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**Original Research Article**

# Association of lifestyle-related activity with gestational diabetes mellitus among pregnant women

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## ABSTRACT

**Background:** Gestational diabetes mellitus (GDM) is a significant health concern with complex etiologies involving sociodemographic, lifestyle, and biological factors. This study aimed to explore the relationships between these factors and the risk of GDM in a cohort of pregnant women, with a focus on understanding the impact of lifestyle activities and pre-pregnancy body mass index (BMI).
**Methods:** A case-control study was conducted with 300 pregnant women (150 diagnosed with GDM and 150 healthy controls) at the antenatal clinic of a hospital in Dhaka, Bangladesh. Participants were assessed through detailed questionnaires covering sociodemographic data, obstetric history, and a comprehensive evaluation of lifestyle activities using the pregnancy physical activity questionnaire (PPAQ). Logistic regression analysis was utilized to explore the associations between physical activity levels, pre-pregnancy BMI, and the incidence of GDM.
**Results:** The study found no significant differences in age and bad obstetric history between cases and controls. However, significant disparities in education level and income brackets were observed, with lower education and income levels associated with higher GDM risk. Lifestyle activities showed varying impacts; higher household activity levels unexpectedly correlated with increased GDM risk, while higher levels of sports, exercise, and transportation activities significantly reduced GDM risk. Additionally, a higher pre-pregnancy BMI was strongly associated with increased GDM risk.
**Conclusions:** The study highlights the influence of socioeconomic factors and lifestyle activities on GDM risk, demonstrating that both higher physical activity levels and maintaining a normal pre-pregnancy BMI are pivotal in reducing GDM incidence. These findings suggest that interventions aimed at enhancing lifestyle modifications and addressing socioeconomic barriers could be effective in mitigating GDM risk among pregnant women.

**Keywords:** Gestational diabetes mellitus, Lifestyle activities, Physical activity, Pre-pregnancy BMI, Socioeconomic factors

## INTRODUCTION

Gestational diabetes mellitus (GDM), a condition marked by the onset of glucose intolerance during pregnancy, represents a significant public health issue, particularly in the context of the increasing prevalence of sedentary lifestyles and obesity. The global incidence of GDM continues to rise, reaching up to 25% of pregnancies globally and around 10% in the US alone, posing severe health risks to both mothers and their offspring.[1] Its prevalence is amplified in regions like South Asia, where rapid urbanization and lifestyle shifts exacerbate the rates of obesity and physical inactivity.[2] In Bangladesh, GDM prevalence ranges from 6% to 14% depending on diagnostic criteria, with cesarean delivery rates at 76% and neonatal complications like macrosomia (25%) and hyperbilirubinemia (12%) remaining high.[3] Understanding lifestyle-related factors such as physical inactivity, diet, and the potential benefits of targeted interventions could significantly impact maternal and neonatal outcomes.[4-6] GDM's risk factors are closely linked to the global obesity epidemic, which continues unabated. This condition is often exacerbated by sedentary lifestyles and traditional practices that limit physical activity among pregnant women. These lifestyle choices, coupled with physiological and hormonal changes, significantly increase GDM risk. A systematic review by Rashidi et al emphasized that sedentary lifestyles and high body mass index (BMI) were significant modifiable risk factors for GDM.[7] Similarly, Sudasinghe et al found that women with GDM were at a higher risk of developing preeclampsia, hypertension, and macrosomia, as well as progressing to prediabetes or type 2 diabetes post-pregnancy.[8] Several regional studies provide insights into the unique challenges posed by GDM. In Dhaka, Bangladesh, a study by Akter et al highlighted that preeclampsia and vaginal candidiasis were common maternal complications of GDM, while macrosomia, respiratory distress, and preterm birth were prevalent neonatal issues.[9] Another study by Al-Rifai et al further corroborated these findings, revealing that the prevalence of GDM in the middle east and north Africa (MENA) region remains high, partly due to factors like obesity, parity, and maternal age.[10] Lifestyle-related activities such as physical inactivity and poor dietary habits significantly contribute to GDM's prevalence. A comprehensive integrative review by Gilbert et al demonstrated that interventions addressing diet, physical activity, and psychosocial well-being yielded significant metabolic improvements.[4] Aburezq et al noted that pregnancy-induced hypertension and physical inactivity were crucial GDM risk factors, with regular walking significantly lowering GDM risk.[5] Another meta-analysis by Russo et al confirmed that physical activity interventions alone reduced GDM risk by 28%.[11] Various studies indicate that lifestyle modifications during pregnancy could yield substantial benefits. Wang et al showed that early pregnancy cycling exercise reduced GDM incidence and gestational weight gain in overweight/obese women.[12] Furthermore, Tsironikos et al found that dietary and exercise interventions significantly reduced GDM incidence among high-risk women.[6] Vargas and González reinforced these findings, emphasizing the importance of lifestyle modification in reducing maternal complications like preeclampsia and caesarean sections.[13] The impact of GDM on pregnancy outcomes is alarming, with significant maternal and neonatal complications. Khursheed et al observed that women with GDM were more likely to undergo caesarean delivery due to preeclampsia and preterm labor, while their neonates often suffered from hypoglycemia, macrosomia, and neonatal intensive care unit admissions.[14] Leng et al stressed that older maternal age and obesity further increase GDM's risk.[15] In summary, GDM remains a significant health challenge globally and regionally. Despite considerable research progress, effective prevention and management strategies remain elusive due to the variability in clinical practices and the heterogeneity of risk factors. However, recent literature underscores the importance of lifestyle interventions, particularly exercise and diet, in reducing GDM risk. Early initiation of lifestyle modifications, especially before 15 weeks of gestation, holds promise for mitigating GDM risk.[6] The continued investigation into the regional and global implications of GDM is crucial for developing comprehensive and tailored approaches to its prevention and management.

## METHODS

This study was a case-control design involving pregnant women attending the antenatal clinic at the Combined Military Hospital, Dhaka, Bangladesh, between January 2017 and December 2017. The participants consisted of 150 pregnant women diagnosed with gestational diabetes mellitus (GDM), who served as cases, and 150 healthy pregnant women as controls. Cases were selected based on a GDM diagnosis according to the Carpenter-Coustan criteria, while controls were selected based on normal glucose tolerance. Both cases and controls were excluded if they had any chronic medical conditions or physical limitations. Sociodemographic and obstetric data were obtained through structured interviews and medical record reviews. The physical activity performed by the participants during their first 20 weeks of pregnancy was assessed at the time of enrolment, from the 20$^{th}$ to the 28$^{th}$ weeks of gestation. Physical activity levels were measured using the pregnancy physical activity questionnaire (PPAQ), which evaluates participation in four domains of activities: household/caregiving, occupational, sports/exercise, and transportation.[16] The duration of each activity was summed and multiplied by its intensity as defined by the compendium of physical activities. Household physical activity included activities such as cleaning, cooking, washing, and ironing that have to be done regularly at home (questions 13-28). A score ≥22.82 was considered as high-level household physical activity, while a score <22.82 was considered as low-level household physical activity. Occupational physical activity referred to activities related to a person's job or profession (questions 29-33). A score ≥2.58 was considered as high-level occupational physical activity,

while a score <2.58 was considered as low-level occupational physical activity. Physical activity related to sports or exercise was defined as activities for keeping fit and improving mental health (questions 34-42). A score ≥3.71 was considered as high-level sports or exercise physical activity, while a score <3.71 was considered as low-level sports or exercise physical activity. Transportation physical activity included activities related to going to any place for any purpose by any means of vehicle or walking (questions 43-45). A score ≥3.09 was considered as high-level transportation physical activity, while a score <3.09 was considered as low-level transportation physical activity. The main outcome of interest was the presence of GDM, with physical activity being categorized into sedentary, light, moderate, and vigorous levels based on metabolic equivalent scores (METs). Other variables included age, body mass index (BMI), parity, education, family history of diabetes, and dietary habits. Descriptive statistics summarized the demographic and obstetric characteristics, while t-tests and chi-square tests were used to compare continuous and categorical variables, respectively, between cases and controls. Logistic regression was performed to assess the association between physical activity and GDM while adjusting for confounding variables. The study obtained ethical clearance from the review board of Combined Military Hospital, Dhaka, with informed consent collected from all participants while maintaining strict confidentiality throughout.

## RESULTS

In the study of 300 participants comparing the sociodemographic characteristics between cases (n=150) and controls (n=150), age distribution showed no significant difference across groups, with a similar average age of 25.41±2.472 years for cases and 25.21±2.63 years for controls (P=0.484). The age categories of 19-22, 23-26, and 27-30 also displayed comparable distributions between the two groups. The educational status showed a slight variation, particularly at the SSC level where cases had a higher percentage (26.67%) compared to controls (16.00%), yielding a marginally significant p value of 0.1. Graduate level education was more prevalent among controls (20.00%) than cases (13.33%). Regarding residence, the majority of both cases (86.00%) and controls (90.67%) resided in urban areas, with no significant difference (p=0.208). The family type, whether nuclear or joint, similarly showed no statistically significant difference, with most participants from both groups living in nuclear families (86.67% of cases, 89.33% of controls). Significant differences emerged in the distribution of income levels between the groups. A greater proportion of cases (52.67%) fell into the 20000-39999 income bracket compared to controls (36.00%), which was statistically significant (p<0.01). Conversely, a higher percentage of controls (40.00%) had incomes of 60000 and above compared to cases (20.00%).

**Table 1: Distribution of sociodemographic characteristics among the participants (n=300).**

| Variables | Case (n=150) | | Control (n=150) | | P value |
|---|---|---|---|---|---|
| | N | % | N | % | |
| **Age (in years)** | | | | | |
| 19-22 | 16 | 10.67 | 23 | 15.33 | 0.459 |
| 23-26 | 85 | 56.67 | 78 | 52.00 | |
| 27-30 | 49 | 32.67 | 49 | 32.67 | |
| **Mean±SD** | 25.41±2.472 | | 25.21±2.63 | | 0.484 |
| **Educational status** | | | | | |
| SSC | 40 | 26.67 | 24 | 16.00 | 0.1 |
| HSC | 70 | 46.67 | 76 | 50.67 | |
| Graduate | 20 | 13.33 | 30 | 20.00 | |
| Post graduate | 20 | 13.33 | 20 | 13.33 | |
| **Residence** | | | | | |
| Rural | 21 | 14.00 | 14 | 9.33 | 0.208 |
| Urban | 129 | 86.00 | 136 | 90.67 | |
| **Type of family** | | | | | |
| Nuclear | 130 | 86.67 | 134 | 89.33 | 0.477 |
| Joint | 20 | 13.33 | 16 | 10.67 | |
| **Income of participant** | | | | | |
| 20000-39999 | 79 | 52.67 | 54 | 36.00 | <0.01 |
| 40000-59999 | 41 | 27.33 | 36 | 24.00 | |
| 60000 and above | 30 | 20.00 | 60 | 40.00 | |

**Table 2: Distribution of obstetric characteristics among the participants (n=300)**

| Variables | Case (n=150) | | Control (n=150) | | P value |
|---|---|---|---|---|---|
| | N | % | N | % | |
| **Gravida** | | | | | |
| Primigravida | 91 | 60.67 | 90 | 60.00 | 0.906 |
| Multigravida | 59 | 39.33 | 60 | 40.00 | |
| **Age at first pregnancy** | | | | | |
| 19-22 | 30 | 20.00 | 44 | 29.33 | 0.091 |
| 23-26 | 119 | 79.33 | 103 | 68.67 | |
| 27-30 | 1 | 0.67 | 3 | 2.00 | |
| **Mean±SD** | 23.65 1.321 | | 23.37±1.508 | | 0.081 |
| **Bad obstetric history** | | | | | |
| No | 136 | 90.67 | 131 | 87.33 | 0.225 |
| Abortion | 5 | 3.33 | 9 | 6.00 | |
| Miscarriage | 7 | 4.67 | 10 | 6.67 | |
| Preterm labour | 2 | 1.33 | 0 | 0.00 | |

**Table 3: Distribution of lifestyle related activity level of participants (n=300).**

| Variables | Case (n=150) | | Control (n=150) | | P value |
|---|---|---|---|---|---|
| | N | % | N | % | |
| **Household activity** | | | | | |
| Low | 123 | 82.00 | 50 | 33.33 | <0.001 |
| High | 27 | 18.00 | 100 | 66.67 | |
| **Occupational activity** | | | | | |
| Low | 142 | 94.67 | 107 | 71.33 | <0.001 |
| High | 8 | 5.33 | 43 | 28.67 | |
| **Sports related activity** | | | | | |
| Low | 113 | 75.33 | 43 | 28.67 | <0.001 |
| High | 37 | 24.67 | 107 | 71.33 | |
| **Transportation related activity** | | | | | |
| Low | 99 | 66.00 | 61 | 40.67 | <0.001 |
| High | 51 | 34.00 | 89 | 59.33 | |

In the analysis of obstetric characteristics among 300 participants, the study compared cases (n=150) with gestational diabetes mellitus and controls (n=150) without the condition. The distribution between primigravida and multigravida was nearly identical, with 60.67% of cases and 60.00% of controls being primigravida, leading to a non-significant p value of 0.906. Age at first pregnancy showed some variation, with 20.00% of cases having their first pregnancy between the ages of 19-22 compared to 29.33% of controls, which was close to statistical significance (p=0.091). The majority of cases (79.33%) had their first pregnancy between 23 and 26 years, higher than 68.67% observed in controls. Very few participants in either group had their first pregnancy between 27 and 30 years. The mean age at first pregnancy was slightly higher among cases (23.65±1.321 years) than controls (23.37±1.508 years), though this difference was not statistically significant (p=0.081). As for bad obstetric history, 90.67% of cases reported no issues compared to 87.33% of controls, which was not significantly different (p=0.225). Specific adverse outcomes such as abortion, miscarriage, and preterm labor were slightly more frequent in cases than controls, but these differences did not reach statistical significance (Table 2).

The level of household activity showed a pronounced difference: 82.00% of cases engaged in low levels of household activity compared to only 33.33% of controls, with a highly significant p value (<0.001). Conversely, 66.67% of controls engaged in high levels of household activity, compared to only 18.00% of cases. This suggests a strong correlation between higher levels of household activity and a lower incidence of GDM. For occupational activity, 94.67% of cases reported low levels of activity, significantly more than the 71.33% observed in controls, with a p value of <0.001. Only 5.33% of cases reported high occupational activity levels compared to 28.67% of controls, indicating that lower occupational activity might be associated with a higher risk of developing GDM. In terms of sports-related activity, 75.33% of cases were in the low activity category, which was significantly higher than the 28.67% among controls (p value <0.001).

Controls were more active in sports, with 71.33% reporting high levels of sports activity compared to only 24.67% of cases. This disparity highlights the potential protective effect of sports-related activity against GDM. Lastly, the distribution of transportation-related activity levels also showed significant differences; 66.00% of cases reported low transportation activity compared to 40.67% of controls. Conversely, high transportation activity was reported by 34.00% of cases and 59.33% of controls, with a p value of <0.001. This pattern further supports the idea that higher physical activity, including transportation, is associated with reduced rates of GDM.

The proportion of participants classified with a normal pre-pregnancy BMI was considerably higher among controls, with 91.33% falling into this category, compared to 69.33% of cases. This significant difference (p value <0.001) indicates a strong correlation between normal BMI and a lower incidence of GDM. Conversely, the percentage of participants who were overweight before pregnancy was significantly higher among cases, with 30.67% of cases being overweight compared to only 8.67% of controls.

**Table 4: Distribution of pre-pregnancy BMI among the participants (n=300).**

| Pre-pregnancy BMI | Case (n=150) | | Control (n=150) | | P value |
|---|---|---|---|---|---|
| | N | % | N | % | |
| **Normal** | 104 | 69.33 | 137 | 91.33 | <0.001 |
| **Overweight** | 46 | 30.67 | 13 | 8.67 | |

**Table 5: Logistic regression of gestational diabetes mellitus with selected attributes.**

| Attributes | β | SE | OR | 95% CI for EXP(B) | | P value |
|---|---|---|---|---|---|---|
| | | | | Lower | Upper | |
| **Household physical activity** | 1.119 | 1.115 | 3.06 | 0.344 | 27.24 | 0.016 |
| **Occupational physical activity** | -1.788 | 1.062 | 0.167 | 0.021 | 1.34 | 0.092 |
| **Sports or exercise related activity** | -1.31 | 0.531 | 0.27 | 0.095 | 0.764 | 0.014 |
| **Transportation related activity** | -2.025 | 0.599 | 0.132 | 0.041 | 0.427 | 0.001 |
| **Pre-pregnancy BMI** | 0.979 | 0.682 | 2.662 | 0.699 | 10.133 | 0.001 |

Table 5 presents a logistic regression analysis evaluating the influence of various lifestyle activities and pre-pregnancy BMI on the likelihood of developing gestational diabetes mellitus among 300 participants. Household physical activity was significantly associated with an increased risk of GDM, indicated by a regression coefficient of 1.119 and an odds ratio (OR) of 3.06 (p value =0.016). This suggests that higher levels of household activity triple the likelihood of developing GDM. In contrast, occupational physical activity showed a negative association with GDM, though it was not statistically significant (p value =0.092), with an OR of 0.167. This implies a potential protective effect, though more evidence is needed for confirmation. Sports or exercise-related activity had a significant negative association with GDM, with a regression coefficient of -1.31 and an OR of 0.27 (p value =0.014). Engaging in such activities reduces the risk of GDM by about 73%. Transportation-related activity also significantly reduced the risk of GDM, evidenced by a regression coefficient of -2.025 and an OR of 0.132 (p value =0.001). This indicates a strong protective effect of increased transportation activity.

Lastly, a higher pre-pregnancy BMI significantly increased the risk of GDM, with a regression coefficient of 0.979 and an OR of 2.662 (p value =0.001), suggesting that managing body weight is crucial for preventing GDM.

## DISCUSSION

This study meticulously explored the intricate relationship between sociodemographic factors, obstetric history, lifestyle activities, pre-pregnancy body mass index (BMI), and the risk of gestational diabetes mellitus (GDM) in a cohort of 300 pregnant women. Our findings present a complex tableau that both corroborates and contrasts with existing literature on GDM. Age distribution among our study participants did not significantly differ, with mean ages for cases and controls closely aligned at 25.41±2.472 and 25.21±2.63 years, respectively (p=0.484). This suggests that age, within the narrow range studied, might not be a significant independent predictor of GDM, consistent with findings from other studies that have indicated a broader age range might be required to detect age-related differences in GDM risk (17,18). Notably, educational attainment showed a divergent pattern; a higher percentage of cases (26.67%) had completed only up to secondary school compared to controls (16.00%), which was marginally significant (p=0.1). This finding suggests that lower educational levels might correlate with higher GDM risk, potentially due to associated differences in health literacy and access to healthcare resources.[19] Income disparity was another critical factor; a significant portion of cases (52.67%) fell into the lower income bracket (20000-39999), compared to controls (36.00%) (p<0.01). Conversely, only 20.00% of cases versus 40.00% of controls had incomes over 60000, highlighting

socioeconomic status as a potential contributor to GDM risk, aligning with broader health disparity literature.[20] The distribution between primigravida and multigravida was nearly identical, with 60.67% of cases and 60.00% of controls being primigravida (p=0.906). This similarity underscores that parity alone may not substantially influence GDM incidence. However, our data indicated that cases tend to experience their first pregnancies at slightly older ages compared to controls, particularly those aged 23-26 years (79.33% versus 68.67%), a trend that approaches significance (p=0.091) and is well-documented as a risk factor in the literature.[21] The absence of significant differences in bad obstetric history between cases (90.67%) and controls (87.33%) suggests that without concurrent risk factors, previous adverse obstetric outcomes may not independently predict GDM.[22] Our results demonstrated significant disparities in lifestyle activities. Notably, 82.00% of cases reported low household activity levels compared to 33.33% of controls (p<0.001), associated with a threefold increase in GDM risk (OR=3.06, p=0.016). This is contrary to studies suggesting that general physical activity reduces GDM risk, potentially indicating that the nature or reporting of household activities may differ in our study population.[23] Occupational and sports-related activities presented a protective trend; lower levels of occupational activity were more prevalent among cases (94.67% versus 71.33%, p<0.001), while higher sports activity was significantly protective (OR=0.27, p=0.014). Transportation activity further supported this protective pattern, with a substantial decrease in GDM risk among those more active (OR=0.132, p=0.001). The role of pre-pregnancy BMI was starkly highlighted in our findings. A normal pre-pregnancy BMI was significantly more common among controls (91.33%) compared to cases (69.33%), and a higher proportion of cases were overweight pre-pregnancy (30.67% versus 8.67%), correlating with a significant increase in GDM risk (OR=2.662, p=0.001). These figures align with global research underscoring overweight and obesity as primary modifiable risk factors for GDM.[11,24] In summary, our study illuminates the multifaceted influences of sociodemographic, lifestyle, and physiological factors on GDM risk. The critical insights into how variations in lifestyle activities and pre-pregnancy BMI impact GDM provide a compelling case for targeted preventive health strategies. This discussion not only places our findings within the broader research context but also underscores the potential for interventions aimed at elevating physical activity levels and managing body weight to mitigate GDM risk effectively.

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

## CONCLUSION

This study comprehensively examined the relationships between sociodemographic factors, obstetric history, lifestyle activities, and pre-pregnancy BMI with the incidence of gestational diabetes mellitus (GDM) in a cohort of 300 pregnant women. The findings underscore the complex interplay of socioeconomic and biological determinants in the development of GDM. Key insights include the significant association of lower educational attainment and lower income with increased GDM risk, suggesting that socioeconomic disparities contribute to the burden of this condition. Additionally, our analysis revealed that lifestyle factors play a crucial role; while higher household activity unexpectedly correlated with increased GDM risk, sports, exercise, and transportation activities provided protective effects, highlighting the importance of these activities in GDM prevention strategies. Furthermore, the study confirmed the critical influence of pre-pregnancy BMI, with overweight and obesity significantly elevating GDM risk. These findings advocate for targeted public health interventions focusing on lifestyle modifications, educational outreach, and nutritional counselling to effectively mitigate GDM risk among pregnant women. The study's multifaceted approach provides valuable insights that can inform healthcare policies and practices aimed at reducing the prevalence and impact of gestational diabetes.

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## REFERENCES

1. Wang MC, Shah N, Petito L, Gunderson E, Grobman W, O'Brien M, et al. Gestational diabetes and overweight/obesity: analysis of nulliparous women in the US, 2011-2019. Am J Prevent Med. 2021;61(6):863-71.
2. Zhu Y, Zhang C. Prevalence of gestational diabetes and risk of progression to type 2 diabetes: a global perspective. Curr Diabetes Rep. 2016;16:1-11.
3. Akhter S, Karim MR. Maternal and fetal outcome in gestational diabetes mellitus. J Armed Forces Med Coll Bangladesh. 2020;16(2):18-21.
4. Gilbert LK, Gross J, Lanzi S, Quansah D, Puder J, Horsch A. How diet, physical activity and psychosocial well-being interact in women with gestational diabetes mellitus: an integrative review. BMC Pregnancy Childbirth. 2019;19.
5. Aburezq M, AlAlban F, Alabdulrazzaq M, Badr HA. Risk factors associated with gestational diabetes mellitus: The role of pregnancy-induced hypertension and physical inactivity. Pregnancy Hypertens. 2020;22:64-70.
6. Tsironikos GI, Potamianos P, Zakynthinos GE, Tsolaki V, Tatsioni A, Bargiota A. Effectiveness of lifestyle interventions during pregnancy on preventing gestational diabetes mellitus in high-risk women: a systematic review and meta-analyses of published RCTs. J Clin Med. 2023;12(22):7038.
7. Rashidi H, Rezaianzadeh A, Tabatabaee S, Mousavi S. Prevalence and risk factors of gestational diabetes

mellitus in Yazd Province, Iran. J Midwife Reprod Health. 2021;9:1-6.
8. Sudasinghe B, Wijeyaratne C, Ginige P. Long and short-term outcomes of gestational diabetes mellitus (GDM) among south Asian women- a community-based study. Diabetes Res Clin Pract. 2018;145:93-101.
9. Akter H, Akter T, Kulsum U, Parveen M. Perinatal complications in women with gestational diabetes mellitus. Int J Res Med Sci. 2023;11:1456-9.
10. Al-Rifai R, Abdo NM, Paulo M, Saha S, Ahmed L. Prevalence of Gestational diabetes mellitus in the middle east and north Africa, 2000-2019: a systematic review, meta-analysis, and meta-regression. Front Endocrinol. 2021;12:668447.
11. Russo LM, Nobles CJ, Ertel K, Chasan-Taber L, Whitcomb B. Physical activity interventions in pregnancy and risk of gestational diabetes mellitus: a systematic review and meta-analysis. Obstet Gynecol. 2015;125(3):576-82.
12. 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(4):340-51.
13. Vargas SEV, Chávez-González E. Obstetric-neonatal complications of gestational diabetes: a systematic review. Mex J Med Res ICSA. 2023;11(21):1-8.
14. Khursheed A. Exploring the role of microfinance in women's empowerment and entrepreneurial development: a qualitative study. Future Business J. 2022;8(1):57.
15. Leng J, Shao P, Zhang C, Tian H, Zhang F, Zhang S, et al. Prevalence of gestational diabetes mellitus and its risk factors in Chinese pregnant women: a prospective population-based study in Tianjin, China. PLoS One. 2015;10.
16. Chasan-Taber L, Schmidt MD, Roberts DE, Hosmer D, Markenson G, Freedson PS. Development and validation of a pregnancy physical activity questionnaire. Med Sci Sports Exercise. 2004;36(10):1750-60.
17. Solomon CG, Willett WC, Carey VJ, Rich-Edwards J, Hunter DJ, Colditz GA, et al. A prospective study of pregravid determinants of gestational diabetes mellitus. JAMA. 1997;278(13):1078-83.
18. Zhang C, Tobias DK, Chavarro JE, Bao W, Wang D, Ley SH, et al. Adherence to healthy lifestyle and risk of gestational diabetes mellitus: prospective cohort study. BMJ. 2014;349:g5450.
19. Torloni MR, Betrán AP, Horta BL, Nakamura MU, Atallah AN, Moron AF, et al. Prepregnancy BMI and the risk of gestational diabetes: a systematic review of the literature with meta-analysis. Obes Rev. 2009;10(2):194-203.
20. Kim SY, Saraiva C, Curtis M, Wilson HG, Troyan J, Sharma AJ. Fraction of gestational diabetes mellitus attributable to overweight and obesity by race/ethnicity, California, 2007-2009. Am J Public Health. 2013;103(10):e65-72.
21. Dempsey JC, Sorensen TK, Williams MA, Lee IM, Miller RS, Dashow EE, et al. Prospective study of gestational diabetes mellitus risk in relation to maternal recreational physical activity before and during pregnancy. Am J Epidemiol. 2004;159(7):663-70.
22. Chasan-Taber L, Schmidt MD, Pekow P, Sternfeld B, Manson JE, Solomon CG, et al. Physical activity and gestational diabetes mellitus among Hispanic women. J Womens Health. 2008;17(6):999-1008.
23. Tobias DK, Zhang C, van Dam RM, Bowers K, Hu FB. Physical activity before and during pregnancy and risk of gestational diabetes mellitus: a meta-analysis. Diabetes Care. 2011;34(1):223-9.
24. van Poppel MNM, Ruchat SM, Mottola MF. Physical activity and gestational diabetes mellitus. Karge; 2014:60.

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