Women. Health. Bull. 2024; 11(1)

Published online 2024 January.

Original Article

The Relationship Between Physical Activity and Primary Infertility in Iranian Women

Abbas Saremi[1,2*], PhD; Rahmatollah Moradzadeh[3], PhD

[1]Department of Sport Physiology, Faculty of Sport Sciences, Arak University, Arak, Iran
[2]Sport Sciences Research Institute, Ministry of Science, Research and Technology, Tehran, Iran
[3]Department of Epidemiology, School of Health, Arak University of Medical Sciences, Arak, Iran

Corresponding author:* Abbas Saremi, PhD; Department of Sport Physiology, Faculty of Sport Sciences, Arak University, Arak, Iran. **Tel: +98 9163622668; **Email:** a-saremi@araku.ac.ir

Received: August 31, 2023; **Revised:** October 01, 2023; **Accepted:** November 04, 2023

Abstract

Background: Inadequate lifestyle choices, such as insufficient physical activity, may be linked to adverse fertility outcomes. Given the profound influence of lifestyle on women's reproductive health, this study was undertaken to compare the levels of physical activity and body composition among fertile and infertile Iranian women in 2022.
Methods: This cross-sectional study encompassed 653 fertile women (mean age: 32.58±5.99 years, mean body mass index (BMI): 25.7±3.64 kg/m²) and infertile women (mean age: 32.59±5.38 years, mean BMI: 26.4±5.6 kg/m²) who sought assistance at infertility centers in six provinces (Guilan, Markazi, Hamedan, Sistan, and Baluchestan, Isfahan, and Khuzestan) during the research period spanning 2021 to 2022. Participants completed questionnaires regarding their lifestyle habits and physical activity levels, body composition was also assessed. Chi-square and multiple logistic regression tests were employed for data analysis.
Results: Fertile women exhibited superior physical activity (P=0.04) and a lower BMI (P=0.001) than their infertile counterparts. Women with a high level of physical activity (OR=4.42, P=0.004) were more likely to experience infertility. Inactive women who spent more than 300 minutes per day sitting were 2.07 times more susceptible to fertility complications than their physically active peers (moderate activity) (OR=2.07, P=0.001).
Conclusion: Given the simultaneous increase in obesity, inactivity, and infertility among Iranian women, it is imperative to place greater emphasis on lifestyle habits, including appropriate physical activity, to prevent and potentially treat infertility.

Keywords: Iran, Body mass index, Infertility, Sedentary behavior, Women

How to Cite: Saremi A, Moradzadeh R. The Relationship Between Physical Activity and Primary Infertility in Iranian Women. Women. Health. Bull. 2024;11(1):20-28. doi: 10.30476/WHB.2024.97668.1216.

1. Introduction

Sedentary behaviors and physical inactivity pose a severe threat to global health. These behaviors have been demonstrated to impact various health factors and mortality rates independently (1). Specifically, physical activity (PA) has conflicting effects on fertility. In men, engaging in light PA is associated with improved semen quality (2). However, some reports fail to establish a clear relationship between PA and sperm fertility (3). Light physical activity, irrespective of body composition, enhances fertility parameters and the live birth rate among women during fertility treatments (4).

Conversely, intense physical activity has been correlated with a decline in semen quality in men (5) and fertility issues in women (6). Notably, sedentary behaviors have not been definitively linked to reduced sperm fertility, although an increase in TV viewing has been associated with decreased sperm count (7). Research on the relationship between sedentary behaviors and female reproductive health has received less attention (8).

On the other hand, excess weight is closely associated with reduced mobility, and obesity is strongly linked to infertility in couples. Studies showed that a BMI exceeding 24.9 kg/m² is associated with infertility (9). Overweight individuals exhibit reduced sperm fertility, lower sperm count, single-stranded sperm DNA, defective eggs, and incomplete ovulation and implantation (10). While the manifold beneficial effects of exercise on human health, such as preventing premature death, have been well established (1), the role of physical activity in male and female fertility remains poorly understood. One study found that engaging in more vigorous exercise was associated with a decreased risk of female infertility (11).

Conversely, Morris and colleagues discovered that women participating in fertility treatment programs who exercised for four hours or more per

week experienced a 40% decrease in the likelihood of live birth and an increased risk of implantation failure (12). Another study by Foucaut and colleagues suggested that sedentary behaviors may contribute to infertility in women, emphasizing the importance of considering the frequency and type of exercise in an exercise program (13). Therefore, although the exact causes remain unclear, lifestyle factors and habits may explain some idiopathic infertility (14).

Hence, it is crucial to consider these risk factors in these individuals, as understanding the underlying causes of this problem can lead to improved management of idiopathic infertility. Nevertheless, while the relationship between physical activity and the fertility of both men and women has been explored to a limited extent globally, this interaction has not been investigated explicitly in Iran. Consequently, due to variations in attitudes and levels of physical activity across different societies, the contribution of this crucial lifestyle factor to the incidence of various diseases also varies. Given the above considerations and the scarcity of research on this critical public health issue, this study investigated the potential relationship between types of physical activity and infertility in Iranian women.

2. Methods

This research was a retrospective study conducted in six provinces of Iran including Gilan, Khuzestan, Markazi, Hamedan, Sistan and Baluchestan, and Isfahan, from 2021 to 2022. In this research, the aim was to encompass all regions of the country in the sampling. The research plan allowed for identifying various independent variables associated with primary infertility. In this study, a total of 653 women were selected and examined as follows:

Out of the 653 cases, 328 involved married women within the reproductive age range of 18-40 years who had been unable to conceive for a minimum of one year despite regular exposure to pregnancy. To determine the required sample size, a prior study (15) was referred to, which reported a type 1 error of 0.05, type 2 error of 0.2, and mean±SD of sitting time in minutes per day as 264.6±126.8 for infertile women and 236.4±109 for fertile women. Utilizing an appropriate formula (16), it was determined that a sample size of 325 individuals for each case and control group was necessary to estimate the effects of the desired risk factors. An additional 10 individuals were added to the initial sample size to account for potential sample reductions, resulting in 335 individuals for each group. Therefore, the total number of participants in each province was increased to 670 women for the survey (Figure 1).

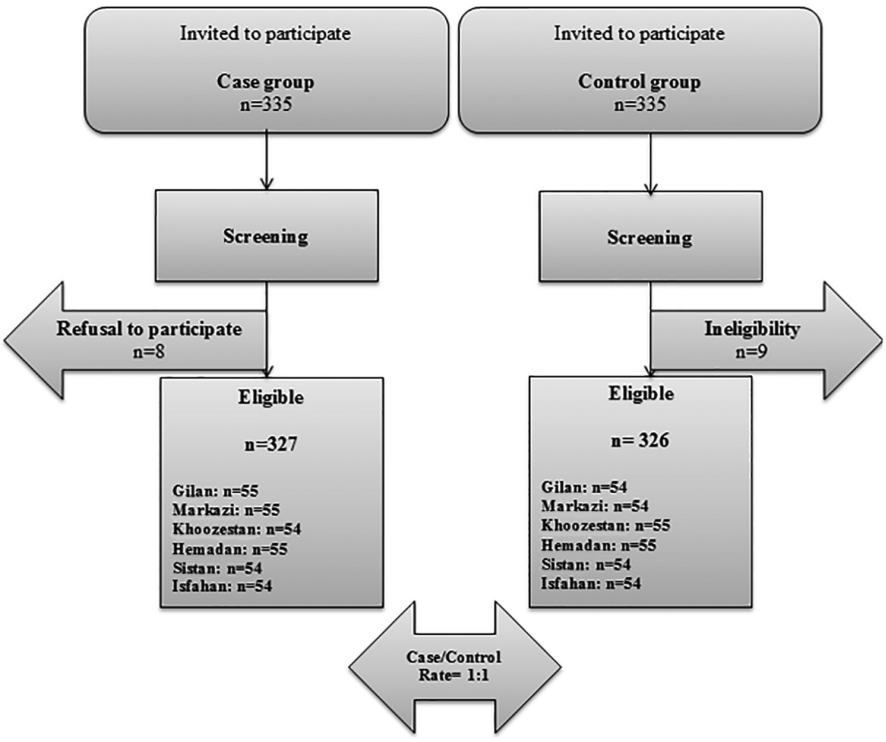

Figure 1: The figures shows the flowchart for selection of study population.

During the screening process, eight individuals from the case group and ten from the control group were excluded from the survey. Consequently, the final number of subjects included in the study was 653 people.

Three infertility treatment centers were selected in each province as part of a simple sampling method encompassing all social strata within the respective cities to establish the sample frame. This selection aimed to ensure an almost equal distribution of samples. The population framework consisted of a list of women who had visited these fertility centers between March 2021 and June 2022, seeking medical advice for infertility. Based on hormonal and ultrasound evaluations, it was confirmed that the cause of infertility was related to the woman in the family. The samples were randomly selected from this list, and questionnaires were completed either at the participants' homes or during visits to the infertility treatment center through telephone interviews, per the participants' preferences.

A multi-stage sampling technique was employed to designate the control group. Firstly, each city was categorized into three classes based on socioeconomic conditions. Subsequently, a health-treatment center (for example, in the city of Arak, centers like Alam Al-Hadi, Hepko, and Vali Asr) was randomly selected from each class, and control group was chosen in proportion to the population served by each center.

The inclusion criteria for women in the case group included being of reproductive age, suffering from infertility, having a general health condition suitable for answering questions, being of Iranian origin, and possessing the ability to engage in a 30-minute conversation with the interviewer. Additionally, participants were required to have a residence history of at least three years in the cities under study. Individuals in the infertile group had engaged in unprotected sexual intercourse for at least 12 months without a diagnosed cause of infertility and had no history of abortion.

Exclusion criteria for the case group encompassed individuals who had previously experienced infertility, those unwilling to answer questions, those with dialects not understood by the interviewer and pregnant women.

2.1. Study Tools

Contributors completed questionnaires detailing their demographic information and lifestyle habits, including gender, age, education level, and smoking status. To assess the participants' physical activity levels, the short form of the International Physical Activity Questionnaire (IPAQ) was utilized, categorizing activities into three levels: walking, light physical work, and intense physical work. Additionally, the questionnaire captured individuals' time without movement (17). A panel of fifteen experts established the Persian version of the questionnaire's validity with a Content Validity Ratio of 0.84 and a Content Validity Index of 0.83 (17). The reliability of the Persian version of the scale, measured by Cronbach's alpha coefficient, was found to be 0.79 (17).

Activities such as cycling, running, jogging, gardening, and walking with added resistance that elevates breathing slightly above the average rate are considered moderate activities. In contrast, vigorous physical activities like jogging and farming require significantly higher exertion, causing breathing to be substantially more strenuous than the standard baseline. Data for each type of activity included the frequency of engagement in such activities over the past week and the total duration in minutes during any given day. Responses were recorded separately, and the data was analyzed by the guidelines set forth by the World Health Organization (17).

During the IPAQ assessment, two distinct categories of information were generated. The first category classified activities as light, moderate, or vigorous; the second category quantified activity regarding metabolic equivalent of task (MET) minutes per week. MET is the unit of measurement for the body's energy expenditure rate and is based on the energy consumption at rest. Intermediate physical activity is anticipated to burn four times as many calories as sedentary activity, while intense activity is expected to burn eight times as many. The mean MET value for each type of physical activity was established using the methodology outlined by Ainsworth and colleagues (18).

2.2. Collecting Data

The weight of individuals, excluding shoes and additional clothing items such as overcoats and tents, was meticulously measured and recorded

using a scale with a precision of 100 grams. The height of females without footwear was determined with a precision of 0.1 cm, ensuring that the back of the head, shoulders, hips, and back of the foot remained in contact with the measuring rod. Subsequently, the BMI was assessed.

2.3. Statistical Methods

Descriptive analysis was performed for quantitative and qualitative variables, reporting the latter's means, standard deviations, frequencies, and percentages. The distribution of quantitative variables was assessed using Kolmogorov-Smirnov's one-sample test, revealing that the related variables exhibited a non-parametric distribution. The Chi-square test was employed to compare fertile and infertile individuals about each qualitative variable. The Mann-Whitney U test was utilized to ascertain differences in scores for each variable between fertile and infertile individuals. In the case of quantitative variables with a normal distribution, the Independent T-test was applied. Multiple logistic regression analysis assessed the relationship between the variables under study and infertility. In this equation, Y represents fertile/infertile with (0, 1), and "P" is the probability of Y being 1. In addition, X1..., Xk is a set of predictor variables. Then, the logistic regression of Y on X_1… ,X_k calculates parameter values for β_0, β_1, …, β_k by maximum likelihood procedure of the subsequent equation:

$$\text{Logit}(P)=\text{Log}(P/1-P)=\beta_0+\beta_1X_1+\ldots+\beta_k X_k$$

Any variable with P>0.2 was subsequently removed from the model. Data analysis was conducted using Stata 12.0.

3. Results

Table 1 displays the demographic characteristics, body composition, and socioeconomic status of fertile and infertile women under study. The mean age of fertile women was 32.58±5.99 years, while that of infertile women was 32.59±5.38 years, indicating no significant difference between the two groups (P=0.98). The onset of menstruation was 13.51±1.55 years for fertile women and 13.38±1.52 years for infertile women, with no statistically significant variation observed (P=0.30). The average age at marriage for fertile women was 22.13±4.27 years, compared to 22.30±5.74 years for infertile women, displaying no significant divergence between the two groups (P=0.66). Concerning BMI, infertile women exhibited a significantly higher BMI than fertile women (26.75±4.60 vs. 25.71±3.64 kg/m^2) (P=0.001).

Furthermore, the study revealed that 18.8% of fertile women had a low level of education, whereas 38.4% of infertile women fell into the same category.

Table 1: Characteristics of the studied fertile and infertile women

	Fertile women	Infertile women	P value
Age(yr.): mean±(SD)	32.58±5.99	32.59±5.38	0.98
Weight(kg): mean±(SD)	68.71±10.93	70.34±11.07	0.05
BMI(kg/m2): mean±(SD)	25.71±3.64	26.75±4.60	0.001
Age of menarche(yr.):mean±(SD)	13.51±1.55	13.38±1.52	0.30
Marital age(yr.): mean±(SD)	22.13±4.27	22.30±5.74	0.66
Education history: number (%)			
Less than 10 years	61(18.8)	126(38.4)	0.001
Between 10 and 12 years	90(27.7)	86(26.2)	
More than 12 years	174(53.5)	116(35.4)	
Employment status: number (%)			
Employed	226(69.5)	256(78.0)	0.01
Unemployed	99(30.5)	72(22.0)	
Use of birth control pills (month)			
Non-use	223(68.62)	211(64.33)	0.001
Less than 12 months	30(9.23)	17(5.19)	
More than 12 months	72(22.16)	100(30.49)	
Smoking: number (%)			
Yes	13(4.0)	31(9.46)	0.04
No	312(96.0)	297(90.54)	

BMI: Body Mass Index

The data also indicated that 69.5% of fertile women and 78.0% of infertile women were housewives, demonstrating no significant disparity in employment status (P=0.01). Additionally, the study found that 68.0% of fertile women and 58.2% of infertile women did not use birth control pills, with 14.28% of fertile women having a history of using birth control pills for more than 12 months, thus highlighting a difference between the two groups (P=0.001). Lastly, it was discovered that 0.4% of fertile women smoked, while the prevalence of smoking in infertile women was 9.46%, signifying a distinction between the two groups in terms of smoking (P=0.04) (Table 1).

The findings about assessing physical activity levels and sedentary behaviors among fertile and infertile Iranian women are presented in Table 2. The analysis revealed that 52.9% of fertile women had a low level of physical activity, whereas 54.3% of infertile women fell into the same category. Conversely, infertile women exhibited significantly more sedentary behavior compared to fertile women (P=0.005). Specifically, 57.0% of infertile women spent more than 5 hours a day in sedentary activities, whereas this proportion was 49.2% for fertile women (Table 2).

The results concerning the relationship between infertility and the variables under examination are outlined in Table 3. In this study, the likelihood of experiencing infertility significantly decreased with advancing age by 8% (OR=0.92, P=0.006). It was observed that individuals with high levels of physical activity had a 4.428 times higher probability of infertility than those with low physical activity (OR=4.428, P=0.004). Additionally, when assessing the adjusted relationship between infertility and sedentary behavior, it was found that individuals with more prolonged periods of daily sitting had a 2.070 times higher likelihood of experiencing infertility (OR=2.070, P=0.001) (Table 3).

4. Discussion

The results of the study indicated that infertility in women may be influenced by lifestyle and body composition. It was observed that inactivity and sedentary behaviors in women were directly associated with infertility. Furthermore, BMI demonstrated a significant relationship with women's infertility conditions. Among the participating

Table 2: Level of physical activity and sedentary behaviors in fertile and infertile women

	Fertile women	Infertile women	P value
Physical activity: number (%)			
Low physical activity	172(52.9)	178(54.3)	
Moderate physical activity	97(29.8)	115(35.1)	0.04
High physical activity	56(17.2)	35(10.7)	
Sitting time(hours/day):mean±(SD)	4.65±1.71	5.05±1.80	0.005
Less than 5	165(50.8)	141(43.0)	0.04
More than 5	160(49.2)	187(57.0)	

Table 3: Multiple logistic regressions adapted to determine the relationship between infertility and the variables

	Classification	Odds Ratio	95% CI	P value
Age		0.928	0.880-0.978	0.006
Body mass index		1.076	0.962-1.203	0.19
Age of menarche		0.992	0.822-1.034	0.14
Marital age		1.178	1.070-1.297	0.001
Birth control pills		1.034	1.000-1.070	0.04
Smoking		0.207	0.058-0.736	0.01
Level of education	Less than 10 years	1		
	Between 10 and 12 years	0.244	0.086-0.692	0.008
	More than 12 years	0.295	0.118-0.741	0.009
Employment status	Employed	1		
	Unemployed	0.412	0.145-1.170	0.09
Physical activity level	Low physical activity	1		
	Moderate physical activity	0.147	0.060-0.362	0.001
	High physical activity	4.428	1.608-12.197	0.004
Sitting time		2.070	1.365-3.141	0.001

women, sedentary behaviors were found to be linked to infertility, although specific studies have not consistently confirmed this relationship (19-24). It is noteworthy that sedentary behavior strongly correlates with leptin release, which can decrease fertility and in vitro fertilization (IVF) gestation rates by disrupting the hypothalamic-pituitary-ovarian (HPO) axis (25). This disruption in the HPO axis can impact gonadotropin synthesis, potentially leading to menstrual irregularities and ovulatory dysfunction (26).

Our study observed that the body mass index of infertile women was higher than that of fertile ones, which was associated with women's fertility (odds ratio 1.076). This could be a confounding factor in the relationship between inactivity and the adjustment of pro-inflammatory cytokines (27). It is important to note that sedentary habits are independently related to central obesity and overall adiposity. This accumulation of harmful fat plays a significant role in the synthesis of adipocytokines, which can affect estrogen biosynthesis (28). Obesity can also pose a threat to the reproductive endocrine system by increasing the release of androgens and estrogens while decreasing the synthesis of sex hormone-binding globulin. The connection between body fat percentage and fertility is more evident in infertile women with ovarian disorders (20, 25). Although previous studies investigated and confirmed the association of infertility with body composition (10, 11, 19), further exploration is needed to understand better the high risk of infertility in women with specific body structures. This relationship has not been well-documented in Iran, especially in a study that includes nearly the entire population.

By other research, the link between physical inactivity and female infertility has been substantiated (24). This underscores that the relationship between physical activity and fertility may vary depending on the individual's body mass index. In line with these findings, Mallinson and colleagues reported that light physical activity enhances fertility indices independently of female body mass index (29). Similarly, Gudmundsdottir and co-workers noted an association between physical activity and infertility in women. Groups engaging in physical activity for fewer than 15 minutes or more than 60 minutes per session exhibited a higher incidence of infertility than those engaging in physical activity between 16 and 60 minutes (6).

Our research also revealed fertile women engaged in higher physical activity levels than infertile ones. Additionally, three sessions of light-intensity aerobic exercise have been shown to increase the likelihood of a live birth in women undergoing IVF compared to sedentary women (24). A novel aspect of our study is the negative association between vigorous physical activity and fertility. Discovering that the odds of infertility are significantly higher in women who engage in intense physical activity, it has been generally accepted that the regularity of the female reproductive hormonal axis is negatively correlated with very strenuous physical activity (25).

It appears that the overall level of physical activity is a variable that indicates a relationship with fertility status, although other parameters of physical activity, including frequency, intensity, duration, and type of exercise, should also be investigated. This analysis, known as the principle of FITT (frequency, intensity, time, and type of training), holds promise for further fertility examination in both men and women.

Physical inactivity has been recognized as a significant risk factor for cardiometabolic diseases. Physical activity has been demonstrated to help regulate blood pressure body weight, and improve glucose tolerance. Numerous studies indicated that physical activity can impact reproductive organs (7, 13, 15, 19). Nevertheless, some studies explored the effect of physical activity on female infertility under normal conditions (20). The exact mechanisms by which vigorous physical activity increases the risk of infertility are not yet fully understood, but high-intensity physical activity may likely impair ovulation (15).

Our results emphasized that sedentary habits and physical inactivity are two independent factors that should be considered in the context of fertility, as recommended for the general population. Factors such as the frequency, duration, intensity, and type of physical activity can influence infertility indices in women (9, 29). To provide more specific recommendations, further research needs to be conducted on the FITT criteria for physical activity. Additionally, sedentary behaviors should be more comprehensively investigated, considering visceral fat accumulation and BMI (6). In-depth studies

exploring the interaction between sedentary behaviors and physical activity on fertility are necessary; furthermore, the relationship between fat and lean mass with fertility warrants further investigation. Recent studies have examined obese mice to investigate the connection between body composition and reproductive processes via the regulation of oxidative stress during exercise (28). The total distribution of fat and lean tissue is believed to influence reproductive indices (27). In addition to standard measures for treating infertility, addressing lifestyle changes should also be considered. A controlled interventional study would be appropriate to test these theories.

4.1. Limitations

While the present study yields valuable insights, it is burdened by certain limitations. Despite the precision of our findings, this study may lack the requisite statistical power to discern associations among certain variables. Additionally, the fertile individuals exhibited slightly greater age than the infertile ones, and they were likely recruited after the birth of their offspring, generally excluding the immediate postpartum period. The examination of pairwise associations was unfeasible and warrants further exploration in subsequent investigations.

5. Conclusions

Our investigation revealed a significant correlation between physical inactivity, sedentary behaviors, and body mass index in women with idiopathic infertility. Notably, this study underscored that physical inactivity, sedentary habits, and a high body mass index each represent independent risk factors for infertility. These findings underscored the imperative of advocating for lifestyle support throughout the lifespan to enhance pregnancy and birth rates.

Acknowledgement

We must express our gratitude to all those who helped us in the implementation of this research.

Ethical Approval

Ethics Committee of the University of Arak University of Medical Sciences confirmed the protocol with the code of IR.ARAKMU.REC.1400.050. In addition, the consent form for participation in the study was obtained from all volunteers.

Conflict of Interest: None declared.

Authors' Contribution

Abbas Saremi: Substantial contributions to the conception and design of the work, drafting the work and reviewing it critically for important intellectual content. Rahmatollah Moradzadeh: Substantial contributions to the conception of the work, analysis of data for the work, reviewing the manuscript critically for important intellectual content.

References

1. Duran AT, Romero E, Diaz KM. Is Sedentary Behavior a Novel Risk Factor for Cardiovascular Disease? Curr Cardiol Rep. 2022;24(4):393-403. doi: 10.1007/s11886-022-01657-w. PubMed PMID: 35182312.
2. Gaskins AJ, Afeiche MC, Hauser R, Williams PL, Gillman MW, Tanrikut C, et al. Paternal physical and sedentary activities in relation to semen quality and reproductive outcomes among couples from a fertility center. Hum Reprod. 2014;29(11):2575–82. doi: 10.1093/humrep/deu212. PubMed PMID: 25164027; PubMed Central PMCID: PMC4191451.
3. Mı´nguez-Alarco´n L, Chavarro JE, Mendiola J, Gaskins AJ, Torres-Cantero AM. Physical activity is not related to semen quality in young healthy men. Fertil Steril. 2014;102(4):1103–9. doi: 10.1016/j.fertnstert.2014.06.032. PubMed PMID: 25064411; PubMed Central PMCID: PMC4393647.
4. Wise LA, Rothman KJ, Mikkelsen EM, Sorensen HT, Riis AH, Hatch EE. A prospective cohort study of physical activity and time to pregnancy. Fertil Steril. 2012;97(5):1136-42. 10.1016/j.fertnstert.2012.02.025. PubMed PMID: 22425198; PubMed Central PMCID: PMC3340509.
5. Kalantari A, Saremi A, Shavandi N, Foroutan Nia A. Impact of Four Week Swimming Exercise with Alpha-Tocopherol Supplementation on Fertility Potential in Healthy Rats. Urol J. 2017;14(5):5023-5026. PubMed PMID: 28853109.
6. Gudmundsdottir SL, Flanders WD, Augestad LB. Physical activity and fertility in women:

The North- Trondelag Health Study. Hum Reprod. 2009;24:3196–204. doi: 10.1093/humrep/dep337. PubMed PMID: 19801570.
7. Gaskins AJ, Mendiola J, Afeiche M, Jorgensen N, Swan SH, Chavarro JE. Physical activity and television watching in relation to semen quality in young men. Br J Sports Med. 2015;49(4):265–70. doi: 10.1136/bjsports-2012-091644. PubMed PMID: 23380634; PubMed Central PMCID: PMC3868632.
8. Gaskins AJ, Williams PL, Keller MG, Souter I, Hauser R, Chavarro JE, et al. Maternal physical and sedentary activities in relation to reproductive outcomes following IVF. Reprod Biomed Online. 2016;33(4):513–521. doi: 10.1016/j.rbmo.2016.07.002. PubMed PMID: 27474489; PubMed Central PMCID: PMC5053884.
9. Ahmad R, Haque M. Obesity: A Doorway to a Molecular Path Leading to Infertility. Cureus. 2022;14(10):e30770. doi: 10.7759/cureus.30770. PubMed PMID: 36320802; PubMed Central PMCID: PMC9612950.
10. Bosdou JK, Konstantinidou E, Anagnostis P, Kolibianakis EM, Goulis DG. Vitamin D and Obesity: Two Interacting Players in the Field of Infertility. Nutrients. 2019;11(7):1455. doi: 10.3390/nu11071455. PubMed PMID: 31252555; PubMed Central PMCID: PMC6683323.
11. Chavarro JE, Rich-Edwards JW, Rosner BA, Willett WC. Diet and lifestyle in the prevention of ovulatory disorder infertility. Obstet Gynecol. 2007;110(5):1050-8. doi: 10.1097/01.AOG.0000287293.25465.e1. PubMed PMID: 17978119.
12. Morris SN, Missmer SA, Cramer DW, Powers RD, McShane PM, Hornstein MD. Effects of lifetime exercise on the outcome of in vitro fertilization. Obstet Gynecol. 2006;108(4):938–45. doi: 10.1097/01.AOG.0000235704.45652.0b. PubMed PMID: 17012457.
13. Foucaut AM, Faure C, Julia C, Czernichow S, Levy R, Dupont C, et al. Sedentary behavior, physical inactivity and body composition in relation to idiopathic infertility among men and women. PLoS One. 2019;14(4):e0210770. doi: 10.1371/journal.pone.0210770. PubMed PMID: 31017887; PubMed Central PMCID: PMC6481765.
14. Skakkebæk NE, Lindahl-Jacobsen R, Levine H, Andersson AM, Jørgensen N, Main KM, et al. Environmental factors in declining human fertility. Nat Rev Endocrinol. 2022;18(3):139-157. doi: 10.1038/s41574-021-00598-8. PubMed PMID: 34912078.
15. Dhair A, Abed Y. The association of types, intensities and frequencies of physical activity with primary infertility among females in Gaza Strip, Palestine: A case-control study. PLoS One. 2020;15(10):e0241043. doi: 10.1371/journal.pone.0241043. PubMed PMID: 33095804; PubMed Central PMCID: PMC7584224.
16. Ma M, Guo L, Liu X, Zheng Y, Gu C, Li B. Genetic correlation between female infertility and mental health and lifestyle factors: A linkage disequilibrium score regression study. Health Sci Rep. 2022;5(5):e797. doi: 10.1002/hsr2.797. PubMed PMID: 36090619; PubMed Central PMCID: PMC9436294.
17. Vasheghani-Farahani A, Tahmasbi M, Asheri H, Ashraf H, Nedjat S, Kordi R. The Persian, last 7-day, long form of the International Physical Activity Questionnaire: translation and validation study. Asian J Sports Med. 2011;2(2):106-16. doi: 10.5812/asjsm.34781. PubMed PMID: 22375226; PubMed Central PMCID: PMC3289200.
18. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, et al. Compendium of physical activities: an update of activity codes and MET intensities. Med Sci Sports Exerc. 2000;32:S498-504. doi: 10.1097/00005768-200009001-00009. PubMed PMID: 10993420.
19. Hammoud AO, Gibson M, Peterson CM, Meikle AW, Carrell DT. Impact of male obesity on infertility: a critical review of the current literature. Fertil Steril. 2008;90(4):897–904. doi: 10.1016/j.fertnstert.2008.08.026. PubMed PMID: 18929048.
20. Pedro J, Brandão T, Schmidt L, Costa ME, Martins MV. What do people know about fertility? A systematic review on fertility awareness and its associated factors. Ups J Med Sci. 2018;123(2):71-81. doi: 10.1080/03009734.2018.1480186. PubMed PMID: 29957086; PubMed Central PMCID: PMC6055749.
21. Reece LJ, McInerney C, Blazek K, Foley BC, Schmutz L, Bellew B, et al. Reducing financial barriers through the implementation of voucher incentives to promote children's participation in community sport in Australia. BMC Public Health. 2020;20(1):19. doi: 10.1186/s12889-019-8049-6. PubMed PMID: 31910846; PubMed

Central PMCID: PMC6947832.
22. Saremi A, Parastesh M, Tavangar M. Does a Course of Aerobic Training Affect the Inflammatory Status and Cardiometabolic Risk Factors of Hookah-smoker Women? Results of a Cross-sectional Study. Addict Health. 2022;14(1):26-34. doi: 10.22122/ahj.v14i1.1193. PubMed PMID: 35573764; PubMed Central PMCID: PMC9057642.
23. Rao A, Tait I, Alijani A. Systematic review and meta-analysis of the role of mental training in the acquisition of technical skills in surgery. Am J Surg. 2015;210(3):545-53. doi: 10.1016/j.amjsurg.2015.01.028. PubMed PMID: 26092443.
24. Belanger MJ, Rao P, Robbins JM. Exercise, Physical Activity, and Cardiometabolic Health: Pathophysiologic Insights. Cardiol Rev. 2022;30(3):134-144. doi: 10.1097/CRD.0000000000000417. PubMed PMID: 34560713; PubMed Central PMCID: PMC9097788.
25. Mena GP, Mielke GI, Brown WJ. The effect of physical activity on reproductive health outcomes in young women: a systematic review and meta-analysis. Hum Reprod Update. 2019;25(5):541-563. doi: 10.1093/humupd/dmz013. PubMed PMID: 31304974.
26. Maïmoun L, Paris F, Coste O, Sultan C. Intensive training and menstrual disorders in young female: Impact on bone mass. Gynecol Obstet Fertil. 2016;44(11):659-663. doi: 10.1016/j.gyobfe.2016.09.001. PubMed PMID: 27751748.
27. Schumacher LM, Thomas JG, Vithiananthan S, Webster J, Jones DB, Bond DS. Prolonged sedentary time adversely relates to physical activity and obesity among preoperative bariatric surgery patients. Surg Obes Relat Dis. 2020;16(4):562-567. doi: 10.1016/j.soard.2019.12.016. PubMed PMID: 32005613; PubMed Central PMCID: PMC7568514.
28. Santos M, Rodríguez-González GL, Ibáñez C, Vega CC, Nathanielsz PW, Zambrano E. Adult exercise effects on oxidative stress and reproductive programming in male offspring of obese rats. Am J Physiol Regul Integr Comp Physiol. 2015;308(3):R219-25. doi: 10.1152/ajpregu.00398.2014. PubMed PMID: 25502750.
29. Mallinson RJ, Williams NI, Hill BR, De Souza MJD. Body composition and reproductive function exert unique influences on indices of bone health in exercising women. Bone. 2013;56(1):91-100. doi: 10.1016/j.bone.2013.05.008. PubMed PMID: 23702387.