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Analysis of Glycosylated Hemoglobin (HbA1c) Level and Homeostasis Model Assessment Insulin Resistance (Homa-IR) Value in Obese Children

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ABSTRACT

Background: Obesity is the excessive growth of adipose tissue arising from chronic consumption of calories in excess of the individual's energy requirements. Insulin resistance is significantly associated with obesity and the risk of metabolic disease in children. Diabetes mellitus can be avoided by preventing insulin resistance in obese children. Homeostatic Model Assessment of Insulin Resistance (HOMA-IR) and glycated hemoglobin (HbA1c) can be indicators of insulin resistance.
Purpose: The aim of this study is to analyze HbA1c levels and HOMA-IR values in obese children.
Method: The research was a cross-sectional study. The research was conducted from November to December of 2021, targeting middle and high school students in Makassar, aged 11 to 18 years who had met the inclusion criteria. The research samples were divided into two groups, namely the group of obese children and the group of non-obese children.
Results: The research subjects consisted of 30 obese children and 30 non-obese children. There is no significant difference in gender and age. There is no significant difference between the HbA1c groups ≥ 5.7% in obese and non-obese children with p= 0.052. At the level of HOMA-IR ≥2.5, there is a difference in several obese (33.3%) and non-obese (3.3%) children with p= 0.008 and OR (95%) = 14.5 (1.718-122.39). The analysis of the correlation between HbA1c and HOMA-IR obtained p value = 0.012, with a value of r= 0.452.
Conclusion: There is a significant relationship between HbA1c and HOMA-IR in obese children. The higher the HbA1c level, the greater the risk of insulin resistance in obese children will be.

Keywords: HbA1c, HOMA-IR, Child, Obese.

INTRODUCTION

Obesity is a disorder or disease characterized by excessive accumulation of body fat tissue. Obesity in children is a global health issue that has been found in low- and middle-income countries, particularly in urban areas. In 2016, over 340 million children and adolescents aged 5 to 19 years were overweight and obese worldwide. The prevalence of overweight and obesity in the world increased by about three times between 1975 and 2016, where it was only 4% in 1975 and 18% in 2016. Overweight and obese children mostly remain obese into adulthood and develop non-communicable diseases such as diabetes and cardiovascular disease in young adulthood.1

Diabetes mellitus (DM) is a chronic metabolic disease characterized by an increase in blood glucose levels that causes serious damage to the heart, blood vessels, eyes, kidneys, and nerves.2 Most people with diabetes mellitus in children are type-1 diabetes, but recently the prevalence of type-2 diabetes in children has also

increased along with the increase in obesity.3 The magnitude of the manifestations of DM in obese children and adolescents often occurs without any symptoms, comorbidities and complications of insulin resistance are often found at the time of diagnosis or appear early during DM. Likewise, impaired glucose tolerance, which is an early sign of type 2 diabetes, does not yet show clinical symptoms of diabetes, so it is also known as the asymptomatic phase. Therefore, this study is important as an initial assessment of the occurrence of diabetes mellitus in obese adolescents.

High HbA1c levels and high HOMA IR values in obese children can be used as screening tools to detect insulin sensitivity and resistance early.4 Strong evidence suggests that the progression from prediabetes to type 2 diabetes can be delayed or prevented. Serious complications of diabetes mellitus can be prevented by early diagnosis and initiation of therapy.5 Therefore, it is necessary to analyze HbA1c levels and HOMA-IR values for early detection of insulin resistance in obese adolescents. To the author's knowledge, research to analyze HbA1c levels and HOMA IR values in obese and non-obese children is still limited and has never been conducted in South Sulawesi.

MATERIALS & METHODS

Study Design

This is an observational study with a cross-sectional study, that aims to analyze HbA1c levels and HOMA IR values in obese and non-obese children. This research was conducted in November–December 2021 on High School students in Makassar City. The sampling method is Cluster Random Sampling (total sampling). The inclusion criteria were: obese children aged 11 to 18 years who were enrolled in private junior and senior high schools in Makassar city, received parental consent to participate in the study. The exclusion criteria were: children who were known to suffer from diabetes mellitus, children who had a history of impaired liver and or kidney function, a history of hematological disease obtained through filling out questionnaires given to parents of students and physical examinations and routine blood tests, obese children on long-term corticosteroid treatment, cytostatics or other drugs, sick or absent children and therefore not participating in the study. Following the determination of weight and height, the body mass index was calculated to determine obesity, followed by an examination of HbA1C levels, GDP, and HOMA-IR values in obese and non-obese children. In carrying out this research, every action was taken after obtaining permission from the principal concerned, the parents of the research subjects and approval from the Commission on Ethics for Biomedical Research in Humans, Faculty of Medicine, Hasanuddin University Makassar.

STATISTICAL ANALYSIS

The data analysis was done using SPSS statistics for Windows, version 22.0 (IBM Co., Armonk, NY, USA). All data obtained were recorded in the research data form, then grouped based on the purpose and type of data and then the appropriate statistical method was selected. Mann Whitney and Chi Square tests were used to determine data characteristics such as frequency, distribution, mean, median (range), and standard deviation. The Chi square test and Fisher's exact test were used to determine HbA1c levels and HOMA-IR values in obese and non-obese children. The Pearson correlation test was used to determine the relationship between HbA1c and HOMA-IR.

RESULT

A total of 60 children participated in the study, 30 obese children and 30 non-obese children. Based on age, the mean age of the obese sample was 15.9 years with a range of 14 to 17 years, and the average age of the non-obese sample was 15.8 years with a range of 14 to 17 years. Based on gender,

the study sample for obese children was 11 male (36.7%) and 19 female (63.3%).

Based on GDP levels, the mean level of obese samples was 109.33 mg/dl with a range of 66 to 190 mg/dl, in non-obese children, it was 94.73 mg/dl with a range of 66 to 115 mg/dl. Based on HbA1c levels, the mean level in obese samples was 3.59% with a range of 2 to 6.2%, in non-obese samples it was 3.65% with a range of 1.9 to 5.3%. In obese samples, the mean insulin level was 9.75, with a range of 3.8 to 40, in non-obese samples it was 6.68, with a range of 3.2 to 11.4. Based on the HOMA-IR value, the mean value of the obese sample was 2.57 with a range of 1 to 9.1, while the non-obese sample was 1.58 with a range of 0.7 to 2.8.

There was no significant difference between the sex ratios in the obese group (Female: 63.3% / Male: 36.7%) and in the non-obese group (Female: 63.3% / Male: 36.7%) with a value of p=1,000. The mean age in the obese group (15.93±1.08 years) was not significantly different from the non-obese group (15.8±1.19). The mean BMI value was 25.55±4.30 in the obese group and 16.63±2.3 in the non-obese group.

In the HbA1c 5.7% group, there were 5 obese children (16.70%) while 0 non-obese children. in the HbA1c < 5.7% group there were 25 obese children (83.3%) while in the non-obese group there were 30 (100%). Based on statistical analysis, there was no significant difference with p value = 0.052.

In the HOMA-IR 2.5 group, 10 obese children (33.30%) were found, while 1 non-obese children (3.30%). In the HOMA-IR <2.5 group, there were 20 obese children (66.7%) while in the non-obese group there were 29 (96.7%). Based on statistical analysis, there was a significant difference with p value = 0.008 and OR value (95%) = 14.5 (1.718-122.39).

The p value for the correlation between HbA1c and HOMA-IR is 0.012, with an r value of 0.452, which is positive (the higher the HbA1c, the higher the HOMA-IR, or vice versa) and falls into the moderate correlation category (r = 0.4- 0.6).

DISCUSSION

In the study of Zehra, et al (2014), it was shown that HOMA-IR levels were correlated with age, especially the stage of puberty. The HOMA−IR cut-off value for insulin resistance in the prepubertal period was calculated to be 2.67 (sensitivity 88.2%, specificity 65.5%) in boys and 2.22 (sensitivity 100%, specificity 42.3%) in girls, and at puberty it was 5.22 (56% sensitivity, 93.3% specificity) in boys and 3.82 (77.1% sensitivity, 71.4% specificity) in girls.4,6 This is consistent with this research. In this study, children with HbA1c levels of 5.7% had a mean age of 15.40 ± 1.14 with a ratio of 3 boys (60.0%), and 2 girls (40.0%). In the HOMA-IR 2.5, the mean age of the children was 15.64 ± 1.12 years, with a ratio of 7 boys (63, 6%) and 4 girls (36.4%). Boys had more insulin resistance than girls, but there was no statistically significant difference, p=0.08.

In the study of Febri, E (2020) on 50 obese and non-obese adolescents, the average HbA1c level in obese adolescents was 6.1% higher than the average HbA1c level in non-obese adolescents, which was 4.7% with a p value = 0.000. The results in this study are different from previous studies. At HbA1c levels 5.7% there were 5 obese children (16.7%) and 0.0% non-obese children, but statistically this was not significantly different, with a p value = 0.052.

Zehra, et al. (2014) stated that the percentage of children with insulin resistance (HOMA-IR 2.5) aged 8–12 years was 14.3% in the obese group and 51.6% in the non-obese group. HOMA-IR was higher in the obese group than in the non-obese group. The percentage of subjects with HOMA-IR 2.5 was 44.3% in the obese group, while the percentage was only 16.7% in the non-obese group.4

In this study, in line with previous studies, the average value of the HOMA-IR level was higher in the obese group than the non-obese group, with an average value of 2.57, while in non-obese children the average HOMA-IR value was 1.58. The percentage of subjects with HOMA-IR 2.5 was 33.3%

in the obese group, while the percentage was only 3.3% in the non-obese group, with a p value = 0.008, OR value (95% CI) = 14.500 (1.718–122.395). Not all forms of obesity result in insulin resistance. The specific relationship between visceral adipose tissue accumulation and insulin resistance continues to be seen. Visceral adiposity correlates with excess lipid accumulation in the liver and results in cell autonomic disturbances in insulin signaling. Insulin resistance was significantly higher in the obese group compared to the non-obese group, according to previous studies obese children were at 14.5 times the risk of developing insulin resistance. In the study, it was found that children with normal HbA1c had increased levels of HOMA-IR. This can occur in children who have experienced early insulin resistance disorders that are only caused by impaired insulin secretion. In this study, there were no children with high HbA1c and low HOMA-IR, which means that there were no children with type I DM. This can occur in children who have experienced early insulin resistance disorders that are only caused by impaired insulin secretion. In this study, there were no children with high HbA1c and low HOMA-IR, which means that there were no children with type I DM.

The correlation between HbA1c levels and HOMA-IR values was found to be significant in this study with a p value = 0.012 and an r value = 0.452 (medium correlation strength). This is in line with Zehra et al. (2014), which state that children with HOMA-IR levels of 2.5 show a significantly higher HbA1c value compared to children with HOMA-IR levels <2. These results suggest that obesity-related insulin resistance plays a major role in the development of diabetes mellitus.4 Although HbA1c is used to diagnose type II diabetes, it is not known whether elevated HbA1c levels in the non-diabetic range can reliably reflect insulin resistance or impaired insulin secretion in individuals not being treated for diabetes.

CONCLUSION

There was no significant difference in HbA1c levels between obese and non-obese children. HOMA-IR values in obese and non-obese children have significant differences in HOMA-IR values ≥ 2.5. Obese children are at risk of 14.5 times to experience insulin resistance. HbA1c levels have a moderate correlation with HOMA-IR values in obese children.

Declaration by Authors

Ethical Approval: Approved

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