/m^2)	31.69	4.90
Baby's weight (kg)	3.28	.56
Systolic blood pressure (mmHg)	122.26	18.33
Diastolic blood pressure (mmHg)	71.70	1.13
Blood glucose (mg/dL)	96.15	18.90
Physical activity	267.12	10.38
State of anxiety (number)	57.98	8.83
Streaks of anxiety (number)	40.15	9.18

Table 2. Pearson correlation test results between physical activity and blood glucose, stress and blood pressure

Variable		Significance level (P)	Correlation coefficient (r)
Physical activity	Blood glucose (mg/dL)	0.011*	-0.55**
	State of anxiety (number)	0.021*	-0.47**
	Streaks of anxiety (number)	0.001*	-0.78**
	Systolic blood pressure (mmHg)	0.003*	-0.62**
	Diastolic blood pressure (mmHg)	0.028*	0.31**

* Significance level ($P< 0.05$), ** indicates the correlation coefficient, and the sign (- and +) indicates the direct or inverse direction of the relationship between two variables.

[DOI: 10.18502/ijdo.v16i4.17289]

physical activity, the level of anxiety in pregnant women decreases. The statistical results showed that there was a significant relationship between physical activity and the anxiety of primiparous women aged 20 to 30 in Shushtar city (*P*= 0.001 and r= -0.78); That is, by increasing the amount of physical activity, the level of anxiety in pregnant women decreases. The results of Pearson correlation test also showed that there was a significant relationship between physical activity and blood pressure of primiparous women aged 20 to 30 in Shushtar city (*P*= 0.003 and r= -0.62); According to the correlation coefficient, this relationship is inverse. Also, the results showed that there is a significant relationship between activity level and diastolic blood pressure (*P*= 0.028 and r= -0.31).

The results of non-parametric Analysis of covariance test showed that there was a significant difference between blood pressure in pregnant women with three levels of physical activity: low, light, moderate, and intense (*P*= 0.001) (Table 3). According to the follow-up test, there was a significant difference in blood pressure between pregnant women with low and light physical activity and women with intense physical activity (*P*= 0.001). This difference was due to higher blood pressure in women with more intense physical activity. Also, a significant difference was observed between the blood pressure of women with moderate physical activity and the blood pressure of women with intense activity (*P*= 0.009). However, no significant difference was observed between the blood pressure of women with low and light activity and the blood pressure of women with moderate activity (*P*= 0.96) (Table 4).

Also, the results of the Analysis of covariance test showed that there was a significant difference between blood sugar levels in pregnant women with three levels of physical activity: low, light, moderate, and intense (*P*= 0.001) (Table 3). According to the follow-up test, a significant difference was observed between pregnant women with low and light physical activity and women with vigorous physical activity (*P*= 0.001). According to the average, blood sugar level was higher in women with more intense physical activity. Also, a significant difference was observed between blood pressure of women with moderate physical activity and blood sugar of women with intense activity (*P*= 0.001). However, no significant difference was observed between the blood sugar of pregnant women with low and light activity and the blood sugar of pregnant women with moderate activity (*P*= 0.98) (Table 4).

Discussion

According to the results of Pearson's correlation test, there was a significant inverse relationship between physical activity and blood glucose level, blood pressure and anxiety state of pregnant women.

Table 3. Analysis of covariance test results of variables

Variable	Physical activity levels	Mean±	Standard deviation	*P*-value
Blood pressure	Low and light	117.82	11.85	0.001
	Medium	120.69	16.91	
	Vigorous	128.28	28.71	
Blood glucose	Low and light	92.36	6.31	0.001
	Medium	91.62	2.31	
	Vigorous	104.48	2.24	

Table 4. The results of the post hoc test of the variables

Variable	Physical activity levels		*P*-value
Blood pressure	Low and light	Medium	0.96
		Vigorous	0.001
	Vigorous	Medium	0.009
Blood glucose	Low and light	Medium	0.98
		Vigorous	0.001
	Vigorous	Medium	0.001

[DOI: 10.18502/ijdo.v16i4.17289]

Also, the results of the research showed that between different intensities of physical activity (light, Medium and vigorou), medium physical activity had the greatest effect on regulating blood glucose levels, blood pressure and anxiety in pregnant women. Therefore, the result obtained is consistent with the study of Wang et al. (2021), this study showed high physical exercise time and abnormal plasma glucose percentage among women with gestational diabetes in Shanghai, China. Diabetic women with longer exercise times had a lower percentage of abnormal plasma glucose, especially when exercise times were more than 60 minutes per day, and complementary treatments should be provided to women with more than 70% of abnormal plasma glucose (16).

The obtained result is also consistent with the findings of Yaping et al. (2021), they concluded that moderate intensity aerobic exercise can help improve blood glucose control and increase insulin sensitivity in diabetic pregnant women (17). Hopkins et al (2010) assessed fasting blood glucose and insulin levels and insulin resistance. They did not report a significant difference in maternal insulin sensitivity (18). In the studies conducted by Oostdam et al., they showed that an exercise program in the second and third trimesters of pregnancy in overweight women at risk of gestational diabetes had a significant effect on fasting blood glucose (19). Depending on the intensity and appropriate duration, sports activity can be mentioned as a factor for increasing insulin sensitivity, reducing insulin resistance and reducing blood glucose in pregnant women. Based on other previous studies, it can be concluded that physical exercises not only reduce resistance to insulin, but also improves glucose homeostasis by increasing the mass and function of beta cells (20). Therefore, the intensity and duration of physical activity are two very important features that should be considered by pregnant women. Since the high-intensity sports activity for a long time may cause risks for pregnant women (8).

Based on the findings of the present study, there was a significant relationship between physical activity and systolic blood pressure and diastolic blood pressure in primiparous pregnant women. With regular physical activity, the blood pressure of pregnant women was within normal limits. Ahrari et al (2018) in a study consistent research showed that aerobic and combined activity had a significant effect on reducing blood pressure in healthy pregnant women (21). A decrease in vasomotor tone and an increase in parasympathetic nerve activity following physical activity can be the cause of lower blood pressure in pregnant women. Also, the possibility of increased mediators such as nitric oxide that have a positive effect on increasing vagal tonus in active pregnant women can be the cause of blood pressure changes. Past research indicates that exercise leads to improvement of nitric oxide bioavailability and reduction of angiotensin II level (22).

In this regard, May et al (2016) in a study showed that the activity of the sympathetic nervous system, blood pressure and heart rate of pregnant women increased after exercise and pregnancy complications worsened. These results are inconsistent with the results of the present study in relation to blood pressure (23). Of course, May's study was a case-control type, so there is a possibility of the influence of intervening factors. Also, the reason for the non-alignment of these studies can be explained by the use of different exercise intensities, pregnant women with different anthropometric characteristics and regularity in the exercise research results. Daily physical exercise is recommended for non-risk or low-risk pregnant women, and regular physical exercise during pregnancy can prevent PIH. In studies of pregnant women with PIH, regular physical exercise during pregnancy has been associated with a reduced risk of adverse outcomes, including preeclampsia, preterm birth and cardiovascular disease (8). Mild physical exercise during pregnancy, including swimming, walking,

[DOI: 10.18502/ijdo.v16i4.17289]

yoga and stretching, improves blood vessel perfusion while stimulating major muscle and effectively reducing pregnancy complications. Even in women who do not physical exercise before pregnancy, a moderate physical exercise during pregnancy can improve their health without affecting placental blood flow resistance and fetal growth (14).

The results of the correlation test also showed that there was a significant inverse relationship between sports activity and the anxiety score of pregnant women. Yan et al. (2020) showed that pregnant women who had regular physical activity in the first trimester of pregnancy had lower blood pressure and lower anxiety scores than pregnant women who had insufficient physical activity. And women with lower anxiety scores had lower blood pressure (24). Physical activity could strengthen the function of the cardiovascular system, enhance the contractility and permeability of blood vessels, maintain the normal conductivity of nerve fibers, stimulate the secretion of neurotransmitters, and help alleviate anxiety symptoms. Immune and inflammatory mechanisms have been proposed as potential connections between anxiety symptoms and delivery outcomes, and most studies have indicated that the physiological function of the hypothalamic-pituitary-adrenal (HPA) axis showed a close association with these variables (25). Additionally, the relationship between anxiety and blood pressure during pregnancy can be explained by the fact that blood pressure increases and hypertension may appear because of a complex interplay of underlying biological mechanisms, such as alterations in the sympathetic and parasympathetic nervous systems, changed immunological processes, or increased HPA activity (26). One of the limitations of the research was primiparous women with a certain age range in one city. Therefore, it is not possible to generalize to women with a higher or lower age range and non-primiparous women.

In this way, intervening factors such as pregnancy process, living conditions, weight gain, changes in heart rate and blood pressure and other physiological changes of pregnancy are important factors during pregnancy. Because with the increase of factors such as weight, gestational age and increase in heart rate and blood pressure, the superiority of sympathetic nervous activity affects the variability of blood pressure and psychological conditions (8,27).

Conclusion

Based on the results of this research, physical activity plays an important role in regulating blood pressure, blood glucose and controlling psychological factors such as anxiety in pregnant women. Also, these findings showed that activities with different intensities can have different effects on pregnant women. Physical activity with moderate intensity can have an effective improvement in controlling anxiety and regulating blood pressure and blood glucose in women during pregnancy and help the conditions of these women.

Acknowledgments

This manuscript is based on the master's thesis of Ms. Ghazal Radfar, who graduated from Shahid Chamran University of Ahvaz in the academic year of 1402-1403. We sincerely thank and appreciate the subjects of this research who cooperated with us.

Funding

This study is not funded by any research or academic organization.

Conflict of Interest

The authors of this article declare that there is no conflict of interest.

Authors' contributions

GhR: doing practical research study, collecting and collaborative data, AA: presenting the topic, planning method to achieve the result, MR: doing statistical

[DOI: 10.18502/ijdo.v16i4.17289]

analysis, AH: writing the manuscript and collecting data.

All authors have accepted responsibility for the entire content of this manuscript and agreed to be accountable for all aspects of the study in ensuring that questions related to the accuracy or integrity of any part of the study are appropriately investigated and resolved and approved the version to be published.

References

1. Poudevigne MS, O'Connor PJ. A review of physical activity patterns in pregnant women and their relationship to psychological health. Sports medicine. 2006;36(1):19-38.
2. Sartika Y, Harahap DA, Rahmi J, Hindratni F, Sari SI. Primigravid patients' cortisol level and anxiety level toward childbirth with pregnancy exercises and healing touch. Journal of Pharmaceutical Negative Results. 2023;14(3):3207-16.
3. Hasanin ME, Elsayed SH, Taha MM. Effect of acupressure on anxiety and pain levels in primiparous women during normal labor: a randomized controlled trial. Journal of Integrative and Complementary Medicine. 2024;30(7):654-61.
4. Brown WJ, Hayman M, Haakstad LA, Mielke GI, Mena GP, Lamerton T, et al. Evidence-based physical activity guidelines for pregnant women. health AGDo, editor. Canberra, Australia. 2020.
5. González-Cazorla E, Brenes-Romero AP, Sánchez-Gómez MJ, Estévez-Ruiz E, Díaz-Enjuto A, Cantón-Cisneros A, Lubián-López D, et al. Physical Activity in Work and Leisure Time during Pregnancy, and Its Influence on Maternal Health and Perinatal Outcomes. Journal of Clinical Medicine. 2024;13(3):723.
6. Rees S, Channon S, Waters CS. The impact of maternal prenatal and postnatal anxiety on children's emotional problems: a systematic review. European child & adolescent psychiatry. 2019;28(2):257-80.
7. McCarthy M, Houghton C, Matvienko-Sikar K. Women's experiences and perceptions of anxiety and stress during the perinatal period: a systematic review and qualitative evidence synthesis. BMC Pregnancy and Childbirth. 2021;21(1):811.
8. Zhu Z, Xie H, Liu S, Yang R, Yu J, Yan Y, et al. Effects of physical exercise on blood pressure during pregnancy. BMC Public Health. 2022;22(1):1733.
9. Committee on Obstetric Practice. ACOG committee opinion. Exercise during pregnancy and the postpartum period. Number 267, January 2002. American College of Obstetricians and Gynecologists. International journal of gynaecology and obstetrics: the official organ of the International Federation of Gynaecology and Obstetrics, 2002;99(1):171-3.
10. Danielli M, Gillies C, Thomas RC, Melford SE, Baker PN, Yates T, et al. Effects of supervised exercise on the development of hypertensive disorders of pregnancy: a systematic review and meta-analysis. Journal of Clinical Medicine. 2022;11(3):793.
11. Hanson MA, Gluckman PD. Developmental origins of health and disease–global public health implications. Best practice & research Clinical obstetrics & gynaecology. 2015;29(1):24-31.
12. Dietz P, Watson ED, Satter MC, Ruf W, Titze S, van Poppel M. The inflence of physical actiity during pregnancy on maternal, fetal or infantheart rate variability: A systemati review. BMC Pregnancy Childbirth.2016; 16(1):326.6.
13. Ashrafi Ha, Zafari A, Kazemzade Y, Heidarimoghadam R, Moeiri A, Mortazavi Ts. Physical Activity and Concentration of Serum Glycosylated Hemoglobin. Journal of Ilam University of Medical Sciences 2013, 21(3): 125-134.(in Persian)
14. Roldan-Reoyo O, Pelaez M, May L, Barakat R. Influence of maternal physical exercise on fetal and maternal heart rate responses. German Journal of Exercise and Sport Research. 2019;49(4):446-53.
15. Lee PH, Macfarlane DJ, Lam TH, Stewart SM. Validity of the international physical activity questionnaire short form (IPAQ-SF): A systematic review. International journal of behavioral nutrition and physical activity. 2011;8:1-11.
16. Wang R, Yang Q, Sun T, Qiang Y, Li X, Li H, et al. Physical exercise is associated with glycemic control among women with gestational diabetes mellitus: Findings from a prospective cohort in Shanghai, China. Diabetes, Metabolic Syndrome and Obesity. 2021:1949-61.
17. Yaping X, Huifen Z, Meijing Z, Huibin H, Chunhong L, Fengfeng H, et al. Effects of moderate-intensity aerobic exercise on blood glucose levels and pregnancy outcomes in patients with gestational diabetes mellitus: a randomized controlled trial. Diabetes Therapy. 2021 Sep;12(9):2585-98.
18. Hopkins SA, Baldi JC, Cutfield WS, McCowan L, Hofman PL. Exercise training in pregnancy reduces offspring size without changes in maternal insulin sensitivity. The Journal of Clinical Endocrinology & Metabolism. 2010;95(5):2080-8.
19. Oostdam N, Van Poppel MN, Wouters MG, Eekhoff EM, Bekedam DJ, Kuchenbecker WK, et al. No effect of the FitFor2 exercise programme on

[DOI: 10.18502/ijdo.v16i4.17289]

blood glucose, insulin sensitivity, and birthweight in pregnant women who were overweight and at risk for gestational diabetes: results of a randomised controlled trial. BJOG: An International Journal of Obstetrics & Gynaecology. 2012;119(9):1098-107.
20. Yang X, Han R, Xiang Z, Li H, Zhao Q, Chen L, Gao L. Clinical practice guidelines on physical activity and exercise for pregnant women with gestational diabetes mellitus: A systematic review. International Journal of Nursing Practice, 2023; 29(6): e13141.
21. Ahrari K, Gholami M, Chamani M, Abed Natanzi H. Effect of combined aerobic and resistance training on blood pressure and heart rate variability in pregnant women: a clinical trial study. Journal of Arak University of Medical Sciences, 2018; 22(6): 241-230.
22. Nystoriak M, Bhatnagar A. Cardiovascular effcts and benefis of exercise. Front Cardiovasc Med. 2018; 5(1):135.
23. May LE, Knowlton J, Hanson J, Suminski R, Paynter C, Fang X, et al. Effects of exercise during pregnancy on maternal heart rate and heart rate variability. PMR. 2016; 8(7):611-7.
24. Yang X, Han R, Xiang Z, Li H, Zhao Q, Chen L, et al. Clinical practice guidelines on physical activity and exercise for pregnant women with gestational diabetes mellitus: A systematic review. International Journal of Nursing Practice, 2023; 29(6): e13141.
25. Wittert GA, Livesey JH, Espiner EA, Donald RA. Adaptation of the hypothalamopituitary adrenal axis to chronic exercise stress in humans. Medicine and science in sports and exercise. 1996;28(8):1015-9.
26. St-Pierre DH, Richard D. The effect of exercise on the hypothalamic-pituitary-adrenal axis. Endocrinology of physical activity and sport. 2020:41-54.
27. Yıldırım Dİ, Balcı Ş, Günenç O, Eryılmaz MA. Effect of physical activity on health-related quality of life and depression anxiety in pregnancy. Cukurova Medical Journal. 2020;45(2):547-55.

[DOI: 10.18502/ijdo.v16i4.17289]