HOMA-IR Values in Pregnant Women Based on Body Weight

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ABSTRACT

Insulin resistance plays a crucial role in maternal metabolic adaptation during pregnancy. Underweight pregnant women have metabolic conditions potentially affecting insulin sensitivity and glucose homeostasis. The Homeostatic Model Assessment of Insulin Resistance (HOMA-IR) quantitatively measures fasting glucose and insulin levels, providing insights into metabolic health during pregnancy. This study aims to determine the differences in HOMA-IR between underweight and normal-weight pregnant women. The research employs a case design with a quantitative approach, using non-probability sampling techniques including quota and purposive sampling. The total sample comprises 24 participants, divided into 12 underweight pregnant women and 12 normal-weight pregnant women. Statistical analysis shows significant differences between groups: glucose levels ($p < 0.001$), insulin levels ($p = 0.018$), and HOMA-IR values ($p < 0.001$), all indicating significant findings ($p < 0.05$). The study found differences in glucose and insulin levels between the two groups. Insulin and glucose levels tended to be higher in underweight pregnant women, indicating insulin resistance involvement with higher HOMA-IR levels compared to normal-weight pregnant women. This study can serve as a basis for understanding the patho-mechanism in underweight pregnant women.

Keywords: HOMA-IR, insulin resistance, underweight pregnant woman, maternal metabolic health

INTRODUCTION

During pregnancy, the fetus develops physiologically in the mother's body. Normal pregnancy described as the baby and mother and gestational age are at the right time (40 weeks). Changes occur in the reproductive system such as the uterus, vagina/vulva, ovaries, breasts and other body systems of women carrying a fetus, such as the respiratory system, digestive tract, blood circulation system, urinary tract, skin system, and others. The pregnancy period is divided into 3 trimesters, where each trimester lasts approximately 13 weeks or 3 months. Physiological changes and adjustments during pregnancy will encourage the development and growth of the fetus in the womb. Hormones in the mother's body will be produced when the placenta develops, then cause changes in the uterus, ovaries, cervix, vagina, breasts, respiratory system, digestive tract, internal organs, urinary system, endocrine glands, cardiovascular system and musculoskeletal system (1,2).

In several other conditions, the mother's pregnancy can be accompanied by Chronic Energy Deficiency (CED) conditions due to an imbalance in intake with energy and protein needs and is generally characterized by upper arm circumference (UAC) < 23.5 cm in pregnant women. Based on the World Health Organization (WHO), the rate of anemia and CED in pregnancy globally is 35-75%, which is higher in the third trimester compared to the first and second trimesters (3). Pregnant women with CED and normal pregnant women are at risk of gestational diabetes, where the risks that can occur to the fetus are fetal death, macrosomia, shoulder dystocia, hypoglycemia, respiratory distress syndrome, and obesity in children. The risks for pregnant women are preeclampsia, delivery that requires caesarean section (C/S), and increased risk of type 2 diabetes mellitus (T2DM) in the future (4,5).

Homeostasis model assessment of insulin resistance (HOMA-IR) is an excellent parameter in detecting insulin resistance. Excess weight experienced before pregnancy, as well as weight gain that occurs during pregnancy, is associated with the development of gestational diabetes. Patients with a high Body Mass Index (BMI) and insulin resistance,

including a history of gestational diabetes, are at risk of developing gestational diabetes. However, a normal BMI without risk factors for gestational diabetes still has the same risk of developing gestational diabetes. Therefore, it is very important to detect gestational diabetes early in pregnancy in underweight pregnant women and take precautions to reduce the risks that can arise, such as preeclampsia which increases the risk of hypertension and organ damage, as well as long-term complications such as a higher risk of developing type 2 diabetes and cardiovascular disease in mothers and children. In underweight pregnant women, gestational diabetes can also cause stunted fetal growth (intrauterine growth restriction), increase the risk of premature birth, and metabolic disorders in the baby and the risk of stunting during the baby's development (6,7). Based on this background, this research was conducted to compare HOMA-IR levels in normal pregnant women with CED pregnant women, so that it can help detect symptoms of insulin resistance and prevent the occurrence of gestational diabetes, both in normal pregnant women and pregnant women with CED conditions.

METHOD

This research was experimental research using a case-control design and quantitative methods. The aim of this study was to determine the difference in HOMA-IR between pregnant women with underweight and normal weight. The population in this study were underweight pregnant women at Made and Simomulyo Public Health Centers. Sampling in this study used non-probability sampling techniques with quota and purposive sampling. The sample consisted of 12 underweight-pregnant women and 12 pregnant women with normal weight, which included in the control group. The inclusion criteria in this study were pregnant women registered at the Made and Simomulyo Public Health Center (gestational age of 28-40 weeks or 3rd trimester) and underweight pregnant women (BMI < 18.5) and normal pregnant women (BMI 18.5 -22.9). The exclusion criteria for this study were gestational age less than 28-40 weeks or less than the 3rd trimester and BMI > 22.9.

This research instrument used a blood sampling process in both research groups, then analysis was carried out using a glucometer to check blood sugar and Enzyme-Linked Immunosorbent Assay (ELISA) to check insulin. Lancets were used to prick the tip of subject's finger and get a drop of blood, which placed neatly to the test strip on the glucometer and the results should appear on the screen. To check the insulin level, blood was drawn using a syringe and stored in a collection tube for analysis. The ELISA test for insulin began by adding a blood sample to a tube containing special antibodies that bind insulin. After incubating and washing, a reaction agent was added which caused a color change if insulin was present. The intensity of the color formed was measured to determine insulin levels in the blood sample. Data were analyzed using SPSS version 28. The test used for blood lipids was Mann-Whitney and for insulin and HOMA-IR used the t-test.

RESULTS AND DISCUSSION

This study evaluates glucose and insulin levels to determine HOMA-IR, which is a frequently used indicator of insulin resistance conditions. It is expected that a comparison of the values obtained by this study will be able to explain potential differences in insulin resistance and its implications for maternal and fetal health, especially the condition of underweight mothers.

Table 1. Research Sample Identification Data

Data	Pregnancy	P
Age	Normal	0.515
	Underweight	0.093
Systolic BP	Normal	0.942
	Underweight	0.061
Diastolic BP	Normal	0.100
	Underweight	0.001

Data	Pregnancy	P
Body Weight (BW)	Normal	0.737
	Underweight	0.154
Body Height (BH)	Normal	0.791
	Underweight	0.216
BMI	Normal	0.461
	Underweight	0.000

Source: Primary data, 2024

Based on the results of the normality test, it was found that the diastolic BP and BMI data for the underweight group were declared abnormal because p < 0.05. Thus, for the comparison test of Normal vs. underweight in age demographics, systolic BP, BW and BH use the t-test, while diastolic BP and BMI use the Mann-Whitney.

Table 2. Demographic Data with BW of pregnant women (Independent Sample Test)

Data	Pregnancy
Age	0,139
Systolic BP	0,004
Diastolic BP	0,031
Body Weight (BW)	<0,0001
Body Height (BH)	0,118
BMI	<0,0001

Source: Primary data, 2024 (Age, Systolic, Diastolic BP, BW and BH with t-test, and Diastolic BP and BMI with Mann-Whitney)

Based on the results of the Normal vs. underweight comparison test on demographic data, it was found that the p-value for age = 0.139 and BH = 0.118, where > 0.05, which means there is no significant or no meaningful difference between age demographics and BH in normal pregnant women and underweight pregnant women. Meanwhile, the p-value for Systole = 0.004, Diastole = 0.031, BW = 0.000, and BMI = 0.000, where < 0.05, which means there is a significant or meaningful difference in the demographics of Blood Pressure, BW, and BMI between normal pregnant women and underweight pregnant women.

Research by Lakshmi, Jain, and Sharma explains the relationship between the age and nutritional status of pregnant women in South India. The results of this study show that younger pregnant women, especially teenagers (<20 years), have a prevalence of underweight of 35%, which is significantly higher than other age groups (p=0.01). The prevalence of underweight decreased by 35%, which was significantly higher compared with other age groups (P=0.01). The prevalence of underweight decreased to 25% at the age of 20-24 years (p=0.02), 15% at the age of 25-29 years (p=0.03), and 10% at the age of 30-34 years (p=0 .04), before increasing to 20% at age 30-34 years (p=0.02).

Educational factors and higher socio-economic status contribute to decrement in the prevalence of underweight in older age groups. Our study is slightly different from Lakshmi's, with the pregnancy rate being approximately overweight at the age of 29. The age range of underweight pregnant women in this study was from 23-33 years old, which is different when compared to Lakshmi's research, where the greatest incidence was in those under 20 years of age or teenagers. This condition explains that in Surabaya, the epidemiology of underweight pregnant women is more towards active reproductive age, and this results in significant effects and outcomes.

Table 3. Mann-Whitney Test on Glucose Levels for Both Groups

Samples	Glucose Mean ± SD	P
Normal-weight pregnant woman	98,08 ± 22,432	< 0,0001
Underweight pregnant woman	157,33 ± 25,567	

Source: Primary data, 2024

Based on the results of the normality test, glucose data in normal pregnant women was declared abnormal because the p-value was <0.05, so the Mann-Whitney test was used as the comparison test. Based on the results of the comparison test between Mann-Whitney normal and underweight Glucose, the p-value was 0.000, where <0.05, which means there is a significant or

meaningful difference in Glucose between normal pregnant women and underweight pregnant women. From the mean or median value, it is found that glucose in underweight pregnant women is higher than in normal pregnant women.

Blood glucose levels that are influenced by BW or BMI are supported by previous research conducted by Betharia et al, showing a fairly strong correlation between blood glucose and BMI in pregnant women, but this research does not specifically show the same conditions regarding comparisons between normal pregnant women and underweight pregnant woman. If blood glucose levels increase, BMI also increases in pregnant women who are overweight, so either an increase or decrease in blood glucose levels will also have an effect on BMI. This research provides the latest findings that increasing blood sugar levels can not only increase BMI but can also occur in underweight pregnant women and affect their BMI (8).

However, different results were found in research conducted by Rami et al, stating that BMI did not affect glucose levels in Sudanese pregnant women. This study explains the differences with other studies, due to possible genetic variations in the adiponectin gene, as well as race, and because gestational diabetes and BMI are the strongest independent determinants of the results of the Oral Glucose Tolerance Test (OGTT) in Asian women compared to Caucasians (9).

Table 4. T-test Analysis of Insulin in both groups

Sample	Glucose Mean ± SD	P
Normal-weight pregnant woman	19,57 ± 13,849	0,018
Underweight pregnant woman	34,55 ± 14,823	

Source: Primary data, 2024

Based on the results of the insulin data normality test in both normal and underweight pregnant women, it was declared normal because the p-value was > 0.05, so the comparison test utilized the t-test. Based on the results of the comparison test for normal vs underweight tests on insulin, the p-value was 0.018 (<0.05), which means there is a significant difference in insulin between normal pregnant women and underweight pregnant women. Insulin in underweight pregnant women is higher than in normal pregnant women.

In previous research conducted by Fakhrul et al, it was stated that the condition of weight disorders accompanied by gestational diabetes was related to insulin resistance and inadequate insulin secretion, but in women with a low BMI, there was a decrease in insulin secretion capacity which was the cause of gestational diabetes in the population of this study. In women who are underweight during pregnancy, insulin resistance can be caused by a combination of several factors. Major hormonal changes occur during pregnancy to support fetal growth, with hormones such as estrogen, progesterone, placental growth hormone, cortisol, and human placental lactogen naturally increasing insulin resistance. Low body weight in pregnant women can affect the production of leptin and adiponectin, hormones that influence insulin sensitivity, and decreased adiponectin is associated with increased insulin resistance. Malnutrition in low-birth-weight mothers can affect pancreatic function and insulin production, and deficiencies in micronutrients important for glucose metabolism, such as magnesium and zinc, can worsen insulin resistance. Additionally, low body weight can lead to increased oxidative stress and inflammation, which can affect insulin sensitivity by damaging pancreatic beta cells. Genetic and epigenetic factors also play an important role in the development of insulin resistance, where epigenetic changes due to maternal nutritional status can affect the function of genes related to glucose metabolism in the mother and fetus. In general, this condition increases the risk of pregnancy complications such as gestational diabetes and fetal growth disorders, which require close monitoring of blood sugar levels, proper nutrition, and appropriate medical intervention (10).

However, there is previous research that supports our research, conducted by Johnson et al., stating that pregnant women with excess body weight accompanied by diabetes have a significantly lower ratio of insulin from cerebrospinal fluid to plasma compared to those with underweight, in addition to the ratio of arterial insulin and umbilical cord vein to plasma in mothers with excess weight is also lower than those with underweight conditions. This research also shows that pregnant women with obesity accompanied by diabetes have relatively less insulin exposure when compared with pregnant women with less weight (11).

Table 5. T-test HOMA-IR analysis in both groups

Sample	Glucose Mean ± SD	P
Normal-weight pregnant woman	4,017 ± 2,713	< 0,0001
Underweight pregnant woman	13,94 ± 6,35	

Source: Primary data, 2024

Based on the results of the HOMA-IR data normality test for both normal and underweight pregnant women, it was declared normal because the p-value was > 0.05, so the t-test was used for the comparison test. Based on the results of the comparison test of the Normal vs underweight test on HOMA-IR, a p-value of 0.000 was obtained (<0.05), which means there is a significant or meaningful difference in HOMA-IR between normal pregnant women and underweight pregnant women. From the mean or median value, it is found that HOMA-IR in underweight pregnant women is higher than in normal pregnant women.

In research by Yanbeli et al, it was stated that an increase in HOMA-IR in early pregnancy is a risk factor for gestational diabetes mellitus which is significantly influenced by body weight, however, that study used the overweight category (overweight or obesity). Underweight pregnant women experience complex hormonal and metabolic changes. One of the main aspects is insulin production which may be insufficient or unbalanced. Insulin is a hormone that regulates glucose metabolism in the body. The bodies of underweight pregnant women are usually more sensitive to insulin or may experience insulin resistance, which means the body needs more insulin to control blood sugar. This imbalance can cause uncontrolled blood sugar, which in turn can affect fetal growth and the health of pregnant women. Monitoring and managing nutrition as well as strict blood sugar control are very important to reduce the risk of complications in this pregnancy (12).

Other research conducted by Siti et al., shows that an increase in body weight of 5 kg has an impact on increasing HOMA-IR 1.6 times, which indicates that BMI is related to HOMA-IR, so the HOMA-IR threshold needs to be adjusted to the value BMI, pre-BMI or first trimester BMI (13).

Regarding the condition of the third trimester, explained in previous research conducted by Chionuma et al., it was explained that non-diabetic Nigerian pregnant women at the end of the third trimester showed insulin resistance independently related to overweight, hypertension and hyperglycemia. Although several things are different from the research we conducted, it can be seen that similar conditions can occur in the third trimester, especially in the HOMA-IR evaluation of pregnant women (14).

From several previous studies, it is known that there is still no research that specifically supports the results found in this study regarding the HOMA-IR comparison between normal pregnancies and underweight conditions. However, this research can be used as a basis and comparison in conducting further research regarding the condition of HOMA-IR in normal pregnant women with underweight. The limitation of this research is that the number of samples and location is limited to only 1 sub-district, so further research is needed in other sub-districts to be able to represent the whole city of Surabaya.

CONCLUSION

Based on this research, it was found that there were differences between glucose and insulin levels in the two research groups. Insulin and glucose levels tend to be higher in underweight pregnant women. This increase proves the involvement of insulin resistance in underweight pregnant women, with the increase in HOMA-IR levels being higher than in normal pregnant women. This research can be used as a basis for pathomechanisms in underweight pregnant women. Based on this research, further research is needed to assess other laboratory markers that can be used as diagnostic instruments in further research and to add research locations in several sub-districts so that they can represent the situation of underweight pregnant women in Surabaya.

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