Physical Activity Level and Gestational Diabetes Mellitus among Pregnant Women Visiting Public Healthcare Facilities

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ABSTRACT

The aim of this study is to assess the prevalence of physical activity among pregnant women during early pregnancy, which is during their first trimester, and to investigate the determinants of Gestational Diabetes Mellitus (GDM) related to sociodemographic and physical activity level. This cross-sectional study focused on pregnant women aged between 18–45 in their second or third trimester of pregnancy and visiting selected public healthcare facilities. Questionnaires including sociodemographic, anthropometric, medical history, and the Pregnancy Physical Activity Questionnaire (PPAQ) were distributed. About 123 mothers were enrolled in this study. About 86.2% of them are physically active during early pregnancy, whereas just 13.8% are physically inactive. There was no statistically significant difference between pregnant mothers with and without GDM in physical activity level. Women aged 30 and older are three times more likely to acquire GDM (AOR=3.363, 95% CI: 1.314–8.609), while women with a pre-pregnancy BMI of overweight or obese are 2.622 times more likely to develop GDM (AOR=2.622, 95% CI: 1.170–5.875). In conclusion, even though both pregnant women with and without GDM have a high level of physical activity, the length of time spent in sedentary activities is notable. However, no significant relationship was observed between physical activity and GDM development, as most individuals were found to be following the suggested physical activity duration, yet advanced age and obese pre-pregnancy BMI were found to be determinants of the GDM occurrence.

Keywords: gestational diabetes mellitus, physical activity, pregnant women

INTRODUCTION

Gestational Diabetes Mellitus (GDM) is defined by the Centres for Disease Control and Prevention (2022) as a type of diabetes that occurs throughout pregnancy and can affect individuals who have never had diabetes before. According to National Health Morbidity Surveys (NHMS), the prevalence of diabetes has increased significantly among Malaysian individuals over the age of 30. In 1996, the prevalence was 8.3%, 14.9% in 2006, and 21.6% in 2020 (Nahappan & Ali 2022). The same occurs for GDM prevalence, which has been rising with time. GDM prevalence was found to be 18.3% in a local investigation with Selangor as the primary study area (Idris *et al.* 2009). The combined incidence of GDM in Asia and Southeast Asia is 11.5% and 10.1%, respectively, according to a meta-analysis research (Nguyen *et al.* 2018a; Lee *et al.* 2018). A lot of evidence points to high pre-pregnancy weight being independent predictors for the development GDM, and people with higher Body Mass Index (BMI) or those who are overweight are more likely to be diagnosed with GDM than women with a normal BMI. One study indicated that more than half of obese or overweight pregnant women have GDM, and they are three times more likely to develop the GDM (do Nascimento *et al.* 2019).

According to the World Health Organization (WHO), physical activity can be defined as any type of physical movement by the skeletal muscle which lead to the production of energy expenditure (WHO 2021). In addition, doing physical activity are found to be reducing the risk of several diseases, such as obesity, coronary heart disease and diabetes (Warburton & Bredin 2017) hence why WHO recommends all adults to spend at l50 to 300 minutes of moderate activity per week (WHO 2021). However, the global

prevalence of not following the recommended physical activity guidelines is still high (Guthold *et al.* 2020). The National Health and Morbidity Survey (NHMS) revealed in 2019 that only two in five adults in Malaysia were practicing Health Enhancing Physical Activity (HEPA), indicating that Malaysian adults spend less time in doing physical activity.

A study conducted by Nasiri-Amiri *et al.* (2016) found that pregnant women in their first trimester has low level of physical activity, and it can elevate one's chance of developing GDM by fourfold compared to those who exercise. According to the findings of a study conducted by Nguyen *et al.* (2018b), there appears to be fairly good evidence that physical inactivity increases the chance of developing GDM, as persons with GDM are more likely to be physically inactive than individuals without GDM. Physical activity during early pregnancy has been shown in studies to help prevent GDM (Anjana *et al.* 2016). Furthermore, in a meta-analysis that was reported by Sanabria-Martnez *et al.* (2015) revealed that further reductions in GDM risk are achievable if physical exercise begins early in pregnancy.

The World Health Organisation (WHO) recommends that pregnant and postpartum women to engage in 150 minutes of moderate-intensity aerobic physical exercise per week. Despite this, pregnant women are prone to limiting their movement throughout pregnancy, which is why WHO emphasises the need of minimising sedentary time and utilising the time with any form of physical activity, regardless of intensity. Nonetheless, despite extensive research about the benefits of PA during pregnancy towards GDM diagnosis, it still has a poor acceptability worldwide (Nascimento *et al.* 2012).

Therefore, the purpose of this study is to assess the physical activity prevalence among pregnant women with and without GDM visiting public health facilities in Selangor. Not only that, but this research also aims to compare the physical activity level of pregnant women with and without GDM and to investigate the determinants of GDM related to sociodemographic and physical activity level among pregnant women.

METHODS

Design, location, and time

This cross-sectional study, which ran from December 2022 to July 2023, was a healthcare facility-based study of all pregnant women attending public healthcare facilities, regardless of their Gestational Diabetes Mellitus (GDM) status. This study was carried out in-person at two Health Clinics (*Klinik Kesihatan*) in Klang districts of Selangor, including Klinik Kesihatan Bandar Botanic and Klinik Kesihatan Meru.

This research was registered with National Medical Research Register (NMRR), and it was approved with ID number: NMRR-19-4204-52471 (IIR) by the Medical Research and Ethics Committee. Ethics approval from *Pejabat Kesihatan Daerah* (PKD) Malaysia was also obtained before we began with the data collection process. All information related to the participants were strictly confidential.

Sampling

A convenience sampling approach was employed. Eligible participants included pregnant women aged 18 to 45 years, in their second or third trimester, carrying a singleton pregnancy, irrespective of Gestational Diabetes Mellitus (GDM) status. Based on the Ministry of Health Malaysia (2017), GDM screening usually occur during 24 until 28 weeks of gestation, which is during the second trimester hence why only pregnant women in their second or third trimester were recruited. Since this is a cross-sectional study, only participants that have done GDM diagnosis will be included. The sample size was then calculated by using Raosoft Software with a margin of error of 5% and a confidence level of 90%. A total number of samples of 134 was determined. However, due to unforeseen circumstances and withdrawal of participants, we were unable to reach the required sample size, and only 123 pregnant women took part in this study.

Data collection

This cross-sectional study required self-administered structure questionnaires consist of 4 main sections: (I) socio-demographic; (II) anthropometric; (III) medical history; and (IV) Malay version of Pregnancy Physical Activity Questionnaire (PPAQ) (Ain Widad *et al.* 2020) which was initially created by Chasan-Taber *et al.* (2004). The participants were approached and upon signing in the consent form, they were given the questionnaire. The PPAQ consisted of

34 questions, and each of the questions came with six durations of time spent to be chosen. The questions prepared were also related to the physical activity according to its domain that included household, occupation, sports, or exercise, commuting and inactivity. The participants were required to answer the PPAQ section according to their physical activity back then during their first trimester only and filled in the anthropometric information by themselves. As for the calculations, all activities and questions asked were classified into several Metabolic Equivalents (METs); sedentary (1.5 METs), light (1.5–3.0 METs), moderate (3.0–6.0 METs) or vigorous (6.0 METs) (Chasan-Taber *et al.* 2004). According to Chasan-Taber *et al.* (2004), to determine the physical activity level in METs*hour/week, answer for each question were multiplied by its corresponding MET values, and the total were then multiplied by 7 to obtain the weekly energy expenditure of pregnant women during their first trimester.

Data analysis

SPSS version 27 was used to analyse the obtained data, in order to accomplish the objectives of the study. Firstly, descriptive analysis was used to determine the percentage and frequency for each of the participants' characteristics, especially the number of pregnant women with and without GDM, also the frequency of pregnant women achieved the recommended physical activity duration in early pregnancy, to know the prevalence of physical activity physical activity level. Next, chi-square test and independent T-test was used to compare the mean difference, and to observe if there was any significant association, between physical activity level of pregnant women, with and without GDM. Finally, binary logistic regression was performed to examine the determinants of GDM diagnosis in relation to sociodemographic factors and physical activity levels, focusing on p-values and Adjusted Odds Ratios (AOR). P-value<0.05 was considered statistically significant.

RESULTS AND DISCUSSION

According to Table 1, 40.7% of the participants were diagnosed with Non-Gestational Diabetes Mellitus (non-GDM) and 59.3% of them are Gestational Diabetes Mellitus (GDM). It was

also found that majority of them aged 30 years old and above, and most of the participants were Malay, with a percentage of 82.1%. In addition, they were also asked about the family history of Diabetes Mellitus (DM), and only 35.8% of them have at least one of their family members with DM. As we obtained the anthropometric information of the participants, it was found that

Table 1. Characteristics of participants

Variables (n=221)	n (%)
Age (years) (Mean±SD)	30.62±5.13
<30 years old	46 (37.4)
≥30 years old	77 (62.6)
Race	
Malay	101 (82.1)
Chinese	6 (4.9)
Indian	16 (12.0)
Others	0 (0.0)
Parity	
First child	46 (37.4)
Second child	44 (35.8)
>Second child	33 (26.8)
Household income	
<RM4,850	85 (69.1)
RM4,850–RM10,959	34 (27.6)
≥RM10,960	4 (3.3)
Marital status	
Single Mother	0 (0.0)
Married	123 (100.0)
Educational level	
No formal education	3 (2.4)
Primary education	1 (0.8)
Secondary education	51 (41.5)
Higher education	68 (55.3)
Employment status	
Unemployed	46 (37.4)
Employed	77 (62.6)
Family history of diabetes	
No	79 (64.2)
Yes	44 (35.8)
Gestational diabetes mellitus diagnosis	
Non-gestational diabetes mellitus	73 (59.3)
Gestational diabetes mellitus	50 (40.7)
Pre-pregnancy BMI (kg/m^2) (Mean±SD)	25.36±5.85
Underweight	12 (9.8)
Normal	57 (46.3)
Overweight	31 (25.2)
Obesity I	14 (11.4)
Obesity II	6 (4.9)
Obesity III	3 (2.4)

SD: Standard Deviation; RM: Ringgit Malaysia; BMI: Body Mass Index

the calculated mean BMI for the participants was 25.36 kg/m².

It was found that only 13.8% of the participant was physically inactive, and 86.2% was physically active, by achieving the recommended duration for physical activity per week (at least 150 minutes of moderate to vigorous activity). The participants of this study spent much of their time doing light activity during early pregnancy, followed by sedentary activity. Vigorous activity recorded the lowest activity median which was 0 METs*hour/week. The highest domain spent by the pregnant women is household activity, and sports activity as the lowest domain recorded (Table 2). No significant association was obtained between physical activity level with GDM diagnosis.

According to the findings of this study (Table 2), physically active participants outnumbered the physically inactive participants with a percentage of 72.4%. The prevalence reported is nearly same to that obtained by Gebregziabher *et al.* (2019), who acquired 78.1% of physically active pregnant women and 21.9% of physically inactive pregnant women from public zonal hospitals in Tigray, Ethiopia. This conflicts with the key findings of our literature review, which discovered that physical inactivity is more common than physical activity as seen in a prospective study conducted in Seremban, Negeri Sembilan, found that only 28.1% to 39.6% of pregnant women met the prescribed physical activity duration, while the majority are physically inactive (Yong *et al.* 2020). Research by Nguyen *et al.* (2018) also obtained higher percentage of physically inactive participants, and only 20.6% of their participants were physically active during their early pregnancy.

Next, the total energy expenditure spent by pregnant women in this study was 249.90 METs*hour/week, which was greater than findings from Nor *et al.*'s (2022) study, which had the average of only 183.3 METs*hour/week. Nguyen *et al.*'s (2018b) research also obtained a lower total activity median for pregnant women on their first trimester (123.2 METs*hour/week) as compared to our study. The median of light activity for our study (108.33 METs*hour/week) is over twofold higher than the median of light activity from Nguyen *et al.* (2018b) finding, which is 51.8 METs per hour, indicating that participants in our study engage more time on doing light activity during their early pregnancy. The amount of time spent on sedentary activity by pregnant women in this study (72.28 METs*hour/week) is greater than the findings from Nor *et al.* (2022)

Table 2. Physical activity level among pregnant women with and without GDM

Physical activity	Overall (Median (IQR[a]))	GDM diagnosis (Median (IQR[a]))		p
		No	Yes	
Total activity (METs*hour/week)[b]	249.90 (195.00)	236.13 (203.90)	270.25 (185.4)	0.952[*]
By intensity (METs*hour/week)[b]				
Sedentary activity	72.28 (77.53)	71.58 (74.38)	88.11 (81.77)	0.311
Light activity	108.33 (82.07)	108.33 (97.82)	108.41 (74.18)	0.673
Moderate activity	60.03 (99.75)	54.80 (87.68)	66.64 (108.03)	0.709[**]
Vigorous activity	0.00 (1.63)	0.00 (1.63)	0.00 (1.63)	0.906[**]
By domain (METs*hour/week)[b]				
Household activity	110.95 (89.60)	105.35 (80.40)	120.23 (97.83)	0.163
Occupational activity	71.05 (119.18)	78.58 (140.44)	65.45 (115.76)	0.329
Sports activity	1.95 (7.08)	1.95 (7.86)	1.79 (5.68)	0.687
Transporting activity	20.13 (39.38)	27.13 (42.00)	20.13 (25.38)	0.233
Inactivity	36.93 (24.83)	22.93 (31.41)	38.50 (33.47)	0.060
Physically active[c] (n (%))				
No	17 (13.8)	7 (41.2)	10 (58.8)	0.10[d]
Yes	106 (86.2)	66 (62.3)	40 (37.7)	

[*]p-value from Independent T-test (Significant at p<0.05); [**]Mann-Whitney U Test was used to determine the p-value; [a]IQR interquartile range; [b]METs metabolic equivalents; [c]Participants that achieved 7.5 METs*hour/week of moderate to vigorous activities; [d]Chi-square test was used to determine the p-value; GDM: Gestational Diabetes Mellitus

for the sedentary activity median, which recorded for only 7.3 METs*hour/week. According to Löf (2011), pregnant women spend much more time sedentary, which justifies the spike in sedentary activity among those who participated.

Based on the findings of this study, there is no significant relationship between physical activity and GDM diagnosis. Anjana *et al.* (2016) discovered that pregnant women with GDM spend considerably more time inactive than those without GDM. Although our result is not statistically significant, pregnant women with GDM spent more time doing sedentary activity (88.11 METs*hour/week) than pregnant women without GDM (71.58 METs*hour/week) during their first trimester. Ming *et al.* (2018) stated that exercise has been shown to lessen the occurrence of GDM. However, it was found that participants of this study, both with GDM or not spent least of their time doing sports or exercise, as that activity obtained the lowest median as seen on Table 2.

According to Table 3, pregnant women aged 30 and above were three fold more likely to be diagnosed as having GDM during their second to

Table 3. Factors associated with GDM diagnosis

Variables	Crude OR (95% CI)	p^*	Adjusted OR (95% CI)	p^*
Age (years)				
<30 years old	1.000	1.000	1.000	1.000
≥30 years old	2.761 (1.246–6.116)	0.012*	3.363 (1.314–8.609)	0.011*
Race				
Malay	2.732 (0.936–7.978)	0.066	2.954 (0.862–10.126)	0.085
Others	1.000	1.000	1.000	1.000
Parity				
First child	0.782 (0.369–1.654)	0.519	1.000 (0.381–2.626)	1.000
Not a first child	1.000	1.000	1.000	1.000
Household income				
Lower income (<RM4,850)	1.000	1.000	1.000	1.000
Higher income (≥RM4,850)	0.794 (0.361–1.744)	0.566	0.731 (0.285–1.876)	0.515
Educational level				
Secondary school or lower[a]	1.000	1.000	1.000	1.000
Higher than secondary school[b]	0.916 (0.445–1.888)	0.813	0.942 (0.374–2.373)	0.900
Employment status				
Unemployed	1.000	1.000	1.000	1.000
Employed	0.719 (0.343–1.509)	0.383	0.799 (0.319 – 2.001)	0.632
Family history of diabetes				
No	1.000	1.000	1.000	1.000
Yes	1.574 (0.745–3.325)	0.234	1.339 (0.555–3.232)	0.515
Pre-pregnancy BMI (kg/m²)				
Non obese	1.000	1.000	1.000	1.000
Obese	3.062 (1.450–6.466)	0.003*	2.622 (1.170–5.875)	0.019*
Physically active[f]				
No	1.000	1.000	1.000	1.000
Yes	0.424 (0.150–1.203)	0.107	0.355 (0.103–1.220)	0.100

*p-value from Binary Logistic Regression (Significant at p<0.05); BMI: Body Mass Index; CI: Confidence Interval; GDM: Gestational Diabetes Mellitus; OR: Odds Ratio; [a]: Adjusted for age, race, parity, household income, educational level, employment status, family history of diabetes, pre-pregnancy BMI, and physical activiy; [b]: Formal education of more than 12 years; [c]: Participants that achieved 7.5 METs*hour/week of moderate to vigorous activities

third trimester than pregnant women aged below 30. Numerous studies have found that women diagnosed with GDM are significantly older than those who are not diagnosed with GDM (Nguyen *et al.* 2018a; Anjana *et al.* 2016). Furthermore, pregnant women with a pre-pregnancy BMI of overweight or obese were 2.622 times more likely to acquire GDM during their pregnancy. It aligns with a study in Taiwan that explained the greater frequency of GDM in overweight or obese women prior to pregnancy as a result of insulin resistance and increased HbA1c (Yen *et al.* 2019).

According to Nguyen *et al.* (2018b), increasing physical activity was also found to be inversely linked with GDM diagnosis. Anjana *et al.* (2016) also mentioned about how physical activity became the first line therapy for the occurrence of GDM among pregnant women, as it can help with the control of glucose, that may lead to the delayed or decreased insulin needs and reduce the extensive outcome of hyperglycemia (Padayachee & Coombes 2015). Nonetheless, the study we conducted failed to corroborate previous findings, as no significant relationships were found between decreased physical activity and the development of GDM. However, our findings support findings from another study indicating physical activity, as measured by following the required duration, did not reduce the chance of developing GDM (Ehrlich *et al.* 2020). An extend physical activity duration recommendation for pregnant women was also suggested by the authors, and further investigation of using it is warranted to observe if the recommendation is associated with the decrease of GDM incidence.

CONCLUSION

Physical activity in early pregnancy is common in both pregnant women with and without GDM, and no significant correlation was found between these two groups with physical activity based on its domain and intensity. However, highest energy expenditure was determined in the light intensity and household activity, while vigorous intensity activity and sports or exercise obtained the lowest energy expenditure among the pregnant women during their first trimester. Age and pre-pregnancy BMI were found to be significantly associated with the development of GDM during pregnancy. Based on our findings,

pregnant women aged 30 and above has three times higher risk in developing GDM, while those with pre-pregnancy BMI of either overweight or obese are 2.622 times more likely to develop GDM. Furthermore, it was also revealed from our study that following the recommended physical activity recommendation does not significantly correlate with the occurrence of GDM.

DECLARATION OF CONFLICT OF INTERESTS

The authors declare they have no conflict of interest regarding this article.

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