



Association between nutritional intake, physical activity, and gestational weight gain in overweight pregnant women: a cross-sectional study

Hubungan antara asupan zat gizi, aktivitas fisik dan penambahan berat badan selama kehamilan pada ibu hamil overweight: studi cross sectional

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Abstract

Excessive weight gain during pregnancy is a risk factor, which can be modified to prevent pregnancy and postpartum complications. Gestational weight gain (GWG) is also influenced by the regulation of nutritional intake and physical activity, especially during the COVID-19 pandemic. This study aimed to analyze the relationship between nutritional intake and physical activity in overweight pregnant women with gestational weight gain. This cross-sectional study was conducted in May and November 2022. A total of 66 overweight/obese pregnant women aged 20 – 40 years at the Public Health Center in Semarang were recruited using a consecutive sampling technique. Data were collected using interviews, questionnaires, and anthropometric measurements. Data analysis was performed using the Pearson's correlation, Spearman's correlation, and linear regression. Pregnant women who were overweight or obese gained an average of 0,42 kg of weight each week, with the bulk of this gain deemed improper (68,2%). Parity ($p=0,011$; $r=-0,309$) and sufficient protein consumption ($p=0,031$; $r=-0,266$) were associated with GWG. The conclusion is that there will be less weight gain during pregnancy if the protein intake is high.

Keywords: Gestational weight gain, Overweight pregnancy, Protein intake

Abstrak

Penambahan berat badan yang berlebihan selama kehamilan merupakan faktor risiko yang dapat dimodifikasi untuk mencegah komplikasi kehamilan dan pascapersalinan. Penambahan berat badan ibu hamil juga dipengaruhi oleh pengaturan asupan gizi dan aktivitas fisik khususnya pada masa pandemi COVID-19. Penelitian ini bertujuan untuk menganalisis hubungan asupan gizi dan aktivitas fisik pada ibu hamil overweight dengan penambahan berat badan kehamilan. Desain penelitian *cross sectional* yang dilakukan bulan Mei – November 2022. Subjek penelitian yaitu ibu hamil *overweight/obese* yang berusia 20 – 40 tahun di Puskesmas Kota Semarang yang berjumlah 66 orang dengan teknik *consecutive* sampling. Data dikumpulkan melalui wawancara, menggunakan kuesioner, dan pengukuran antropometri berat badan. Analisis data menggunakan korelasi Pearson, Spearman, dan regresi linier. Rerata kenaikan berat badan ibu hamil overweight obese sebesar 0,42 kg/minggu, dengan mayoritas kenaikan berat badan yang tergolong tidak sesuai (68,2%). Terdapat hubungan antara kecukupan asupan protein ($p=0,031$; $r=-0,266$) dan paritas ($p=0,011$; $r=-0,309$) dengan penambahan berat badan. Kesimpulan Jika asupan protein semakin tinggi maka peningkatan berat badan selama hamil semakin rendah.

Kata Kunci: Asupan protein, penambahan berat badan hamil, kehamilan overweight

Introduction

Pregnancy is critical within 1000 days of life and determines a baby's health. Pregnancy could be a time when a pregnant woman encounters physical and mental changes due to increased pregnancy hormones. One of the physical changes in pregnant women is weight gain during pregnancy (gestational weight gain/GWG). Excessive weight gain during pregnancy can result in excess weight in pregnant women (Likhar&Patil, 2022).

Overweight or obesity can occur before pregnancy. The recommended weight increase for overweight pregnant women (body mass index/BMI 25 – 29,9 kg/m²) is 6,8 – 11,4 kg or 0,28 kg/week in the 2nd and 3rd trimesters. For obese pregnant women (BMI > 30 kg/m²), the recommended weight increase is 5 – 9,1 kg during pregnancy or around 0,22 kg/week in the 2nd and 3rd trimesters (Goldstein, 2017).

According to Chang's research in Taiwan, 44% of pregnant women experienced weight gain exceeding the Institute of Medicine (IOM) recommendation by 44% (Hornig HC, 2018). In West Sumatra, research indicates that, according to the Asian BMI categorization, 5,3% of pregnant women are obese (BMI > 27,5 kg/m²) and 21,7% are overweight (BMI 23,0-27,4 kg/m²). According to the international BMI classification, the incidence rates of obesity (BMI > 30,0 kg/m²) and overweight (BMI 25,0-29,9 kg/m²) were 1,1% and 13,5%, respectively. Pregnant women who are obese are 13,46 times more likely to give birth to macrosomic babies than pregnant women with a normal BMI (Soltani et al., 2017). A study of pregnant women in Semarang City showed that 56,2% experienced excessive weight gain (Astuti et al., 2020). This indicates an increased health risk for pregnant women.

Obesity is a health concern in pregnant women. This can have detrimental effects on both mother and baby, including maternal and neonatal complications, such as increased unsuccessful labor, fetal abnormalities and mortality, high risk of gestational hypertension, gestational diabetes, preeclampsia, increased risk of cesarean section, macrosomia, and complications related to childbirth (Goldstein, 2017).

Based on studies in Australia, only a few pregnant women have met the recommendations for food intake and physical activity. Food intake that is not fulfilled includes

vegetables and fruits. In addition, only one-third of pregnant women meet the recommended 30 min of daily physical activity (Malek et al., 2016). A study conducted on pregnant women in Semarang in 2018 found that most of the respondents' weight gain (56,2%) was classified as over gestational weight gain. There was a correlation between total calorie consumption and weight gain ($p = 0,031$) but not between the macronutrient components of protein, fat, and carbohydrates and gestational weight gain. Pregnant women's food consumption does not meet the recommendations of balanced nutrition guidelines with insufficient portions of vegetables and fruits (Astuti et al., 2020).

Studies conducted before the pandemic showed that pregnant women's food intake and weight gain during pregnancy did not meet recommendations. Therefore, this study aimed to analyze the food intake of pregnant women, especially those with an overweight/obese nutritional status and gestational weight gain. Gestational weight gain in pregnant women with overweight/obesity pre-pregnancy nutritional status is lower than that in pregnant women with normal nutritional status (Basoeki et al., 2024).

Pregnant women are known to have low physical activity because sedentary behavior in pregnant women is interpreted as an activity carried out by spending daily time without moving (Badon, 2018). Fatigue and discomfort during pregnancy are factors that cause pregnant women to be less active. Research has shown that pregnant women with obesity have limited levels of physical activity because daily time is spent doing low-intensity activities and not moving much (Chandonnet, 2018). Pregnant women who are overweight and obese do not show changes in the volume of physical activity during pregnancy. In addition, it has been reported that overweight and obese pregnant women experience a decrease in physical activity between the beginning and middle of pregnancy (Bacchi, 2016).

To help pregnant women meet the macronutrient requirements for fetal growth, sustain their increased energy needs throughout pregnancy, and achieve adequate gestational weight gain, nutrition education is a particular intervention (Ota et al., 2015). Programs for pregnant women have been implemented at the Public Health Center (Puskesmas), including antenatal care and classes for pregnant women. During this pandemic, most of the class activities for pregnant women were online

to reduce the transmission of Covid-19, so online pregnancy education classes may influence the level of maternal knowledge related to food intake and physical activity recommendations during pregnancy.

Semarang City Health Office data showed an increase in the Maternal Mortality Rate (MMR) from 15 mothers in 2018 to 17 mothers in 2019. The cause of maternal death due to hypertension also tended to increase in the last 3 years, and as many as 35% of the mothers died due to hypertension. Other causes include bleeding (17%), infection (8%), and others (40%) (Dinkes Jateng, 2019).

Pregnant women who were deemed overweight or obese either before or during pregnancy, particularly during COVID-19, showed a weak correlation between gestational weight gain, maternal nutritional intake, and physical activity throughout pregnancy. Previous studies have only highlighted GWG, without considering the COVID-19 pandemic conditions that affect the lifestyle of pregnant women. This study aimed to analyze the relationship between food intake, physical activity, and gestational weight gain in overweight pregnant women during the COVID-19 pandemic.

Methods

This observational study used a cross-sectional design and was conducted between May and November 2022. The research subjects were overweight pregnant women aged 20 – 40 years at Semarang City Health Center. The sample size was calculated using the proportion estimation sample size formula with an estimated proportion of pregnant women with poor weight gain of 81,7% with $\alpha = 0,05$ and an estimated error (d) = 0,1 (Harti et al., 2016). The sample size was determined using the following formula (Sastroasmoro, 2014):

$$n = \frac{za^2x p(1 - p)}{d^2}$$

Information:

n : Minimum sample size from both sample groups

$Z\alpha$: 95% level of significance (1,96 using $\alpha=0,05$)

P : Proportion of exposure in the case group

Sixty-six overweight pregnant women were as many as 66 people. The research subjects were selected using a consecutive sampling method with the following inclusion criteria: pregnant women in the 2nd and 3rd trimesters who had not yet given birth, had monthly medical record data on their weight in the Maternal and Child Health book, were in good health, did not have chronic diseases such as heart disease, kidney disease, liver disease, etc.) and/or were not under medical care for the last 6 months, and were willing to become research subjects by providing informed consent. The exclusion criteria for this study were having a given birth or withdrawal from the study.

Nutrient intake (carbohydrates, protein, and fat) and physical activity were measured, while the dependent variable was weight gain. Data on respondents' food intake were obtained via the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) and analyzed using Nutrisurvey software, which was adapted to local needs. The SQ-FFQ form used in this study was valid and reliable (Syauqy et al., 2021). Data on the adequacy of macronutrient intake were calculated based on nutritional adequacy figures for pregnant women in the 2nd and 3rd trimesters. Physical activity data were obtained using a Global Physical Activity Questionnaire (GPAQ). Gestational weight gain data were calculated based on the weight data at the time of data collection and subtracted from the mother's weight data before pregnancy, which were recorded in the Maternal and Child Health book. The data were divided by gestational age at data collection (minus 13 weeks). The results were adjusted to the recommended weekly weight gain for pregnant women. It was categorized as appropriate if the increase in weight during pregnancy per week is following recommendations (0,23 – 0,33 kg/week for overweight and 0,17 – 0,27 kg/week for obesity). GWG data were inappropriate if the weight increased during pregnancy. The pregnancy period did not comply with IOM recommendations (Goldstein, 2017). Intake is categorized as sufficient and insufficient, as obtained from the 2019 RDA based on age classification and additional nutrients for pregnant women in the third trimester, sufficient if the intake is >80% of the total needs (Kemenkes, 2019).

Data normality was tested using the Kolmogorov-Smirnov test. Data distribution was found to be abnormal; therefore, the Spearman test was used to test for differences in energy, carbohydrate, physical activity, age, and parity with gestational weight gain. Analysis to determine the relationship between protein and fat and gestational weight gain was carried out using Spearman's test with a confidence interval of 95%. Multivariate analysis with Linear Regression. This study was approved by the Health Research Ethics Committee, Faculty of Medicine, Diponegoro University No. 105/EC/KEPK/FK-UNDIP/IV/2022. All respondents who took part in the study voluntarily filled out informed consent (respondent's rights, including privacy and risk) voluntarily.

Result and Discussion

The study participants were 66 pregnant women. The average age of the pregnant women was 30 years, with the majority (72,7%) belonging to the age group not at risk of pregnancy (<35 years). Based on the respondents' characteristics, most were in the

age group not at risk of becoming pregnant (< 35 years). Older pregnant women tended to have a higher risk of obesity (Jalil & Shahrir, 2020).

All respondents in their pre-pregnancy nutritional status were classified as overweight or obese, with the majority having obesity nutritional status level 1 (BMI 25 – 29,9 kg/m²). Overweight and obesity are conditions in which excess fat accumulates due to an imbalance in energy intake and expenditure over a long period, which can cause health problems. Pre-pregnancy obesity was associated with the risk of gestational diabetes, gestational hypertension, cesarean delivery, and high birth weight (Faucher & Barger, 2015). Overnutrition in pregnant women can increase the risk of offspring obesity, asthma, coronary heart disease (CHD), stroke, gestational diabetes, gestational hypertension, and preeclampsia (Godfrey et al., 2017).

Most respondents had more multiparous parities than nulliparous parities. The income level was above the Semarang City Regional Minimum Wage (RMW) of 80,3%. The education level of most respondents was high school (51,4%). As many as 87,9% of respondents had no history of disease.

Table 1. Characteristics of pregnant women

Characteristics	n (%)	Mean+SD	Min	Max
Age (years)		30,0 ± 4,96	22	42
Risk (≥35)	18 (27,3)			
No risk (<35)	48 (72,7)			
Pre-pregnancy BMI (kg/m ²)*		27,7±3,68	23,00	37,78
Overweight (23 – 24,9)	18(27,3)			
Obesity 1 (25 – 29,9)	33 (50,0)			
Obesity 2 (> 30)	15 (22,7)			
Gestational Age (weeks)		28,1±6,23	16	40
2 nd Trimester	26 (39,4)			
3 rd Trimester	40 (60,6)			
Paritas		0,89±0,99	0	4
Nullipara	28 (42,4)			
Multipara	38 (57,6)			
Income				
Above the RMW	53 (80,3)			
Below RMW	13 (19,7)			
Education				
College	23 (34,8)			
High school	35 (53,0)			
Elementary, junior high school	8 (12,2)			
History of illness				
Yes	8 (12,1)			
No	58 (8,9)			

Note: Regional Minimum Wage (RMW), * cut off BMI for Asian

Most energy intake (65,2%), protein (74,2%), fat (86,4%), and carbohydrates (69,7%) were classified as not according to the recommended maternal nutritional adequacy rate (RDA) for pregnant women (Table 2). The average energy sufficiency of the respondents was 105,91%, protein was 124,42%, fat was 188,11%, carbohydrates were 83,31%. Carbohydrates consumed by pregnant women include white rice, bread, and noodles. The sources of animal proteins include eggs, chicken, and milk. Most side dishes consumed were fried. The physical activity of pregnant women was 394,86 METs, with the physical activity category being classified as low (54,5%). Most activities of pregnant women are classified as sedentary, such as sitting, watching TV, and playing with gadgets. Most participants walked slowly for 10–20 min/day and exercised for pregnant women once a week for 30 min. According to IOM recommendations, the average weight gain for pregnant women is 0,42 kg/week, with most weight gain classified as inappropriate (68,2%).

According to IOM guidelines, the majority of pregnant women who were overweight or obese (68,2%) were categorized as having excessive weight gain during pregnancy. Pregnant obese women who gain more weight than recommended by the IOM may be at

increased risk of maternal and fetal complications. (Faucher & Barger, 2015). Based on these studies, mothers with a history of high parity are at a greater risk of obesity. Multiparous women commonly experienced abdominal obesity compared with the other groups. A prospective study suggested that childbearing may increase visceral adipose tissue independent of increases in overall body fat.

Placental release of corticotropin-releasing hormone (CRH) during pregnancy stimulates the hypothalamic-pituitary-adrenal axis and cortisol levels in the mother. Both have been found to play a role in the pathophysiological mechanisms of abdominal obesity, which may be partly mediated by insulin resistance. In addition, non-biological disorders during pregnancy, including socioeconomic and psychosocial stress, unhealthy lifestyles, and features of depression and anxiety, can cause hypothalamic-pituitary-adrenal hyperactivity. In addition, pregnancy can trigger peripheral insulin resistance, resulting in excess calorie storage. When the ability of adipose tissue to store excess energy is limited owing to insulin resistance, excess triacylglycerol is stored in undesirable parts such as visceral adipose tissue (Li et al., 2016).

Table 2. Description of food intake and physical activity of pregnant women

Variable	n (%)	Mean±SD	Min	Max
Energy (%)		105,91±35,13	53,04	187,5
Sufficient	23(34,8)			
Insufficient	43(65,2)			
Protein (%)		124,42±53,06	46,9	284,4
Sufficient	17(25,8)			
Insufficient	49(74,2)			
Fat (%)		188,11±77,52	68,4	401,3
Sufficient	9(13,6)			
Insufficient	57(86,4)			
Carbohydrate (%)		83,31±30,49	31,6	174,3
Sufficient	20(30,3)			
Insufficient	46(69,7)			
Physical activity (METs)		394,86±331,79	105	1680
Sufficient	30(45,5)			
Insufficient	36(54,5)			
Gestational weight gain (kg/week)		0,42±0,36	-0,56	1,83
Sufficient	21(31,8)			
Insufficient	45(68,2)			

Table 3. Correlation test of independent variables with gestational weight gain

Variable	r	p
Energy (%)**	-0,197	0,114
Protein (%)*	-0,266	0,031
Fat (%)*	-0,216	0,081
Carbohydrate sufficiency (%)**	0,054	0,666
Physical activity (METs)**	-0,121	0,333
Age (years)**	-0,085	0,500
Paritas**	-0,309	0,011

Note: * pearson, ** spearman

Table 3 shows the correlation results, which showed a relationship between adequate protein intake ($p=0,031$; $r=-0,266$) and parity ($p=0,011$; $r=-0,309$) and gestational weight gain. If adequate protein intake is higher, weight gain during pregnancy will be lower. The pregnancy weight increased with decreasing parity. However, this correlation shows a weak negative relationship between protein intake, parity, and GWG during pregnancy.

The increase in protein requirement in the third trimester is 30 g, and the total adequate protein intake for women aged 22 – 42 years, according to the 2019 RDA, is 60 g. Therefore, the total protein requirement for pregnant women was 90 g (Kemenkes, 2019). Additional natural food protein sources are utilized during pregnancy for the development of the fetus, growth of the placenta, generation of amniotic fluid, expansion of the volume of the mother's blood, and development of more maternal tissue. Approximately 82% of the total protein requirement (925 g) for maternal and fetal needs accumulates during the last half of the pregnancy. Due to a lack of certain amino acids involved in cell metabolism and function, inadequate protein consumption by a mother may result in embryonic losses, intrauterine growth restriction, and decreased postnatal growth (Herring et al., 2018).

A higher protein-to-carbohydrate ratio seems to be the primary cause of excessive gestational weight gain. Due, in part, to a lower intake of added sugar, a high protein-to-carbohydrate ratio is linked to lower weight gain during pregnancy. However, this finding was more significant when linked to protein in meat and fish, but not milk (Clark, 2018).

The bivariate test in Table 3 shows a relationship between parity and gestational weight gain, with a correlation value of -0,309; $p=0,011$. The greater the number of maternal

parities, the lower the gestational weight gain. This is consistent with a study by Kominiarek et al., which found that multiparous women had a higher likelihood of having a lower GWG than nulliparous women (74,2% vs. 25,8%).

Hill et al. found no difference in GWG between multiparas and nulliparas. Parity is a crucial factor in promoting pregnancy at a healthy weight, attaining sufficient and healthy GWG, and preventing the development of obesity in women and their children, because the majority of women will have several children (Hill et al., 2016).

Based on research in Brazil, multiparous women tend to gain less weight during pregnancy than primiparous women do. This is because of the relationship between maternal weight and GWG, where GWG decreases as the mother's BMI increases (Paulino et al., 2016). Studies on West Nusa Tenggara have shown that parity is related to GWG (Harti, 2016).

Most pregnant women (54,5%) reported relatively low levels of physical activity. The subjects of this study adopted light physical activity with activities carried out including jogging and doing housework (15-30 minutes), while pregnant women with appropriate physical activity carried out physical activities such as walking with moderate intensity, yoga, or swimming (1-2x/week) with duration 10-15 minutes for each activity. The bivariate results showed no relationship between physical activity and GWG. This is in line with a study in Pekanbaru, which showed no relationship between physical activity and nutritional status of pregnant women ($p>0,05$) (Haryanti R, 2021). Some subjects had light physical activity during pregnancy, changes in body mass became greater, and fatigue and discomfort as the gestational age increased were one of the causes of the decreased physical activity that occurred in pregnant women, and the intensity and duration of activity became less intense so that they chose more comfortable activities (Flannery C, 2019). In addition, the Covid-19 pandemic has limited outdoor physical activities.

Other factors, such as adequate energy, fat, and carbohydrate intake, and age, showed an insignificant relationship ($p>0,05$). The variables included in the multivariate analysis ($p < 0,25$) were energy, protein, fat, and parity intake, and the gestational weight gain equation was $8,907 - 1,433 \times \text{parity}$. The R^2 value was 0,101, which means that the number of parities of pregnant

women with overweight/obese nutritional status influences the change in gestational weight gain of 10,1%. The limitations of this study include recall bias in the SQ-FFQ and physical activity assessment in pregnant women. Efforts were made to minimize recall bias by using the facilitated SQ-FFQ questionnaire and by conducting apperception on the enumerator.

Conclusion

Protein intake plays an important role in gestational weight gain. There will be less weight gain during pregnancy if appropriate protein intake is high. The chance of weight gain during pregnancy increased with decreasing parity. Other factors such as sugar intake, stress, knowledge related to pregnancy nutrition, and history of hypertension may contribute to gestational weight gain.

Pregnant women are expected to be able to control weight gain during pregnancy according to the recommendations given by adjusting the BMI before pregnancy so that it does not exceed the recommended limit. In addition, sufficient rest is required. Further research is needed to determine GWG using a cohort design.

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