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The physical activity and sedentary behavior of pregnant women with gestational diabetes mellitus: A cross-sectional study

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KEYWORDS
Gestational diabetes mellitus;
Physical activity;
Sedentary behavior;
Risk factor

Abstract
Background: Although physical activity is recommended as a measure for treatment and management of gestational diabetes mellitus (GDM), little is known about the status of sedentary behavior, barriers and enablers to exercise, and the needs for exercise guidance in pregnant women with GDM.
Aim: The objectives of this study were to investigate the status of physical activity, sedentary behaviors and needs for exercise guidance in pregnant women with GDM, and explore its barriers, enablers and determinants.
Method: A cross-sectional study was conducted. A self-designed questionnaire was used to collect the data of exercise, sedentary behavior and barriers/enablers to exercise. Pregnancy Physical Activity Questionnaire was used to evaluate the physical activity. A stepwise multivariate logistic regression was conducted to analyze the determinants of exercise among pregnant women with GDM.
Findings: A total of 371 questionnaires were collected. The exercise compliance rate was only 27.42%. 41% of pregnant women with GDM had sedentary time more than 6 h per day. 50.9% of participants had sedentary lifestyle. The most common barriers and enablers to physical activity were pregnancy symptoms or discomfort (32.1%) and easier glycemic control (88.9%), respectively. Advanced age ($\geq$ 35 years old), low capita monthly family income, and the number of sedentary-lifestyle days (*OR* = 1.227, 95%CI 1.090–1.382, *P* = 0.001) were the independent risk factors for failing to meet exercise standard among pregnant women.

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Discussion/Conclusion: Health care providers should provide interventions based on reducing sedentary behavior and increasing moderate physical activity to minimize the potential health problems in pregnant women with GDM.

PALABRAS CLAVE
Diabetes gestacional;
Actividad física;
Comportamiento sedentario;
Factor de riesgo

La actividad física y el comportamiento sedentario de las mujeres embarazadas con diabetes gestacional: un estudio transversal

Resumen
Antecedentes: Aunque la actividad física se recomienda como una medida para el tratamiento y la gestión del diabetes gestacional (GDM), se sabe poco sobre el estado del comportamiento sedentario, las barreras y los facilitadores para el ejercicio, y las necesidades de orientación en ejercicio en las mujeres embarazadas con GDM.
Objetivos: Los objetivos de este estudio fueron investigar el estado de la actividad física, los comportamientos sedentarios y las necesidades de orientación en ejercicio en mujeres embarazadas con GDM, y explorar sus barreras, facilitadores y determinantes.
Método: Se realizó un estudio transversal. Se utilizó un cuestionario diseñado específicamente para recopilar datos sobre ejercicio, comportamiento sedentario y barreras/facilitadores para el ejercicio. El Cuestionario de Actividad Física en el Embarazo se utilizó para evaluar la actividad física. Se realizó una regresión logística múltiple en pasos para analizar los determinantes del ejercicio entre las mujeres embarazadas con GDM.
Hallazgos: Se recolectaron un total de 371 cuestionarios. La tasa de cumplimiento con el ejercicio fue solo del 27,42%. El 41% de las mujeres embarazadas con GDM tenía más de 6 horas de tiempo sedentario al día. El 50,9% de las participantes tenía un estilo de vida sedentario. Los obstáculos y los facilitadores más comunes para la actividad física fueron los síntomas o el malestar del embarazo (32,1%) y un mejor control de la glucemia (88,9%). La edad avanzada ($\geq$ 35 años), un ingreso familiar mensual per cápita bajo y el número de días con estilo de vida sedentario (OR = 1,227, 95%CI 1,090-1,382, P = 0,001) fueron los factores de riesgo independientes para no alcanzar el estándar de ejercicio entre las mujeres embarazadas.
Discusión/Conclusión: Los proveedores de atención médica deben proporcionar intervenciones basadas en la reducción del comportamiento sedentario y el aumento de la actividad física moderada para minimizar los posibles problemas de salud en las mujeres embarazadas con GDM.

Introduction

Gestational diabetes mellitus (GDM) is defined as impaired glucose tolerance firstly found or diagnosed during pregnancy.[1] International Diabetes Federation (IDF) reported that the prevalence of GDM was 16.7% in 2022 worldwide. The highest prevalence of GDM was 25.9% in Southeast Asia region, followed by North America and the Caribbean (20.7%), Latin America (15.8%), Europe (15.0%), Middle East and North Africa (14.1%), Western Pacific (14.0%), and Africa (13.0%).[2] In China, the prevalence of GDM in 2021 reported by IDF was 8.6%, with 860 million live births were affected one year. To date, although the prevalence of GDM in China is lower than the international average level, resulting by the increased incidence of GDM yearly due to the implementation of the two-child policy, and the huge population base, GDM has become one of the main health problems faced by pregnant women in China.

Physical activity was one of the important measures for treatment and management of GDM by consensus widely. Many studies demonstrated that exercise was benefit for glucose metabolism,[3] pregnancy outcome,[4] and reducing medicine use[5,6] of GDM. World Health Organization (WHO)[7] and other authoritative organizations[8,9] recommend that healthy pregnant women should undertake regular physical activity throughout pregnancy and postpartum, and do at least 150 min of moderate-intensity aerobic physical activity throughout the week for substantial health benefits.

Primary care plays a key role in managing gestational diabetes and promoting health. Both family physicians and nurses are an essential part of primary care and are often the first link of contact between individuals, families, and communities and health care facilities. Family physicians and nurses can provide comprehensive health education and psychological support for GDM patients and their families, guide pregnant women to monitor blood glucose, provide

personalized nutrition programs and exercise guidance for GDM patients, carry out regular follow-up management, find potential problems in time, and provide timely referral and coordination services when needed.

However, many studies reported that pregnant women with GDM had low level of physical activity level.[10,11] In China, the studies focusing on the physical activity level of pregnant women with GDM mostly used self-designed questionnaires as measurement tools to the results were difficult for quantification and comparison. Harrison[12] and Coll[13] synthesized the results of barriers and enables to exercise, and found the barriers and enablers among healthy pregnant women can be classified into intrapersonal, interpersonal (social) and environmental level, but there were few studies focusing on barriers and enablers among pregnant women with GDM. Furthermore, many of the current studies only focused on the status of physical activity among pregnant women. However, little known is about the needs for exercise guidance among pregnant women with GDM. This is one of the main reasons that health care providers are unable to provide accurate, effective exercise guidance for pregnant women with GDM. Therefore, we aimed to investigate the status of physical activity, sedentary behaviors and needs for exercise guidance in pregnant women with GDM, and explore its barriers, enablers, and determinants.

Methods

Study design and participants

We conducted a cross-sectional study in West China Second University Hospital of Sichuan University, a hospital serving > 5 provinces in Southwest China. We used convenience sampling method to select pregnant women who visited obstetric clinic from November 2021 to February 2022. The inclusion criteria of participants as follow: (1) had a diagnosis of GDM; (2) aged ≥18 years old; (3) regular prenatal examinations were performed; (4) voluntarily participated in this survey. We excluded pregnant women with the following conditions: (1) severe respiratory diseases (e.g., chronic obstructive pulmonary disease, restrictive lung disease, and cystic fibrosis); (2) severe acquired or congenital heart disease with exercise intolerance; (3) uncontrolled or severe arrhythmias; (4) physical disabilities that resulted in inability to exercise. Sample with data missing > 20% was eliminated.

All pregnant women performed the 2-h 75 g oral glucose tolerance test between 24 and 28 gestational weeks and were diagnosed with GDM if the values exceeding the established thresholds (fasting 5.1 mmol/L, 1 h 10.0 mmol/L, 2 h 8.5 mmol/L).[14] GDM management was implemented by a multidisciplinary team comprising obstetricians, nurses, and clinical dietitians. Key management strategies included dietary guidance, exercise recommendations, and blood glucose monitoring. Pregnant women with GDM were advised to maintain dietary records for all meals and performed self-monitoring of fasting and 2-h postprandial blood glucose using fingertip glucometers. Routine antenatal follow-ups were scheduled at 30–32 weeks, 34–36 weeks, and weekly after 37 weeks of gestation.

Sample size

The sample size was estimated using the formula for the overall rate estimating sample rate:

$$N = \left(\frac{Z\alpha/2}{\delta}\right)^2 p(1-p).$$

In the formula, $\alpha = 0.05$, $\beta = 0.80$, $\delta = 5\%$. We used Pregnancy Physical Activity Questionnaire[15] for pilot survey and 30 participants were recruited. There were 8 participants reached the standard of physical activity according to World Health Organization recommendation,[7] with a success rate of 26.67%. The sample size was calculated as 301, and to compensate for missing value of 20%, the final sample size was calculated as 361.

Measurement tools

The questionnaire was used to collect sociodemographic characteristics such as age, ethnicity, educational level, and occupation, etc., and obstetric data such as gestational age, history of GDM, insulin use, and pregnancy complication, etc. We designed this questionnaire according to literature review and revised using Delphi method.[16] Seven experts from the field of obstetric medicine, obstetric nursing, sports health, evidence-based nursing were invited via email to independently evaluate each item using a 4-point Likert scale (1 = irrelevant, 2 = weakly relevant, 3 = moderately relevant, 4 = highly relevant) based on its relevance to the study and requested to return the questionnaire within one week. The content validity of the questionnaire was assessed by computing both item-level (I-CVI) and scale-level content validity indices (S-CVI). After two rounds of expert consultation and revisions, all item exhibited I-CVI values > 0.78, and modified kappa statics > 0.85, with S-CVI/universal agreement at 0.84 and S-CVI/average at 0.98, suggesting a good validity of this questionnaire according to Lynn's study.[17] Subsequently, we used convenience sampling method to invite one hundred pregnant women to complete the questionnaire and calculated the Cronbach's α was 0.902. The questionnaire included four parts: exercise, sedentary behavior, barriers/enablers to physical activity and the needs for exercise guidance. The subscale of the needs for exercise guidance was scored on a 5-point Likert of 1–5, with 1 indicating ''strongly not needed'' and 5 indicating ''strongly needed''. We defined 4 (needed) and 5 (strongly needed) as having a needs of exercise guidance.

The PPAQ authorized by Chasan-Taber[15] was used to measure the physical activity of pregnant women with GDM. The PPAQ was initially developed by Chasan-Taber in 2004 and then translated and introduced into China by Xiang[18] in 2016. It was a self-reported scale and included 31-item. According to intensity, physical activity was classified as sedentary, mild, moderate, and vigorous physical activity. According to type, physical activity was classified as household, occupational, transport, exercise activity and inactivity. The duration of physical activity could be measured, and energy expenditure could be calculated. Zhang[18] verified the content validity coefficient and test-retest reliability coefficient of Chinese version-PPAQ in Chinese pregnant women were 0.940 and 0.944, respectively.

Data collection and management

Participants were recruited offline from the obstetric outpatient clinic of West China Second University Hospital of Sichuan University. Pregnant women who met the inclusion and exclusion criteria of this study were provided with a detailed explanation of the research objectives, content and procedures through face-to-face communication, with dedicated time allocated for question. Written informed consent was then obtained from each participant. The participants independently completed the questionnaire, with an estimated time of 15 min. The questionnaire was collected on the spot, and the researchers checked the gaps in the questionnaire with problems. After data collection, all personally identifiable information was removed, and each participant was assigned a unique identification number. Only authorized researchers were granted access to the database.

Data analysis

The questionnaire was coded and inputted in excel software. We used SPSS 23.0 (IBM Corp., Armonk, NY, USA) to establish database and conduct statistical analysis. Shapiro–Wilk was used to perform normality test. Quantitative data of normal or skewed normal distribution was described as mean and standard deviation (*SD*). Quantitative data of non-normal was described as median and interquartile range (*IQR*). Qualitative data was descried as frequency and percent (%). A stepwise multivariate logistic regression was used to analyze the risk factor for exercise among pregnant women with GDM. We divided participants into case group and control group according to their weekly exercise duration (case group: < 150 min; control group: $\geq$ 150 min). Hosmer–Lemeshow statistic were calculated as a measure of model fit. The significant level was set at a < .05.

Results

Sociodemographic characteristics of participants

A total of 371 pregnant women were recruited in this study, with a questionnaire recovery rate of 100%. The average age of pregnant women was 32.40 (*SD* 4.28) years old. Majority of participants was Han ethnicity (97.8%). Sixty participants had a history of GDM, and there were 30 participants received insulin treatment (Table 1).

Table 1 The sociodemographic characteristics of participants ($n = 371$).

Variables	n (%) / *Mean ± SD / M (IQR)*
Age (Mean ± SD, year)	32.40 ± 4.18
Height (Mean ± SD, cm)	159.50 ± 5.62
Weight (Mean ± SD, kg)	66.67 ± 13.92
Pre-pregnancy weight (Mean ± SD, kg)	58.05 ± 13.07
Pre-pregnancy BMI Mean ± SD, kg/m²)	22.84 ± 5.11
Ethnicity, n (%)	
Han	363 (97.8)
Minority	8 (2.2)
Occupation status, n (%)	
Unemployed	41 (11.1)
Employed	284 (76.5)
Missing data	46 (12.4)
Education level, n (%)	
Primary and below	0
Junior high	4 (1.1)
Senior high	19 (5.1)
Junior college	72 (19.4)
Bachelor and above	275 (74.1)
Missing data	1 (0.3)
Living address, n (%)	
City center	350 (94.3)
Downtown/county/migrant	21 (5.7)
Marital status, n (%)	
Married	368 (99.2)
Single	3 (0.8)
Divorced	0
Widowed	0
Living status, n (%)	
With husband	195 (52.6)
With husband and own parents	84 (22.6)
With husband and his parents	82 (22.1)
Other	9 (2.4)
Missing data	1 (0.3)
Capita family monthly income, n (%)	
< 3000 yuan	13 (3.5)
3001-5000 yuan	59 (15.9)
5001-10000 yuan	138 (37.2)
> 10000 yuan	160 (43.1)
Missing data	1 (0.3)
Gravidity (time)	2 (2)
Parity (time)	0 (1)
Abortion (time)	0 (1)
Gestational week (Mean ± SD, week)	35.21 ± 2.65
History of GDM, n (%)	
Yes	60 (16.2)
No	310 (83.6)
Missing data	1 (0.3)
Insulin treatment, n (%)	
Yes	30 (8.1)
No	341 (91.9)

Physical activity and sedentary behavior of participants

The exercise compliance rate of pregnant women with GDM was only 27.49%, and the median exercise duration was 1 (*IQR* 2.76) hour per week (Table 2), which was lower than the recommended standard. Table S1 displays that 45.6% of pregnant women diagnosed as GDM exercised less than 3 times per week. The main type of exercise was walking, and the single exercise time was between 15 min and 30 min. 87.1% of pregnant women had not received exercise guidance during pregnancy. 41% of pregnant women with GDM

Table 2 Physical activity of participants.

Variables	All ($n = 371$)	Participants with insulin treatment		Participants with previous GDM	
		Yes ($n = 30$)	No ($n = 341$)	Yes ($n = 60$)	No ($n = 310$)
Exercise compliance, n (%)[a]	102 (27.49)	11 (36.67)	91 (26.67)	13 (21.67)	89 (28.71)
Different intensity (hour), M (IQR)[b]					
Sedentary activity	10.5 (14.00)	9.17 (17.08)	10.50 (14.0)	7.0 (6.16)**	10.5 (14.0)**
Light-intensity activity	25.46 (40.32)	9.59 (28.25)**	28.0 (41.09)**	36.12 (39.72)	24.0 (40.41)
Moderate-intensity activity	3.0 (4.16)	3.30 (4.94)	3.30 (4.94)	4.69 (5.20)**	3.0 (3.87)**
Vigorous-intensity activity	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Moderate-vigorous intensity activity	3.0 (4.16)	3.30 (4.94)	3.30 (4.94)	4.69 (5.20)**	3.0 (3.75)**
Different type (hour), M (IQR)[b]					
Household activity	4.34 (7.84)	2.94 (9.03)	4.34 (7.42)	10.85 (12.98)	3.36 (6.16)
Occupational activity	28.0 (42.0)	1.68 (42.0)	28.0 (42.0)	16.59 (41.16)	28.0 (42.0)
Exercise activity	1.0 (2.76)	0.5 (2.88)	1.0 (2.64)	1.0 (1.88)	1.0 (2.64)
Transportation activity	2.52 (4.34)	2.1 (6.37)	2.52 (4.34)	4.34 (6.16)	2.52 (5.18)
Inactivity	14.0 (14.84)	12.67 (14.67)	14.0 (14.84)	8.26 (8.82)**	14.0 (14.84)**

[a] Chi-square test was performed.
[b] Mann–Whitney *U* test was performed.
** Compared with another group, $P < 0.01$.

Table 3 Multivariate logistic regression analysis of risk factor for exercise.

Variables	β	*Wald*	*OR* (95%CI)	*P* value
Age				
≥ 35 years old	Reference	Reference	Reference	–
< 29 years old	−0.774	5.889	0.783 (0.362–1.694)	0.535
30–34 years old	−0.244	0.385	0.461 (0.247–0.862)	0.015
Family per monthly income				
> 10,000 yuan	Reference	Reference	Reference	–
≤ 5000 yuan	0.987	6.870	2.684 (1.283–5.617)	0.009
5001–10,000 yuan	0.422	2.201	1.524 (0.873–2.660)	0.138
Sedentary day[a]	0.205	11.448	1.227 (1.090–1.382)	0.001

[a] Sedentary days was defined as sedentary time > 6 h per day.

had sedentary time more than 6 h per day. 50.9% of participants had sedentary lifestyle (Table S2 Appendix A).

Barriers and enablers to physical activity

Pregnancy symptoms or discomfort (32.1%), work types such as sedentary work (17.3%), and bad weather (24.5%) were the most important barriers to exercise of pregnant women with GDM at the intrapersonal, interpersonal and environmental levels, respectively. Easier glycemic control (88.9%), advice from doctor (14.8%) and good weather (5.4%) were the most important enablers to exercise of pregnant women with GDM at the intrapersonal, interpersonal and environmental levels, respectively (Table S3 Appendix A).

The demands for exercise guidance in pregnant women with GDM

Table S4 displays that the most important of participants' demands for sports guidance were exercise safety matters (80.9%), followed by exercise contraindications (80.8%), exercise risks (80.8%), and exercise monitoring (78.9%), etc.

Risk factor for exercise of pregnant women with GDM

Table 3 shows the results of multivariate logistic regression analysis for exercise. Compared with pregnant women aged ≥35 years old, pregnant women aged between 30 and 34 years old decreased the risk of failing to meet exercise standard ($OR = 0.461$, 95%CI 0.247–0.862, $P = 0.015$). The risk of failing to meet exercise standard among participants with capita monthly family income < 5000 yuan was 2.684 times higher than those with capita monthly family income > 10,000 yuan ($P = 0.009$). The number of sedentary days increased the risk of failing to meet exercise standard ($OR = 1.227$, 95%CI 1.090–1.382, $P = 0.001$). The Hosmer–Lemeshow goodness of fit test indicated no statistical difference between the observed and the expected values ($\chi^2 = 2.328$, degrees of freedom = 8, $P = 0.969$).

Discussion

This study suggested that pregnant women with GDM faced a health crisis of lack of physical activity and prolonged sedentary time. The barrier and enablers of physical activity of pregnant women with GDM was from intrapersonal, interpersonal (social) and environmental level. The most common barrier was pregnancy symptoms or discomfort and the most enabler was easier glycemic control. Low capita monthly family income and more sedentary days were the independent risk factors for failing to meet exercise standard among pregnant women with GDM.

The survey showed that the exercise duration of pregnant women with GDM was 60 min. According to the cumulative exercise time, the exercise compliance rate was only 27.49%. The proportion of pregnant women with GDM who exercised over 30 min/time was 31.8%. More than half of participants did not meet the WHO and other authorities' recommendations of ''at least 30 min of moderate-intensity exercise at least 5 days per week or 150 min and above per week''.[7,19] Our result was at an intermediate level compared to other study.[20–22] A survey conducted by Rand[11] found that only 30.1% of pregnant women with diabetes had 150 min and over of aerobics exercise per week. However, one study conducted in China showed that 82.67% of pregnant women with GDM had exercise time $\geq$ 150 min/week,[23] much higher than the results reported in this study. The difference may contribute by different measurement tools and different evaluation criteria. The main exercise type of pregnant women was walking, with a small part supplemented by yoga, maternity exercise and other exercise types. The reason for the single exercise type in pregnant women with GDM may be related to the insufficient cognition of physical activity of pregnant women with GDM. A qualitative study showed that pregnant women with GDM lacked correct knowledge of exercise therapy due to the influence of family concept and constrained by their own cognition level.[24] In this study, pregnant women with GDM mainly engaged in low-intensity physical activity and inactivity, and the duration of moderate-intensity physical activity was only 26 min/day, which was higher than the result of 8.04 min/day reported by American scholars Ferrara et al.[10] It suggested that the lack of physical activity in GDM pregnant women was a relatively common phenomenon.

In recent years, ''sedentary'' as a new health concept has gradually attracted attention of health care providers. WHO 2020 Guidelines on Physical Activity and Sedentary Behavior reported that long sedentary time is associated with the development of cardiovascular disease, type 2 diabetes, and cancer.[7] A study published in Lancet by Cao[25] demonstrated that the risk of development of ischemic heart disease, diabetes, chronic obstructive pulmonary disease increased by 11–31% among human people who sitting for more than 6 h per day more than 6 h compared with those who had sedentary time less than 2 h. In this study, more than 5 days per week and cumulative sitting time of more than 6 h per day were defined as having a sedentary lifestyle,[25] and it was found that more than half (50.9%) of pregnant women had a sedentary lifestyle, which was close to the 63.3% reported by da Silva.[21] In the group of GDM pregnant women, the situation of prolonged sedentary time is quite serious. This situation is even more severe during the COVID-19 pandemic, due to factors such as infection and increased time spent at home, most pregnant women's physical activity level decreases and sedentary time increases during this period.[26]

This study found only 12.9% of pregnant women had received physical activity guidance from medical institutions. Some studies found that most pregnant women consider that physical activity is safe and effective, and pregnant women prefer to obtain information and support about physical activity directly from health care providers.[27,28] However, there is a contradiction between the huge demand for exercise guidance of pregnant women and the difficulty of medical institutions to provide resources related to physical activity during pregnancy. One study reported 76% of pregnant women had a will to participate online pregnancy exercise program, but only 13% of them obtained related resources form medical institutions.[26] A survey conducted in Brazil suggested that pregnant women with GDM consider that there was a lack of exercise reminders,[28] so pregnant women with GDM who have the need for physical activity and have acquired the corresponding knowledge may not engage in corresponding physical activity due to the lack of reminders. This can better be addressed through primary care. In recent years, the coverage of contracted family physicians services in China has been continuously improved. Family physicians can provide contracted services, on-site services, telemedicine services and community health management, etc., to provide patients with full-cycle and timely health management services, including scientific exercise prescriptions provided by family physicians and regular reminders of relevant physical exercise by family nurses during follow-up.

This study found that the age of 30–34 years old was a protective factor for failing to meet exercise standard among pregnant women with GDM compared with those with the age of 35 years old and above. A study found that the risk of failing to meet exercise standard among pregnant women aged $\geq$ 35 years old increased to 5.580 times compared with those who aged $\leq$ 29 years old.[29] This may be related to the high participation rate of young pregnant women due to their better physical strength, physical activity skills and exercise tolerance. It suggested that age should be taken into consideration in the design of the physical activity management program for pregnant women with GDM in the future. Additionally, we found that low capita monthly family income was the risk factor for failing to meet exercise standard, which was inconsistent with Wu's study.[30] This study investigated 233 pregnant women in Chongqing city and found that the risk of substandard exercise among pregnant women with capita monthly family income $\geq$ 5000 yuan and 3001–4999 yuan was 32.825 and 5.265 times higher than that of pregnant women with capita monthly family income $\leq$ 3000 yuan, respectively.[30] The reason for this discrepancy may contributed to the change of people's conception about the relationship between exercise and health. Additionally, the pandemic of COVID-19 affected the lifestyle of pregnant women at stay-home period. These participants were more likely to spend time on programs that improved their health, such as exercise. Moreover, pregnant women with higher capita family income had more resources and accesses to conduct physical activity and seek exercise guidance. Sedentary time was another risk factor for failing to meet exercise

standard, which was a new finding in this area. It suggested that reducing sedentary time was an important measure to improve exercise behavior among pregnant women with GDM.

Limitations

Our study also had some limitations. Firstly, we didn't collect pregnancy outcome of participants. Therefore, the relationship between pregnancy outcome, and physical activity and sedentary cannot be identified in this study. Secondly, we didn't use a more accurate, objective accelerometers to evaluate physical activity and sedentary time in our study. Therefore, a follow-up longitudinal study with more accurate measurement tools should be performed to explore the relationship between physical activity, sedentary behavior and pregnancy outcome.

Conclusion

GDM patients with low capita monthly family income and more sedentary days were the high-risk of failing to meet exercise standard. Primary care providers should reduce barriers and increase enablers to exercise among pregnant women with GDM at interpersonal, intrapersonal (social) and environmental level. Interventions focused on increasing light-to-moderate physical activity to replace sedentary behavior were important to reduce potential problems in pregnant women with GDM.

Ethical statement

This study was approved by Ethics Committee of West China Second University Hospital, Sichuan University (No. 2021184). The purpose, content and significance of the study were explained to the participants during the investigation. We abided research process by the ethical principle of informed consent, voluntary, harmless. All study procedures were strictly followed the Declaration of Helsinki.

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Conflict of interests

The authors declare that they have no competing interests.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found in the online version available at https://doi.org/10.1016/j.aprim.2025.103312.

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