PUBLIC HEALTH RESEARCH

Factors Influencing Excessive Gestational Weight Gain Among Pregnant Women in Urban Malaysia

Nora Saliza Md Salim,[1] Idayu Badilla Idris,[1*] Ida Dalina Noordin,[2] Rafidah Hod,[3] Nafisah Abdul Rashid,[1] Sumiyah Ismail,[1] Rozita Hod[1]

[1]Department of Public Health Medicine, Faculty of Medicine, Universiti Kebangsaan Malaysia, Cheras, Wilayah Persekutuan Kuala Lumpur, Malaysia.
[2] Maternal and Child Health Unit, Johor State Health Office, Johor Bahru, Johor Darul Takzim, Malaysia.
[3]Faculty of Medicine & Health Sciences, Universiti Putra Malaysia, Serdang, Selangor Darul Ehsan, Malaysia.

Corresponding author: idayubadilla.idris@ukm.edu.my

ABSTRACT

Introduction Excessive gestational weight gain (GWG) is a growing public health concern due to its association with higher risk of adverse maternal and perinatal outcomes. Recognising the key factors of underlying GWG incidence is thus crucial for developing targeted interventions. This study aims to determine the prevalence of excessive GWG and its associated factors among pregnant women in an urban district of Klang Valley, Malaysia.

Methods A retrospective cross-sectional study was conducted (between November 2017 and October 2018) among 472 pregnant women who gave birth between January 2015 and December 2016. Data on sociodemographic characteristics, medical illnesses, and pre-pregnancy body mass index (BMI) were retrieved from the birth registry and maternal health records. The classification of GWG is based on the Institute of Medicine's recommendation

Results The classification of GWG is based on the Institute of Medicine's recommendation. A total of 113 (23.9%) pregnant women had excessive GWG. Multiple logistic regression showed the odds of getting excessive GWG were higher among those with lower education levels (Adj. OR = 1.85; 95% CI = 1.084, 3.147), being employed (Adj. OR = 2.30; 95% CI = 1.342, 3.928), nulliparous (Adj. OR = 2.46; 95% CI = 1.450, 4.164), and having pre-pregnancy BMI of ≥25kg/m^2 (Adj. OR = 6.47; 95% CI = 3.909, 10.721).

Conclusions Lifestyle interventions, such as weight reduction programs and health education, should focus on women with high pre-pregnancy BMI, nulliparous women, working women and women with low education levels. Pre-pregnancy clinics and workplaces can serve as platforms to promote healthy dietary choices and encourage regular physical exercise.

Keywords Gestational Weight Gain; Determinants; Maternal Health; Antenatal Care; Pregnancy

Article history
Received: 28 April 2025
Accepted: 22 December 2025
Published: 11 March 2026

INTRODUCTION

Gaining weight during pregnancy is essential for maintaining optimal foetal development,[1] while simultaneously preparing the mother's body for birth and nursing,[2,3]. Additionally, gaining excessive weight can significantly influence both maternal and neonatal health outcomes.[4] Women with excessive gestational weight gain (GWG) have a higher risk of caesarean section,[2,5-10] assisted delivery,[7] pregnancy-induced hypertension,[7, 10, 11] and a higher probability of delivering a macrosomic baby,[7,8,10] while neonates born to mothers with excessive GWG are susceptible to preterm delivery,[8] shoulder dystocia,[10] neonatal hypoglycaemia,[10] poor Apgar score,[7] long-term metabolic health outcomes and mortality.[4, 12, 13] Furthermore, a long-term consequence of excessive GWG may worsen the global obesity crisis,[14] as GWG is one of the predictors of postpartum weight retention, which might lead to weight-related health problems among women, such as obesity,[15,16] cardiovascular diseases[17] and other non-communicable diseases.[15,16] Studies also showed that excessive GWG can perpetuate the intergenerational cycle of overweight and obesity,[18,19] which can worsen the current prevalence of obesity among children,[14,20] and therefore leading to more obesity-related health problems among the younger age groups.[21-23]

GWG is defined as the total weight that a pregnant woman gains throughout the pregnancy.[24] According to the Institute of Medicine (IOM), the recommended weight increment is based on a woman's pre-pregnancy body mass index (BMI), whereby in excessive GWG, a which woman who is underweight (<18.5kg/m^2) gains 12.8-18.0 kg, a normal weight woman (18.5-24.9kg/m^2) gains 11.5-16.0kg, an overweight woman (25.0-29.9kg/m^2) gains 7.0-11.5kg while an obese woman (≥30.0kg/m^2) gains 5.0-9.0kg[25] during pregnancy. Globally, the prevalence of excessive GWG is estimated to be at 39.4%,[26] with the highest prevalence reported in Africa (55.2%), followed by the United States (49.8%), Oceania (49.0%), and Europe (42.3%), while Asian countries recorded the lowest prevalence, i.e. at 38.2%.[27] Meanwhile a meta-analysis reported a 22% global prevalence of excessive GWG in low- and middle-income countries,[28] while in Malaysia, the prevalence ranges from 13.0 to 53.3%.[29-31]

Environmental, behavioural, and biological variables can influence the complex process of excess GWG.[7,32] Previous studies have identified multiple associated variables or factors, including race, income, pre-pregnancy BMI, mood disorder and living areas.[33-35] A meta-analysis further demonstrated that smoking, primiparity, and unemployment may increase the risk of excessive GWG.[27] Additionally, one study reported that there was a significantly higher prevalence of excessive GWG among urban population compared to rural residents.[35] However, research on factors influencing excessive GWG among pregnant women in the urban population, particularly in Malaysia are fairly limited. Nonetheless, previous studies had found that pre-pregnancy overweight or obesity,[29,31,36] have higher Healthy Eating Index scores during their third trimester[37] and lower levels of physical activity were significantly associated with increased risk of excessive GWG.[36] This study aims to determine the prevalence of excessive GWG and its associated factors among pregnant women in the Klang Valley, Malaysia. The findings may help identify women at higher risk for developing GWG, and this study may also provide healthcare providers with evidence that are needed to support early risk identification and therefore offer counselling to women with GWG. This will also help in the implementation of targeted intervention programs to prevent GWG that can give rise to adverse outcomes to both mother and foetus.

METHODS

This retrospective cross-sectional study was conducted between November 2017 and October 2018 in Klang Valley, which encompasses Kuala Lumpur and Selangor, where both have the urban area coverage of 100% and 95.8%, respectively.[38] A multistage sampling was performed. First, a simple random sampling was used to select two urban districts within Klang Valley. Subsequently, one health clinic was selected from each district using simple random sampling. The study participants included pregnant women who registered for antenatal care at the selected sampled health clinic, who were within their 12 weeks of gestation and later gave birth to delivered term infants between 1st January 2015 and 31st December 2016. Exclusion criteria were women who received antenatal care outside the selected sampled health clinic and women with multiple pregnancies. The sample size was calculated using OpenEpi version 3.0 according to one proportion formula, based on the sample size calculation with a minimum requirement of 383 participants. All eligible women were recruited through universal sampling to improve the study's statistical power. Birth records from 1st January 2015 to 31st December 2016 were retrieved from the birth registry, and maternal data were subsequently extracted from the respective maternal health records.

Data that was collected included sociodemographic characteristics such as age, ethnicity, education, and occupation. Age was measured as completed years that the respondents have been living during their first antenatal visit. Ethnicity consisted of Malay, Chinese, Indian, and others, while education level was classified as primary, secondary, or tertiary education based on the highest education they received. Participants who reported working full-time, part-time or self-

employed were classified as 'Yes' (employed), and those who reported as housewives, students, or not working were classified as 'No' (unemployed). Smoking status or presence of medical illness were categorised as 'Yes' for smokers or presence of medical illness and 'No' for non-smoker or absence of medical illness, respectively. Parity was categorized as nulliparous for no previous childbirth or multiparous for one or more previous childbirth. Maternal pre-pregnancy weight was obtained from the maternal health record at the first antenatal booking visit and was used to calculate pre-pregnancy body mass index (BMI). The BMI was categorized into underweight (<18.5kg/m^2), normal (18.5-24.9kg/m^2), overweight (25.0-29.9kg/m^2) and obese (≥30kg/m^2). Total GWG was calculated as the increment of maternal weight measured at the first antenatal booking to the last antenatal visit at or beyond 37 weeks of gestation. Excessive GWG was defined based on pre-pregnancy BMI in which underweight gained >18.0kg, normal weight gained >16.0kg, overweight gained >11.5kg or obese gained >9.0kg.[25] GWG was categorized as a binary variable (excessive and not excessive) which aligned with prior research and also to enhance clinical relevance.[7,34]

Data was analysed using Statistical Package for Social Sciences (SPSS) version 26. We reported descriptive analyses using frequencies and percentages for categorical data, while mean and standard deviation (SD) were used for numerical data. Subsequently, simple logistic regression was conducted, and variables with p-value <0.05 or clinical relevance were included in multiple logistic regression analysis to determine factors influencing excessive GWG. For analysis purposes, selected variables were regrouped into dichotomous categories to improve model stability and interpretability during multiple logistic regression analysis. Education level was regrouped into higher education, i.e. tertiary education, while lower education consisted of primary and secondary education. Pre-pregnancy BMI was regrouped into <25kg/m^2, (underweight and normal BMI), and ≥25kg/m^2 (overweight and obese). Ethical approval was obtained from the Research Ethics Committee Universiti Kebangsaan Malaysia (FF-2017-332) and the Medical Research and Ethics Committee, Ministry of Health (NMRR-17-1797-34676 (IIR)). Participants and healthcare professionals remained anonymous, and no identifying information was disclosed.

RESULTS

Of the 472 participants, 23.9% experienced excessive GWG. Table 1 summarizes the participants' characteristics. The mean age was 29.6 years (SD 4.77). The majority were Malay (74.4%) and obtained secondary education (49.1%). Most participants were employed (59.7%), were non-smokers (98.7%), multiparous (90.0%) and with no medical illness (90.0%). Regarding pre-pregnancy body mass index, 49.8% had a normal BMI.

Table 2 shows the relationship between sociodemographic factors and GWG. An increased risk of excessive GWG was associated with being employed (p = 0.008) and a pre-pregnancy BMI of ≥25kg/m^2 (p <0.001).

Table 1 The sociodemographic characteristics among participants (n=472)

Variables	Frequency (%)
Age (years)	29.6 (4.77) *
Ethnicity	
Malay	351 (74.4)
Chinese	54 (11.4)
Indian	31 (6.6)
Other	36 (7.6)
Education level	
Tertiary	207 (43.9)
Secondary	232 (49.1)
Primary	33(7.0)
Employment status	
Yes	282 (59.7)
No	190 (40.3)
Smoking status	
No	466 (98.7)
Yes	6 (1.3)
Parity	
Multiparous	320 (67.8)
Nulliparous	152 (32.2)
Medical illness	
Yes[#]	47 (10.0)

No	425 (90.0)
Maternal pre-pregnancy BMI	
Underweight (<18.5kg/m^2)	35 (7.4)
Normal (18.5-24.9kg/m^2)	235 (49.8)
Overweight (25.0-29.9kg/m^2)	129 (27.3)
Obese (≥30kg/m^2)	73 (15.5)
GWG	
Excessive	113 (23.9)
Not excessive	359 (76.1)

**Mean (SD)*
[#]Medical illnesses included bronchial asthma (n=20), allergic rhinitis (n=9), gastritis (n=5), hyperthyroidism (n=4), hypertension (n=2), rhesus negative (n=2), thalassaemia (n=1), rheumatic heart disease (n=1), polycystic ovarian syndrome (n=1), uterine fibroid (n=1).

Table 2 The relationship between sociodemographic factors and gestational weight gain

Variables	n	Gestational weight gain		Crude OR (95% CI)	*p*-value
		Excessive (n=113) n (%)	Not excessive (n= 359) n (%)		
Age (years)	472	30.0 (4.76) *	29.4 (4.77) *	1.02 (0.976, 1.066)	0.385
Ethnicity					
Malay	351	87 (24.8)	264 (75.2)	1	
Chinese	54	9 (16.7)	45 (83.3)	0.62 (0.289, 1.312)	0.209
Indian	31	11 (35.5)	20 (64.5)	1.70 (0.781, 3.678)	0.182
Other	36	6 (16.7)	30 (83.3)	0.30 (0.248, 1.530)	0.297
Education level					
Higher	207	48 (23.2)	159 (76.8)	1	
Lower	265	65 (24.5)	200 (75.5)	1.06 (0.687, 1.618)	0.807
Employment status					
No	190	34 (17.9)	156 (82.1)	1	
Yes	282	79 (28.0)	203 (72.0)	1.85 (1.173, 2.923)	0.008[#]
Smoking status					
No	466	111 (23.8)	355 (76.2)	1	
Yes	6	2 (33.3)	4 (66.7)	1.62 (0.292, 8.954)	0.581
Parity					
Multiparous	320	68 (21.2)	252 (78.8)	1	
Nulliparous	152	45 (29.6)	107 (70.4)	1.53 (0.984, 2.368)	0.059
Medical illness					
Yes	425	104 (24.5)	321 (75.5)	1	
No	47	9 (19.1)	38 (80.9)	1.35 (0.632, 2.887)	0.438
Maternal pre-pregnancy BMI					
<25kg/m^2	270	31 (11.5)	239 (88.5)	1	
≥25kg/m^2	202	82 (40.6)	120 (59.4)	5.16 (3.232, 8.242)	<0.001[#]

OR odd ratio, CI confidence interval
**mean (SD), [#]significant variable (p-value <0.05)*

Education level and parity were not significantly associated with excessive gestational weight gain in the univariable analysis. However, both lower education level and nulliparity emerged as significant risk factors in the multiple logistic regression model after adjustment for other covariates. Table 3 shows the multiple logistic regression analysis for factors associated with excessive GWG. The odds of excessive GWG were higher among women with lower education levels (Adj. OR = 1.85; 95% CI = 1.084, 3.147), being employed (Adj. OR = 2.30; 95% CI = 1.342, 3.928), nulliparous (Adj. OR = 2.46, 95% CI = 1.450, 4.164) and with a pre-pregnancy BMI of ≥25kg/m^2 (Adj. OR = 6.47, 95% CI = 3.909, 10.721).

Table 3 Multiple logistic regression analysis for factors associated with excessive gestational weight gain (n=472)

	Adjusted OR (95% CI)	Wald statistics (df)	*p*-value
Education level			
Higher	1		
Lower	1.85 (1.084, 3.147)	5.088 (1)	0.024
Employment status			
No	1		
Yes	2.30 (1.342, 3.928)	9.213 (1)	0.002
Parity			
Multiparous	1		
Nulliparous	2.46 (1.450, 4.164)	11.154 (1)	0.001
Maternal pre-pregnancy BMI			
<25kg/m^2	1		
≥25kg/m^2	6.47 (3.909, 10.721)	52.641 (1)	<0.001

OR odd ratio, CI confidence interval, df degrees of freedom

The model is based on forward LR. Hosmer-Lemeshow test is not significant (p-value = 0.461). Specificity is 95.6%, Sensitivity is 24.1% and Accuracy is 78.6%. No interaction. No multicollinearity. No outlier. The Nagelkerke value, $R^2 = 0.232$. The model fits well.

DISCUSSION

The observed prevalence of excessive GWG in this study was comparable to rates reported in other regional studies i.e. Negeri Sembilan, (23.3%) and Selangor, (21.4-22.9%); both states located in Malaysia; and Iran (23.2%).[31, 37, 39] These similarities suggest consistent patterns of GWG across diverse Malaysian populations and international settings. However, the prevalence exceeds the 13% prevalence observed in another state in Malaysia, i.e. Kelantan. This discrepancy may reflect urban-rural disparities, as the latter study was conducted in a rural setting with distinct sociodemographic characteristics compared to the urban area.

This study found that excessive GWG was associated with pre-pregnancy BMI ≥25kg/m^2. These findings aligned with established literature demonstrate a similar association between pre-pregnancy overweight and obesity and the risk of having excessive GWG.[29,31,32,34,40]. A scoping review on GWG also noted that approximately half of the studies showed a positive association between pre-pregnancy BMI and GWG.[41] Another study showed that up to 47% of women engaged in unhealthy lifestyles, such as poor diet and less physical activity during pregnancy, which had led to excessive GWG.[42] Correspondingly, obese pregnant women generally understand general health information but have difficulty translating the knowledge into specific healthy behaviours.[43] Additionally, obese pregnant women were reported to have a higher intention to consume diets high in fat and had cravings for sweets and fast food.[44]

This study also demonstrated that nulliparous women were at higher risk of developing excessive GWG compared to multiparous women. This was consistent with previous studies and meta-analyses[27] Primigravida may lack knowledge or are unaware of the recommended weight gain compared to multiparous women who had repeated exposure to information on nutrition during previous pregnancies.[45] Studies also reported that nulliparous women displayed poor dietary profiles and reduction in physical activity compared to multiparous women.[46,47] However, some studies showed no significant findings between parity and GWG.[32,40]

This study also demonstrated a positive association between being employed and gaining excess weight during pregnancy. The results were in line with previous studies that were conducted among pregnant women in Turkey.[48] Possible contributing factors include work-related stress, poor work-life balance and improper dietary habits due to time constraints, which resulted in gaining excessive weight.[49] Employment may be associated with more sedentary work environments, characterised by prolonged sitting time and reduced physical activity, which have been shown to be associated with excessive gestational weight gain in observational studies.[50] Having a job also boosts an individual's income, and research has linked higher per capita income to an increased risk of excessive GWG[51] However, the literatures on this finding was mixed. A meta-analysis by Zhou et al found that unemployed women were more likely to develop excessive GWG compared to their employed counterparts.[27] Contradictorily, a study conducted among Iranians found that employment status was not associated with excessive GWG.[52]

On another note, this study indicated that women with lower education levels had higher odds of having excessive GWG compared to those with higher education levels. This conclusion aligns with a systematic review reported that individuals with lower education levels were most at risk of gaining weight.[53] It is also consistent with a Canadian study

that pregnant women with lower education levels were associated with excess GWG.[54] Individuals with low education levels were prone to eat meals that were high in carbohydrates, sweets and red meats but low in fibre.[55] This pattern may reflect lower health literacy, defined as the ability to access, understand, and apply health information; to make appropriate health-related decisions, including dietary choices during pregnancy.[56] On the contrary, a study conducted in the state of Kelantan, Malaysia, showed that participants who received primary or lower education were significantly associated with inadequate gestational weight gain.[30] This was probably because the participants had low nutritional knowledge and might not be aware of the dietary requirements needed which led to poorer diet intake.[57] Other studies concluded that there was no significant association between GWG and education level, and this might be due to the different outcome categories used in those studies.[27,29,32,40]

The major strength of this study was that all data were obtained directly from the maternal health record books, with weight measured in the healthcare facilities using a standardised method by trained healthcare professionals during follow-ups, and these datas were not self-reported. Nevertheless, this study has few limitations. Weight gain during pregnancy is a complex issue and it is not solely influenced by sociodemographic characteristics, but also by dietary status, physical activity level, environmental, psychological, family and cultural factors [25] which were not directly measured in this study. This study was also conducted in urban areas and therefore this may prevent the generalization of the results to other suburban or rural areas. As a recommendation, future studies should explore other factors that can influence weight gain among pregnant women and conducted in variety of areas.

CONCLUSION

In conclusion, this study revealed factors associated with excessive GWG, which were pre-pregnancy overweight and obesity, nulliparous, being employed and low education level. Strategies and interventions should be focused on women with these risk factors during the pre-pregnancy period to reduce the risk of gaining excessive weight during pregnancy and further reduce maternal and neonatal unfavourable outcomes. This includes the introduction of a weight reduction programme before conception takes place, together with a health education programme that can be conducted during pre-pregnancy care clinics. Besides that, a healthy lifestyle awareness programme that includes education on nutrition and physical activity can be conducted at the workplace to enhance the knowledge of the importance of good dietary choices and regular physical exercise among employed women in the reproductive age group.

ACKNOWLEDGEMENTS

The authors would like to thank the Director General of Health Malaysia for granting permission to conduct the study and publish this article. We thank the health staff clinic for their support and assistance in the data collection process.

REFERENCES

1. Kominiarek MA, Peaceman AM. Gestational weight gain. Am J Obstet Gynecol. 2017;217(6):642-51.
2. Huang Y, Ouyang YQ, Redding SR. Maternal Prepregnancy Body Mass Index, Gestational Weight Gain, and Cessation of Breastfeeding: A Systematic Review and Meta-Analysis. *Breastfeed Med*. 2019;14(6):366-74.
3. Martin H, Thevenet-Morrison K, Dozier A. Maternal pre-pregnancy body mass index, gestational weight gain and breastfeeding outcomes: a cross-sectional analysis. *BMC Pregnancy Childbirth*. 2020;20(1):471.
4. Champion ML, Harper LM. Gestational Weight Gain: Update on Outcomes and Interventions. *Curr Diab Rep*. 2020;20(3):11.
5. Dzakpasu S, Fahey J, Kirby RS, Tough SC, Chalmers B, Heaman MI, et al. Contribution of prepregnancy body mass index and gestational weight gain to caesarean birth in Canada. *BMC Pregnancy and Childbirth*. 2014;14:106.
6. Eloranta AM, Gunnarsdottir I, Thorisdottir B, Gunnlaugsson G, Birgisdottir BE, Thorsdottir I, Einarsdottir K. The combined effect of pre-pregnancy body mass index and gestational weight gain on the risk of pre-labour and intrapartum caesarean section-The ICE-MCH study. *PLoS One*. 2023;18(1):e0280060.
7. Golawski K, Giermaziak W, Ciebiera M, Wojtyla C. Excessive Gestational Weight Gain and Pregnancy Outcomes. *J Clin Med*. 2023;12(9):3211.
8. Goldstein RF, Abell SK, Ranasinha S, Misso M, Boyle JA, Black MH, et al. Association of Gestational Weight Gain With Maternal and Infant Outcomes: A Systematic Review and Meta-analysis. *JAMA*. 2017;317(21):2207-25.
9. Huang L, Zhang J, Sun H, Dong H, Li R, Cai C, et al. Association of gestational weight gain with cesarean section: a prospective birth cohort study in Southwest China. *BMC Pregnancy Childbirth*. 2021;21(1):57.
10. Kominiarek MA, Saade G, Mele L, Bailit J, Reddy UM, Wapner RJ, et al. Association Between Gestational Weight Gain and

Perinatal Outcomes. *Obstet Gynecol*. 2018;132(4):875-81.
11. Rajendra PP, Himabindu N, Geetha K. Assessment of first trimester BMI and total weight gain during pregnancy as a predictor for maternal and fetal outcome at a tertiary care centre. *The New Indian Journal of OBGYN*. 2023;9(2):221-7.
12. Lin LH, Weng YL, Lin YY, Huang XX, Lin Y, Xiu XY, et al. Examining the effects of second-and third-trimester gestational weight gain rates on the perinatal outcomes among Chinese twin pregnancies: a retrospective cohort study. *BMC Pregnancy Childbirth*. 2022;22(1):137.
13. Zhong W, Fan X, Hu F, Chen M, Zeng F. Gestational Weight Gain and Its Effects on Maternal and Neonatal Outcome in Women With Twin Pregnancies: A Systematic Review and Meta-Analysis. *Front Pediatr*. 2021;9:674414.
14. World Health Organization. Obesity and overweight [WHO Web site].2024 12 April 2024 [cited 2024 12 April 2024]. Available from: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.
15. Fadzil F, Shamsuddin K, Wan Puteh SE, Mohd Tamil A, Ahmad S, Abdul Hayi NS, et al. Predictors of postpartum weight retention among urban Malaysian mothers: A prospective cohort study. *Obes Res Clin Pract*. 2018;12(6):493-9.
16. Ha AVV, Zhao Y, Pham NM, Nguyen CL, Nguyen PTH, Chu TK, et al. Postpartum weight retention in relation to gestational weight gain and pre-pregnancy body mass index: A prospective cohort study in Vietnam. *Obes Res Clin Pract*. 2019;13(2):143-9.
17. Waagaard L, Herraiz-Adillo A, Ahlqvist VH, Higueras-Fresnillo S, Berglind D, Wennberg P, et al. Body mass index and weight gain in pregnancy and cardiovascular health in middle age: A cohort study. *BJOG*. 2024;131(8):1136-45.
18. Baran J, Weres A, Czenczek-Lewandowska E, Leszczak J, Kalandyk-Osinko K, Luszczki E, et al. Excessive Gestational Weight Gain: Long-Term Consequences for the Child. *J Clin Med*. 2020;9(12):3795.
19. Heslehurst N, Vieira R, Akhter Z, Bailey H, Slack E, Ngongalah L, et al. The association between maternal body mass index and child obesity: A systematic review and meta-analysis. *PLoS Med*. 2019;16(6):e1002817.
20. Di Cesare M, Soric M, Bovet P, Miranda JJ, Bhutta Z, Stevens GA, et al. The epidemiological burden of obesity in childhood: a worldwide epidemic requiring urgent action. *BMC Med*. 2019;17(1):212.
21. Brady TM. Obesity-Related Hypertension in Children. Front Pediatr. 2017;5:197.
22. Chung ST, Onuzuruike AU, Magge SN. Cardiometabolic risk in obese children. *Ann N Y Acad Sci*. 2018;1411(1):166-83.
23. Faienza MF, Chiarito M, Molina-Molina E, Shanmugam H, Lammert F, Krawczyk M, et al. Childhood obesity, cardiovascular and liver health: a growing epidemic with age. *World J Pediatr*. 2020;16(5):438-45.
24. Ministry of Health Malaysia. *Maternal Dietary Guidelines for Malaysia*. In: Malaysia. MoH, editor.: Ministry of Health Malaysia.; 2023.
25. Rasmussen KM, Yaktine AL. Weight gain during pregnancy: Reexamining The Guidelines. The National Academies Press; 2009.
26. Martinez-Hortelano JA, Cavero-Redondo I, Alvarez-Bueno C, Garrido-Miguel M, Soriano-Cano A, Martinez-Vizcaino V. Monitoring gestational weight gain and prepregnancy BMI using the 2009 IOM guidelines in the global population: a systematic review and meta-analysis. *BMC Pregnancy Childbirth.* 2020;20(1):649.
27. Zhou M, Peng X, Yi H, Tang S, You H. Determinants of excessive gestational weight gain: a systematic review and meta-analysis. *Arch Public Health*. 2022;80(1):129.
28. Darling AM, Wang D, Perumal N, Liu E, Wang M, Ahmed T, et al. Risk factors for inadequate and excessive gestational weight gain in 25 low- and middle-income countries: An individual-level participant meta-analysis. *PLoS Med*. 2023;20(7):e1004236.
29. Chee WF, Si YM, Siew CY. Factors Associated with Rates of Gestational Weight Gain among Pregnant Women in Batu Pahat District of Johor state, Malaysia. *J Med Health Science*. 2019;15:33-9.
30. Farhana MFN, Rohana AJ, Alina TIT. Excessive and Inadequate Gestational Weight Gain among Malaysian Pregnant Women in Rural Area: Are There Any Associated Factors? *Pakistan Journal of Nutrition*. 2015;14(12):854-61.
31. Nurul-Farehah S, Rohana AJ, Hamid NA, Daud Z, Asis SHH. Determinants of Suboptimal Gestational Weight Gain among Antenatal Women Residing in the Highest Gross Domestic Product (GDP) Region of Malaysia. *Nutrients*. 2022;14(7):1436.

32. Silva T, Viana TGF, Pessoa MC, Felisbino-Mendes MS, Inacio MLC, Mendes LL, et al. Environmental and individual factors associated with gestational weight gain. *BMC Public Health*. 2022;22(1):540.
33. Garay SM, Sumption LA, Pearson RM, John RM. Risk factors for excessive gestational weight gain in a UK population: a biopsychosocial model approach. *BMC Pregnancy Childbirth.* 2021;21(1):43.
34. Kouba I, Del Pozzo J, Lesser ML, Shahani D, Gulersen M, Bracero LA, Blitz MJ. Socioeconomic and clinical factors associated with excessive gestational weight gain. *Arch Gynecol Obstet.* 2024;309(4):1295-303.
35. Silva T, Viana TGF, Duarte CK, Inacio MLC, Velasquez-Melendez G, Pessoa MC, et al. Environmental factors associated with excessive gestational weight gain: a meta-analysis and systematic review. *Cien Saude Colet*. 2023;28(1):171-80.
36. Yong HY, Mohd Shariff Z, Koo SJ, Binti Sa'ari NS. Pre-pregnancy body mass index, height and physical activity are associated with rate of gestational weight gain among Malaysian mothers. *J Obstet Gynaecol Res*. 2016;42(9):1094-101.
37. Yong HY, Mohd Shariff Z, Mohd Yusof BN, Rejali Z, Tee YYS, Bindels J, van der Beek EM. Pre-Pregnancy BMI Influences the Association of Dietary Quality and Gestational Weight Gain: The SECOST Study. *Int J Environ Res Public Health*. 2019;16(19):3735.
38. Key Findings of Population and Housing Census of Malaysia 2020: Urban and Rural [Internet]. 2024. Available from: https://www.dosm.gov.my/portal-main/release-content/key-findings-population-and-housing-census-of-malaysia-2020-administrative-district#:~:text=On%20average%2C%20Malaysia%20has%20a,Timur%20Laut%20(4%2C403%20persons).
39. Farhangi MA. Gestational weight gain and its related social and demographic factors in health care settings of rural and urban areas in northwest Iran. *Ecol Food Nutr*. 2016;55(3):258-65.
40. Feng YY, Yu ZM, van Blyderveen S, Schmidt L, Sword W, Vanstone M, et al. Gestational weight gain outside the 2009 Institute of Medicine recommendations: novel psychological and behavioural factors associated with inadequate or excess weight gain in a prospective cohort study. *BMC Pregnancy Childbirth*. 2021;21(1):70.
41. Samano R, Martinez-Rojano H, Ortiz-Hernandez L, Najera-Medina O, Chico-Barba G, Gamboa R, Mendoza-Flores ME. Individual, Family, and Social Factors Associated with Gestational Weight Gain in Adolescents: A Scoping Review. *Nutrients*. 2023;15(6):1530.
42. Claire Dunney, Deirdre J. Murphy. Healthy lifestyle behaviours in pregnancy: A prospective cohort study in Ireland. *British Journal of Midwifery*. 2015;23(12):874-84.
43. Meldgaard M, Jensen AL, Johansen AD, Maimburg RD, Maindal HT. Health literacy and related behaviour among pregnant women with obesity: a qualitative interpretive description study. *BMC Pregnancy Childbirth*. 2022;22(1):712.
44. Most J, Rebello CJ, Altazan AD, Martin CK, Amant MS, Redman LM. Behavioral Determinants of Objectively Assessed Diet Quality in Obese Pregnancy. *Nutrients*. 2019;11(7):1446.
45. Gebremichael MA, Lema TB. Prevalence and Predictors of Knowledge and Attitude on Optimal Nutrition and Health Among Pregnant Women in Their First Trimester of Pregnancy. *Int J Womens Health*. 2023;15:1383-95.
46. Fernandez-Gomez E, Luque-Vara T, Moya-Fernandez PJ, Lopez-Olivares M, Gallardo-Vigil MA, Enrique-Miron C. Factors Influencing Dietary Patterns during Pregnancy in a Culturally Diverse Society. *Nutrients*. 2020;12(11):3242.
47. Restall A, Taylor RS, Thompson JM, Flower D, Dekker GA, Kenny LC, et al. Risk factors for excessive gestational weight gain in a healthy, nulliparous cohort. *J Obes*. 2014;2014:148391.
48. Cataloluk A, Sibel S. The Relationship of Gestational Weight Gain with Familial and Social Properties. *International Journal of Caring Sciences*. 2021;13(3):1627-35.
49. Sohyun Park, Eunju Sung. 'You gotta have something to chew on': perceptions of stress-induced eating and weight gain among office workers in South Korea. *Public Health Nutr*. 2021;24(3):499-511.
50. Hamann V, Deruelle P, Enaux C, Deguen S, Kihal-Talantikite W. Physical activity and gestational weight gain: a systematic review of observational studies. *BMC Public Health*. 2022;22(1):1951.
51. Reis MO, Maia de Sousa T, Oliveira MNS, Maioli TU, Dos Santos LC. Factors Associated with Excessive Gestational Weight Gain Among Brazilian Mothers. *Breastfeed Med*. 2019;14(3):159-64.
52. Dolatian M, Sharifi N, Mahmoodi Z, Fathnezhad-Kazemi A, Bahrami-Vazir E,

Rashidian T. Weight gain during pregnancy and its associated factors: A Path analysis. *Nurs Open*. 2020;7(5):1568-77.

53. O'Brien EC, Alberdi G, McAuliffe FM. The influence of socioeconomic status on gestational weight gain: a systematic review. *J Public Health (Oxf)*. 2018;40(1):41-55.
54. Benham JL, Booth JE, Donovan LE, Leung AA, Sigal RJ, Rabi DM. Prevalence of and risk factors for excess weight gain in pregnancy: a cross-sectional study using survey data. *CMAJ Open*. 2021;9(4):E1168-E74.
55. Narges AF, Gianmarco DFM, Yelena M, Rossano S. On the interplay between educational attainment and nutrition: a spatially-aware perspective. *EPJ Data Science*. 2021;10:18.
56. Nawabi F, Krebs F, Vennedey V, Shukri A, Lorenz L, Stock S. Health Literacy in Pregnant Women: A Systematic Review. *Int J Environ Res Public Health*. 2021;18(7).
57. Rippin HL, Hutchinson J, Greenwood DC, Jewell J, Breda JJ, Martin A, et al. Inequalities in education and national income are associated with poorer diet: Pooled analysis of individual participant data across 12 European countries. *PLoS One*. 2020;15(5):e0232447.