

# The Relationship between Obesity and Fasting Blood Glucose Levels in High School Teachers

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## Abstract

The prevalence of chronic and non-communicable diseases worldwide sharply increasing as an alarming rate including obesity and high level of glucose on blood which can lead to diabetes. The study aimed to look at the relationship between obesity and fasting blood glucose levels. The study was a cross sectional studies involving 57 teachers in Senior High School 5 Palu. The obesity was measure by BMI and glucose level was measured with Gluco Test. The study found a relationship between obesity and glucose level with  $p = 0.000$ .

**Keywords:** Obesity, Hyperglycemia, glucose blood level, teachers.

## Introduction

The prevalence of chronic and non-communicable diseases worldwide sharply increasing as an alarming rate including obesity and high level of glucose on blood which can lead to diabetes.<sup>(1)</sup> Obesity has been subjected as a leading public health problem worldwide.<sup>(2)</sup> Obesity is one of risk factors of many diseases including Type-2 diabetes, insulin resistance, <sup>(3,4)</sup> cardiovascular diseases, hypertension, hyperlipidemia, musculoskeletal overloads, chronic renal disease, heart failure and cancers.<sup>(5-8)</sup> Obesity occurs because of an imbalance between energy intake and energy output (energy expenditures) so that excess energy occurs and stored in the form of fat tissue. This excess energy can be caused by high energy intake or low energy output. The cause of obesity involves several factors such as genetic, lifestyle and psychological.<sup>(9)</sup> The prevalence of obesity remains increasing in both developing and developed countries.

This condition is followed by a high risk of increasing glucose levels on the blood or diabetes particularly type-2 diabetes. In the last 20 decade, the numbers of obesity have tripled in low-income countries which have imitated western life style.<sup>(1,8)</sup> In 2016, about 1.9 billion people aged 18 years and above were overweight and 650 million were obese.<sup>(10)</sup>

High fat concentration on human body can cause insulin retention and impaired glucose tolerance and certainly affect blood glucose levels. Blood glucose is a health term that refers to the glucose content in the bloodstream in the body, so it is at risk of pre-diabetes. Meanwhile pre-diabetes is a condition where blood sugar levels are higher than normal (normal blood glucose is 100-125 mg/dL, but not enough to diagnose diabetes but it can lead to diabetes when not handled properly.<sup>(1,9,11)</sup> Both obesity and diabetes is highly related to eating behavior. Palu is well known with its spicy and high fat food particularly its traditional foods.

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## Methodology

The study is an observational analytic study with a cross sectional study. This cross sectional study aimed to analyze the relationship between obesity to blood glucose levels among teachers of High School 5 (SMA 5) Palu City, Indonesia. The study applied total sampling to 57 teachers in the school were involved in the study. The data collected on November 2016 in

SMA 5 Palu during the school time. In prior to the data collection, we managed legal permission in the study location than conducted primarily induction of the study to all teachers. In the primarily induction, we gave the informed concern to participants for those agreed to participate in the study, we then asked them to fasting (min 8 hours) in the data collection day. The obesity was obtained by measuring Body Mass Index (BMI) using height gauge (Microtoise Statumeter) for body height and Weight Gauge for measuring body height. Additionally, blood glucose level was measured with using Gluco Test. Chi-square test was applied to look at the correlation between obesity and glucose level with 95% of confidentiality ( $\alpha = 0.05$ ).

### Results

#### a. Sample Distribution by Gender

**Table 1. Sample Distribution by Gender**

Gender	Frequency	Percentage (%)
Male	25	43.9
Female	32	56.1
Total	57	100

Resource: Primary Data. 2016

Table 1 showed the total participants based on their gender. There were 57 teachers participated in the study; 25 (43.8%) male and 22 (56.2%).

#### b. Distribution of BMI (Body Mass Index)

**Table 2. BMI (Body Mass Index)**

Variables	Obesity		Normal	
	N	(%)	N	(%)
Sex				
Male	5	31.25	20	48.7
Female	11	68.75	21	51.3
Total	16	100	41	100

Variables	Obesity		Normal	
	N	(%)	N	(%)
Age Group (Year)				
26-35	1	6.25	6	14.6
36-45	4	25	20	48.8
46-55	10	62.5	15	36.6
56-65	1	6.25	0	0
Total	16	100	41	100

Resource: Primary Data. 2016

The study found that there were 16 (28.1%) obese teachers and 41 (71.90%) non-obese teachers involved in the study. The highest incidence of obesity was experienced by teachers aged 46-55 years old (62.5%) and followed by teachers aged 36-45 years old (25%).

#### c. Distribution of Blood Glucose Level

**Table 3. Distribution of Blood Glucose Levels**

Variables	High (Hyperglycemia)		Normal	
	N	(%)	N	(%)
Sex				
Male	8	47	17	42.5
Female	9	53	23	57.5
Total	17	100	40	100
Age Group (Year)				
26-35	0	0	7	17.5
36-45	5	29.4	19	47.5
46-55	11	64.7	14	54
56-65	1	5.9	0	0
Total	17	100	40	100

Resource: Primary Data. 2016

17 participants of the study suffered high blood glucose levels (hyperglycemia), 47% and 53% were male and female respectively. 64.6% happened among teachers aged 46-55 years old and followed by teachers aged 36-45 years old (29.4%).

#### d. The correlation Between Obesity and Levels of Blood Glucose

**Table 4. The Correlation between Obesity and Levels of Blood Glucose**

BMI	Blood glucose level				p Value	Phi Cremmer	Risk Ratio
	High (Hyperglycemia)		Normal				
	N	%	N	%			
Obesity	13	76.5	3	7.5	0,000	0,702	8,3
Non Obesity	4	23.5	37	92.5			
Total	17	100	40	100			

Resource: Primary Data 2016

Table 4 above shows that teachers with obesity are more likely to suffer from hyperglycemia (76.5%) compared to non obese teachers (23.5%). This is also supported by the results of the Chi-Square test where the value of  $p < \alpha$  is = 0,000 which shows a relationship between obesity and hyperglycemia. Furthermore, to find out the strength of the relationship between the two variables, the Phi test is performed, from the statistical results found the Phi value of 0.702 and is in the range 0.501 to 0.750. This means that obesity has a strong relationship with blood glucose levels. Based on the results of this study there was a 8.3 risk ratio, so obese people were 8.3 times more likely to experience an increase in blood glucose levels compared to people who were not obese.

### Discussions

The chi-square correlation test found that there was a relationship between obesity and high blood glucose levels (hyperglycemia). This is based on the value of  $p < \alpha$  which is  $p = 0,000$ . A similar result was obtained by Novriana which states that there is a relationship between obesity and increased blood sugar levels. Obesity is a predisposing factor for the rise of blood sugar levels, this is due to several things, namely, beta cells of the island of Langerhans become less sensitive to stimuli or due to rising sugar levels and obesity will also reduce the amount of insulin receptors in cells throughout the body.<sup>(12)</sup>

According to Septa, the condition of obesity is influenced by the imbalance of excess energy intake rather than the excretion and lack of physical activity. Fat accumulation in fat cells resulting in fat cell hypertrophy (adipocytes) is the process of obesity begins. When adipocytes reach a certain level, there will be stimulation of the formation of new fat cells from the fat cells preadipocytes so that there is addition or hyperplasia and adjacent fat cells undergo hypertrophy. In adults it is proven that fat cell hypertrophy will cause increased inflammatory mediators such as IL-6 and TNF- $\alpha$  which are thought to inhibit phosphorylation of IRS-1 (insulin substrate receptor), so that the mechanism of action of insulin is disrupted and will cause insulin resistance.<sup>(13)</sup>

The primary research shows that time insulin resistance factors began to be dominant as a cause of hyperglycemia and various tissue damage. The high level of insulin resistance at this stage can also be seen from the increase in fasting blood glucose levels. This

is in line with what happens in liver tissue, the higher the level of insulin resistance, the lower the inhibitory capacity of the glycogenolysis and gluconeogenesis processes, and the higher the level of glucose production from the liver. Hyperglycemia that occurs in disorders of glucose metabolism due to impaired insulin performance (deficiency and resistance), then gives various effects of metabolism and other tissue damage directly or indirectly.<sup>(14)</sup>

Disorders of the mechanism of action of insulin can cause obstacles in glucose utilization and increase in blood glucose levels. This will cause glucose to remain only in the blood so that blood glucose levels increase. Clinically, the disorder is known as diabetes mellitus. (14) An increase in mRNA Lipopolysaccharides (LPS)-induced TNF- $\alpha$  factor (LITAF) and protein levels along with increased BMI indicate a parallel relationship between LITAF and metabolic disorders. According to the study, LITAF is activated in obese patients and contributes to the development of obesity which induces inflammation and insulin resistance, based on the fact that LITAF plays a role in the inflammatory process in regulating the expression of TNF- $\alpha$ , IL-6 and MCP-1 which results in insulin resistance, and TLR4, one of the LITAF receptors in macrophages can also be stimulated by free fatty acids, which can cause an inflammatory process in obese patients.<sup>(15)</sup>

Lipopolysaccharides (LPS) -induced TNF- $\alpha$  factor (LITAF) is a TNF- $\alpha$  description regulator, which should play a role in the immune mechanism against infection. The LITAF gene is significantly present in the lymph, lymph nodes, and peripheral blood leukocytes. TNF- $\alpha$  is a powerful trigger for proinflammatory adipocytokinin such as IL-6, MCP-1, leptin and PAI-1, and it is very involved in the inflammatory process in obese patients. The increase in TNF- $\alpha$  observed in the fatty tissue of obese patients shows a direct relationship to the emergence of insulin resistance in obese patients. Insulin binds and acts primarily through insulin receptors, as well as receptor insulinlike growth factor-1 (IGF-1). Cellular insulin action has a variable effect on the post-receptor pathway in target cells.<sup>(16)</sup>

According to Lee et al. (2007), obesity is the most common cause of insulin resistance associated with a decrease in the number of receptors and failure of post-receptors to activate tyrosine kinase which is a subunit b of insulin receptors activated when insulin binds to subunits a. Activation of this complex will

activate autophosphorylase and insulin-mediated action to control blood sugar levels. Failure to deliver signals to regulate blood sugar levels causes interference with blood glucose levels.<sup>(16-18)</sup>

Weight loss has a beneficial effect on comorbid obesity. Even a weight loss of 5 to 10 percent of the initial weight can result in significant health improvements. Although no retrospective studies have shown changes in mortality rates with weight loss in obese patients, with weight loss, a reduction in these risk factors is thought to reduce the development of type 2 diabetes and cardiovascular disease. There is strong evidence that weight loss in obese individuals and overweight reduces risk factors for diabetes and cardiovascular disease. Other strong evidence also shows that weight loss can reduce blood pressure in overweight normotensive individuals and hypertension; reduce serum triglycerides and increase HDL-cholesterol and generally result in a reduction in total serum cholesterol and LDL cholesterol. Weight loss can also reduce blood glucose levels in overweight and obese individuals without diabetes; and also reduce blood glucose levels and HbA1c in some patients with type 2 diabetes.<sup>(19)</sup>

### Conclusions

A strong correlation between obesity and high level of blood glucose among teacher in Senior High School 5 Palu. 16 teachers suffered obesity and 13 of them were hyperglycemia with  $p = 0.000$  or  $p \leq 0.05$ .

**Conflict of Interest:** I declare that there is no conflict of interest related to the study.

**Ethical Clearance:** The study has been approved by Ethical Commission of Faculty of Medicine, Universitas Tadulako, No. 1107/UN 28.1.30/KL/2016.

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### References

- Hossain P, Kavar B, El Nahas M. Obesity and Diabetes in the Developing World — A Growing Challenge. *N Engl J Med*. 2007 Jan 18;356(3):213-5.
- Agrawal N, Agrawal MK, Kumari T, Kumar S. Correlation between Body Mass Index and Blood Glucose Levels in Jharkhand Population. *Int J Contemp Med Res*. 2017;4(8):1633-6.
- Martyn JAJ, Kaneki M, Yasuhara S. Obesity-induced Insulin Resistance and Hyperglycemia: Etiologic Factors and Molecular Mechanisms. *Anesthesiology*. 2008 Jul;109(1):137-48.
- Bano G. Glucose homeostasis, obesity and diabetes. *Best Pract Res Clin Obstet Gynaecol*. 2013 Oct;27(5):715-26.
- Bhaskaran K, Douglas I, Forbes H, dos-Santos-Silva I, Leon DA, Smeeth L. Body-mass index and risk of 22 specific cancers: a population-based cohort study of 5.24 million UK adults. *The Lancet*. 2014 Aug;384(9945):755-65.
- Na YM, Park HA, Kang JH, Cho YG, Kim KW, Hur YI, et al. Obesity, Obesity Related Disease, and Disability. *Korean J Fam Med*. 2011;32(7):412.
- Sturm R, Ringel JS, Andreyeva T. Increasing Obesity Rates And Disability Trends. *Health Aff (Millwood)*. 2004 Mar;23(2):199-205.
- Bhurosy T, Jeewon R. Overweight and Obesity Epidemic in Developing Countries: A Problem with Diet, Physical Activity, or Socioeconomic Status? *Sci World J*. 2014;2014:1-7.
- Suyoto S. Pathophysiology of Diabetes mellitus in the book *Integrated Diabetes Management as a Guide to Management of Diabetes Mellitus for doctors and diabetes educators*. Faculty of Medicine, Universitas Indonesia; 2011.
- WHO. Obesity and overweight [Internet]. World Health Organization (WHO); 2018 [cited 2019 Apr 23]. Available from: <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight>
- Nangge M, Masi G, Oroh W. The relationship between obesity and diabetes mellitus in the territory of Ranomut Health Centre in Manado City. *Ejournal Keperawatan EKp* [Internet]. 2018;6(1). Available from: [https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=2ahUKEwin5drS\\_-XhAhXWR30KHXEGBt0QFjABegQIBBAC&url=https%3A%2F%2Fjournal.unsrat.ac.id%2Findex.php%2Fjkp%2Farticle%2Fdownload%2F19465%2F19016&usg=AOvVaw1yZVPe4nKWE35W8eU5cSSm](https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=2ahUKEwin5drS_-XhAhXWR30KHXEGBt0QFjABegQIBBAC&url=https%3A%2F%2Fjournal.unsrat.ac.id%2Findex.php%2Fjkp%2Farticle%2Fdownload%2F19465%2F19016&usg=AOvVaw1yZVPe4nKWE35W8eU5cSSm)
- Justitia NL. The relationship between obesity and glucose blood levels increase among junior high school 3 Medan. 2012;
- Triani SK. The differences of main time glucose blood level among obese and non obese adult in Jebres Sub-district, Surakarta City. 2016.
- Suzuki H, Fukushima M, Usami M, Ikeda M,

- Taniguchi A, Nakai Y, et al. Factors Responsible for Development From Normal Glucose Tolerance to Isolated Postchallenge Hyperglycemia. *Diabetes Care*. 2003 Apr 1;26(4):1211–5.
15. Ji Z-Z, Dai Z, Xu Y-C. A new tumor necrosis factor (TNF)- $\alpha$  regulator, lipopolysaccharides-induced TNF- $\alpha$  factor, is associated with obesity and insulin resistance. *Chin Med J (Engl)*. 2011 Jan;124(2):177–82.
  16. Handelsman Y, Bloomgarden ZT, Grunberger G, Umpierrez G, Zimmerman RS, Bailey TS, et al. AMERICAN ASSOCIATION OF CLINICAL ENDOCRINOLOGISTS AND AMERICAN COLLEGE OF ENDOCRINOLOGY – CLINICAL PRACTICE GUIDELINES FOR DEVELOPING A DIABETES MELLITUS COMPREHENSIVE CARE PLAN–2015—EXECUTIVE SUMMARY: Complete guidelines are available at <https://www.aace.com/publications/guidelines>. *Endocr Pract*. 2015 Apr 2;21(4):413–37.
  17. Shimomura T, Wakabayashi I. Inverse associations between light-to-moderate alcohol intake and lipid-related indices in patients with diabetes. *Cardiovasc Diabetol*. 2013;12(1):104.
  18. Lee KR. Measurement of plasma triglyceride and total cholesterol in sudanese patients with controlled and uncontrolled type 2 diabete. *Natl Lipid Assoc*. 2007;
  19. Bray GA. *The metabolic syndrome and obesity*. Totowa, N.J: Humana Press; 2007. 303 p.