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The relationship between nutrition adequacy level, physical activity, and pregnancy outcomes in mothers and infants

Hubungan kecukupan zat gizi, aktivitas fisik, dan outcomes kehamilan pada ibu dan bayi

Hamidah Aula Rusydiana[1*], Mira Dewi[2], Hadi Riyadi[3], Lilik Kustiyah[4]

[1] Departemen Gizi Masyarakat, Fakultas Ekologi Manusia, IPB University, Bogor, Indonesia.
E-mail: hamidahrusydiana@gmail.com
[2] Departemen Gizi Masyarakat, Fakultas Ekologi Manusia, IPB University, Bogor, Indonesia.
E-mail: mirade@apps.ipb.ac.id
[3] Departemen Gizi, Fakultas Ekologi Manusia, IPB University, Bogor, Indonesia.
E-mail: hadiriyadi@gmail.com
[4] Departemen Gizi, Fakultas Ekologi Manusia, IPB University, Bogor, Indonesia.
E-mail: lilik.kustiyah@gmail.com

***Correspondence Author:**
Departemen Gizi Masyarakat, Fakultas Ekologi Manusia, IPB University. Gedung FEMA W1-L2 Jl. Kamper Kampus IPB Dramaga, Bogor 16680, Indonesia.
E-mail: hamidahrusydiana@gmail.com

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Abstract

Pregnancy outcomes are affected by many factors: nutrition and physical activity. This study aims to determine the relationship between physical activity and nutritional adequacy level of pregnant women in the third trimester with pregnancy outcomes, namely maternal fasting blood glucose levels, blood pressure and amniotic fluid volume, and baby's birth weight and length. An observational study on a cohort was conducted on 34 pregnant women in their third trimester and followed until delivery in the Ciampea sub-district, Bogor, Indonesia. The data were processed through descriptive analysis for each variable. Bivariate tests between the predictor and outcome variables were performed using Pearson's correlation and Multiple Regression at 95% CI. Based on multiple regression analysis, we found that the samples' fasting blood glucose in the third trimester was predicted to be 36,9% positively affected by pre-pregnancy body mass index (b= 2,521; p= 0,009) and total physical activity during the third trimester (b= 0,055; p= 0,006). In conclusion, the nutritional adequacy level of macronutrients in the third trimester has not yet significantly affected pregnancy outcomes in this study. It is suggested that pregnant women should avoid prolonged sedentary activity and increase appropriate exercise to achieve maternal health and improve birth outcomes.
Keywords: Nutrient adequacy, physical activity, pregnancy outcome

Abstrak

Outcomes kehamilan dapat dipengaruhi oleh berbagai faktor, di antaranya adalah zat gizi dan aktifitas fisik. Penelitian ini bertujuan untuk mengetahui hubungan antara aktivitas fisik dan kecukupan zat gizi pada wanita hamil terhadap outcomes kehamilan yakni tekanan darah, kadar glukosa darah, dan volume cairan ketuban ibu hamil serta panjang dan berat badan bayi lahir. Desain pada penelitian ini adalah studi observasional pada kohort 34 ibu hamil di wilayah kecamatan Ciampea Bogor. Data diproses melalui analisis deskriptif untuk setiap variabel. Uji bivariat antara variabel prediktor dan variabel hasil dilakukan dengan menggunakan korelasi Pearson dan Regressi berganda pada CI 95%. Berdasarkan analisis regresi ganda, diketahui indeks massa tubuh sebelum hamil (b= 2,521; p= 0,009) dan total aktivitas fisik ibu di trimester ketiga (b= 0,055, p= 0,006) diprediksi 36,9% berpengaruh positif signifikan terhadap peningkatan kadar glukosa darah puasa di trimester ketiga. Kesimpulan, tingkat konsumsi zat gizi pada trimester ketiga belum signifikan berhubungan dengan outcome kehamilan dalam penelitian ini. Disarankan ibu hamil untuk menghindari aktivitas sedentari yang terlalu banyak dan berolahraga yang sesuai untuk meningkatkan kesehatan ibu dan bayi.
Kata Kunci: Aktivitas fisik, outcomes kehamilan, kecukupan zat gizi

Introduction

The intensity level and physical activity can be divided into sedentary, light, moderate, and heavy. Sedentary activities are activities performed outside of bedtime which emit low calories or less than 1,5 MET (Metabolic Equivalent), such as lying down and sitting (Tremblay et al., 2017). Revealing that total sedentary activity was negatively related to cardiorespiratory fitness, muscle strength, and balance (Nasrulsyah et al., 2022; Silva et al., 2020).

Sedentary behaviors need to be limited because several studies have shown that this behavior is a factor in obesity, which increases the risk of various health issues. 33,5% of the population has physical activity, which is included in the lower category (Kemenkes RI, 2018; Rahmad, 2021). Pregnant women may engage in sedentary or low physical activity. According to studies conducted in Ethiopia, only 21,9% of pregnant women engaged in sufficient physical exercise (Gebregziabher et al., 2019). A year later, research in the same country found no different results, namely 79,3% or four of five pregnant women had a sedentary lifestyle or low physical activity (Hailemariam et al., 2020).

In general, physical activity has many benefits. The World Health Organization (WHO) recommends moderate physical activity for 150 minutes per week or an equivalent of 75 minutes per week of heavy-intensity physical activity to obtain benefits. Especially for pregnant women, non-sedentary activities have many benefits for their and their babies well-being. According to research, physical activity can lower the risk of gestational hypertension (WHO, 2018). Based on a meta-analysis, it is known that the incidence of gestational diabetes mellitus (GDM) might decrease by as much as 24% in the intervention group when compared to the control group (Nasiri-Amiri et al., 2019).

However, strenuous physical activity, such as lifting weights, can increase pregnancy complications, such as decreased amniotic fluid, placental abruption, and low birth weight (Khojasteh et al., 2016). According to Legesse et al. (2020) strenuous exercise has been linked to a higher prevalence of low birth weight in term pregnancies. There was a 2,48-fold increase in strenuous physical activity, a 3,37-fold higher risk of standing for a long time, and a 2,61-fold higher risk of squatting in the third trimester of pregnancy.

The baby's weight and length, which are one of the outcomes of pregnancy, are influenced by physical activity and the food the mother eats during pregnancy. Usrina et al. (2021) said that energy and protein intake in the last trimester affected the baby's body length at birth. Therefore, nutritional support is essential if you want to benefit from physical activity without compromising the health of the mother and baby. The level of adequacy of nutrients, especially macronutrients, is essential when balancing inputs, namely nutrients supplied, with outputs, namely daily physical activity, which can affect pregnancy outcomes.

In addition, the amount of nutrients the mother consumes affects the pregnancy. In a study by Waksmańska et al. (2020), daily fat consumption was highest among pregnant women with arterial hypertension and lowest among women in good health. A Stevens et al. (2015) meta-analysis showed that protein supplementation significantly increased birth weight. Based on the above description, this study aimed to investigate the effects of physical exercise on pregnancy outcomes in mothers and infants, including blood pressure, fasting blood glucose levels, maternal amniotic fluid volume, and birth weight and length.

Based on the description above, researchers want to see that the relationship between physical activity, input in the form of nutritional adequacy levels, such as BMI prior to pregnancy and growing weight throughout pregnancy, are all connected to pregnancy outcomes, such as blood pressure, blood sugar, amniotic fluid volume, and the weight and length of the newborn infant.

Methods

The design used in This was an observational study on a cohort of 34 pregnant women who checked their pregnancies at an Integrated Health Post in the Ciampea District of Bogor. Observations were made on Pregnant women were observed from the third trimester until childbirth. The data were collected from August 2019 to March 2020.

The study obtained ethical approval from the Research Ethics Commission Involving Human Subjects (LPPM) IPB University, number 225/IT3.KEPMSM-IPB/SK/2019. The primary study's inclusion criteria for pregnant

women were as follows:1) 25–40 weeks (trimester 3), 2) 18–40 years old. Pregnant women were excluded if they had any of the following conditions:1) they were expecting twins, triplets, or more; 2) they were dealing with a chronic illness at conception; or 3) the fetus had a congenital disability. Subjects were selected using the purposive sampling method, including pregnant women who satisfied the inclusion criteria from several Integrated Health Posts in the Ciampea sub-district.

The control group consisted of 34 subjects from the main study. The minimum calculation for the subject of pregnant women uses a sample calculation formula for correlation analysis with the following formula (Hulley et al., 2013):

$$n = \left[\frac{(z_\alpha + z_\beta)}{\left(0.5 x ln\left[\frac{(1+r)}{(1-r)}\right]\right)}\right]^2 + 3$$

The type I error value (α) was set at 5%, yielding a Zα= 1,64, and the type II error (β) at 20% yielded a Zβ= 0,84. The expected correlation coefficient (r) of 0,45 results in a calculation of n (sample size) 29. Based on the calculation, it can be said that 34 subjects were sufficient for analysis.

Information on personal and socioeconomic variables was gathered through interviews and a questionnaire. Height was measured using a stature meter. Physical activity data were obtained using the Pregnancy Physical Activity Questionnaire (PPAQ) in Indonesia in the third trimester of pregnancy and processed to yield equivalent metabolic hours per week (MET-h/week). In the third trimester of pregnancy, consumption information was acquired through an interview with a meal recall performed 2 × 24 hours—the Mifflin-St. The Jeor formula determines Resting Energy Expenditure (REE) figures, which depend on each person's age, height, and optimum body weight. The calorie requirement during pregnancy calculated based on the RDA (Recommended Dietary Allowances), which is 300 kcal/day, is multiplied by the activity factor based on the body activity data gathered.

Blood samples taken from the mother's peripheral vein after fasting for at least eighth at one point in the third trimester of pregnancy were analyzed in the laboratory using the GOD PAP method to determine their glucose levels. Amniotic fluid volume is approximated by the single-deepest vertical pocket (SDVP) value through diagnostic sonography (USG), which measures the height of the most profound distance between the amniotic sac and the fetus. Data on maternal blood pressure during pregnancy, birth weight, and birth length were acquired from medical records in the form of MCH records (maternal and child health) owned by the mother and birth records by health personnel.

Data processing and analysis were performed using Microsoft Excel 2013 and the Jamovi software. The data were processed through descriptive analysis for each variable. Bivariate tests between the predictor and outcome variables were performed using Pearson's correlation. Based on the results of the bivariate test, the variables that met the regression requirements, especially the significance level <0,25, were then tested further for each outcome variable using Multiple Linear Regression with several assumptions as requirements by checking linearity, normality, independence, and homoscedasticity.

Result and Discussion

Nutrient Adequacy Level

Based on the RDA, 2019, it is recommended that there be an additional 300 kcal of energy per day in the third trimester of maternal pregnancy to support the growth of the rapidly developing fetus. The adequacy of nutrients per day is a determinant of nutritional status during pregnancy, which is very important to note because the study results show that pregnant women with chronic and acute energy deficiencies influence the baby's birth weight (Assefa et al., 2012).

On a 2 x 24 hours recall in the third trimester, it is known that the average intake of pregnant women is 1603 kcal, 54 grams of protein, 44,6 grams of fat, and 241,6 grams of carbohydrates. To better illustrate whether consumption is sufficient, daily consumption was compared to each individual's needs based on age, weight, height, and activity. The resulting level of nutrient consumption was expressed in percentage units. Participants

were considered sufficient for their daily needs if they met at least 80% of their nutritional adequacy level. The average adequacy per macronutrient is shown in Table 1.

Table 1. Consumption of nutrients by pregnant women

Variable	Mean ± SD	n	%
Energy Consumption	80,9 ± 23,9		
Deficit		18	52,9
Enough		16	47,1
Protein Consumption	73,1 ± 27,2		
Deficit		22	64,7
Enough		12	35,3
Fat Consumption	80,7 ± 34,6		
Deficit		21	61,8
Enough		13	38,2
Carbohydrate Consumption	81,2 ± 25,1		
Deficit		19	55,9
Enough		15	44,1

Looking at the average value, the level of consumption of macronutrients for pregnant women in the third trimester in this study was in a suitable category (enough), namely fulfilling 80% of daily nutrient needs, except for protein nutrients, which were still in the deficient category. Based on the percentage of the sample, it can be seen that the level of adequacy of macronutrients is generally poor because more than half of the respondents were still in the energy and nutrient deficits category.

Lack of adequate energy and nutrients can be attributed to several factors. According to the results of observations through the form recall, it was found that not all pregnant women added a snack between main meals, so the amount they consumed was reduced. Some pregnant women also choose to end their meals earlier in the afternoon and only consume snacks at night, which is thought to play a role in fulfilling their consumption levels. Research related to diet during pregnancy has been conducted by Schwedhelm et al. (2022), in which the average subjects consumed three meals a day, with approximately one per three subjects skipping one or more eating times. This study compared pregnancy and the postpartum period and found that skipping meals was associated with lower energy intake during pregnancy.

Physical Activity of Pregnant Women

Physical activity measured using the PPAQ is specifically related to physical activity in the third trimester.

The calculation is approached by calculating the energy expenditure in units of metabolic equivalents per hour per week. MET describes the amount of oxygen consumed at any time, indicating energy expenditure. The results of calculating the average MET hours/week for pregnant women are presented in Table 2.

Table 2. Physical activity of pregnant women based on hourly/weekly MET values

Physical Activity	Mean ± SD
Activity total value	187 ± 176
Based on intensity	
Sedentary	34,52 ± 35,9
Wispy	84,26 ± 54,8
Moderate	67,41 ± 121,8
Heavy	1,23 ± 2,2
By type of activity	
Household and caregiving	99,52 ± 81,5
Work-related	45,7 ± 86,5
Sport or exercise	5,2 ± 5,7

Looking at these average values, it can be seen that, in general, much energy is expended in light and moderate activities, little in sedentary activities, and minimal in strenuous activities. Based on the type of activity, the distribution of subjects spending energy on household activities is, on average, more significant than on activities related to work or sports. The results of descriptive statistics show that the physical activity of pregnant women is at a minimum of 18,3 to a maximum of 264, with an average of 187 MET hours/week.

Research by Papazian et al. (2020), using a similar questionnaire in the Middle East, presented an average MET value of 210,48 hours/week of total activity in the third-trimester group of pregnant women, which was higher than that in this study. Yin et al. (2019)classified the adequacy of sports physical activity as meeting an accumulation of at least 10 MET h/hour. Cohen et al. (2010) mention the minimum MET requirement of 8.5 MET h/week for light-moderate activities. Based on the cutoff mentioned, the participants' total physical activity has fulfilled adequacy, but sports activity or exercise is still less than the recommended limit. In this study, it was also known that things

were consistent with this research, namely, the greater number of subject activities in the type of household and parenting activities.

The Relationship between Nutrient Intake Levels and Physical Activity of Pregnant Women on Pregnancy Outcomes

Bivariate statistics were used to investigate which predictor variables were included in the regression model, both multiple and logistic. Using a significant value of $p < 0,05$, there was only a slight correlation with the r-value, whereas most other variables showed no significant value.

Total physical activity in the third trimester of pregnancy was associated with fasting blood glucose levels in the third trimester (r= 0,518; p= 0,002). Another related characteristic was that pre-pregnancy BMI correlated positively with fasting blood glucose levels in the third trimester, with a correlation (r= 0,503; p= 0,002). It means that the higher the values of the two predictor variables, the higher the fasting blood glucose levels of pregnant women. The results shown above also fulfil the requirements of $r > 0,45$ according to the requirements for the number of samples considered significant in this study.

Table 3. Results of multiple regression test predictor variables on fasting blood glucose levels

Predictor	Estimate	SE	t	p-value
Intercept	12,404	21,314	0,583	0,564
Pre-Pregnancy BMI	2,521	0,905	2,785	0,009*
Total physical activity	0,055	0,019	2,924	0,006*

*Significant at $p< 0,05$; $R^2 = 0,369$

Furthermore, a regression test was carried out to determine the effect of the predictor variable on the variable outcomes, in this case, fasting blood glucose level. Maternal BMI before pregnancy and physical activity during the third trimester significantly positively affected blood glucose levels (Table 3). Referring to Table 3, it can be interpreted that every increase in pre-pregnancy BMI by one unit can increase fasting blood glucose levels by 2,521 units per unit increase. Changes in the variance of this predictor can predict a 36,9% change in the variance of fasting blood glucose levels.

Several studies have reported similar results. Kim et al. (2021) wrote in their research that pregnant women carrying twins had fasting blood glucose levels increase with an increase in pre-pregnancy BMI. Mi et al. (2021) also stated that overweight subjects have a higher risk of fasting blood glucose levels (gOGTT-FPG) than subjects with a normal pre-pregnancy BMI.

A previous study by Harmon et al. (2011) stated that the glycemic levels of obese pregnant women were higher than those of women with a normal BMI at the beginning and end of pregnancy. Insulin regulation is the mechanism underlying an increase in glucose levels in the body. Both BMI before pregnancy and weight gain during pregnancy can affect insulin resistance (Genova et al., 2018). This study adds to the scientific evidence that pre-pregnancy BMI is related to fasting blood glucose levels. Thus, mothers or expectant mothers must pay attention to their nutritional status before starting a pregnancy.

A cohort study by Padmapriya et al. (2017) on pregnant women found that physical activity was related to decreased blood glucose levels two h post-prandial. However, it was not related to fasting blood glucose levels. A meta-analysis conducted by Boniol et al. (2017) concluded that physical activity interventions maintained for some time could reduce fasting blood glucose levels in pregnant women with gestational diabetes.

However, in contrast to this study, the results imply that total physical activity positively affects fasting blood glucose levels in the third trimester, which can potentially increase fasting blood glucose levels by 0,055 for every 1 unit increase in total physical activity. We suspect that these results are caused by different physical activity definitions and classifications, which influence variable outcomes in different ways.

The total physical activity used in this study included sedentary physical activity, which has the opposite benefit to moderate physical activity, as recommended. As described, research by Loprinzi et al. (2013) stated that sedentary activity increased fasting blood glucose levels (b= 0,02 [95% CI: 0,001-0,04]; p= 0,006). Research results by Wagnild et al. (2019) reported an increase in fasting blood glucose levels associated with total sedentary activity in pregnant women aged 24-28 weeks.

The weakness of this study is that it was not possible to separate the relationship between exercise intensity due to the use of the same subject, which can lead to multicollinearity, causing the regression results to be invalid. Further studies regarding the relationship between physical activity and fasting blood glucose levels in pregnant women in the third trimester need to be carried out by explicitly separating subjects based on the type and intensity of physical activity.

In general, the results of this study illustrate that even though total physical activity met the recommended amount, the lack of sports physical activity, which causes the proportion of other physical activities to increase in pregnant women in the third trimester, still has a negative impact in the form of an increase in fasting blood glucose levels. So it is worth noting.

Conclusion

The mother's nutritional status (BMI) before pregnancy affects the increase in fasting blood glucose levels, which need to be maintained during pregnancy so that it does not develop into gestational diabetes. Thus, expectant mothers must maintain their nutritional status before planning pregnancy. Physical activity is related to fasting blood glucose levels; therefore, pregnant women should reduce sedentary activity and increase the proportion of appropriate exercise during pregnancy.

This study did not find a significant relationship between the level of nutritional adequacy in pregnant women and pregnancy outcomes. Research on the relationship between consumption during pregnancy and pregnancy outcomes still needs to be conducted to contribute solutions to overcome the nutritional problems that might occur.

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