ORIGINAL ARTICLE

Neck Circumference and Waist to Hip Ratio Related to Fasting Blood Glucose Levels in Security Officers

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ABSTRACT

Introduction: Diabetes Mellitus is a metabolic disease that occurs due to several risk factors, including obesity and occupation. Measurement of neck circumference, waist circumference, and waist to hip ratio (WHR) are obesity indicator methods that are suspected to be related to diabetes mellitus. This study aimed to determine the correlation between neck circumference and WHR with fasting blood glucose levels in security officers. **Methods:** A cross-sectional study included 92 male security officers aged 20 – 45 years chosen with purposive sampling methods from Diponegoro University. All subjects were asked to fast and take no medications for the previous 8 hours before their venous blood plasma samples were taken for testing. Subjects were categorized based on their nutritional status, namely Body Mass Index (BMI), Neck Circumference and Waist to Hip Ratio (WHR). Neck circumference and WHR were measured using a non-stretchable plastic replicated twice to obtain the mean value. Data were analyzed using Spearman's test. **Results:** This study found that 9.8% subjects were categorized as obese (BMI ≥ 30 kg/m^2), subjects who had a high fasting blood glucose level (≥ 110 mg/dl) was found 4.3% or about 4 male security officers , 41.3% subjects had a neck circumference ≥ 38 cm and 29.3% subjects had WHR ≥ 0.9. **Conclusion:** There was a positive correlation between WHR and blood glucose levels (r=0.254 and p=0.015). Also, neck circumference was found to be significantly associated with blood glucose (r=0.454 and p<0.001).

Keywords: Fasting blood glucose levels, Neck circumference, Security officer, Waist to hip ratio.

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INTRODUCTION

Diabetes Mellitus (DM) may be a metabolic syndrome disease characterized by a fasting blood glucose (FBG) of more than 126 mg/dL. The International Diabetes Federation (IDF) is predict to extend from 382 million in 2013 to 592 million in 2035. According to the 2017 IDF Atlas also reports that Indonesia is that the sixth country within world after China, India, the United States, Brazil and Mexico with the amount of individuals with diabetes aged 20 - 79 years of around 10.3 million people.(1) Diabetes Mellitus is caused by several risk factors, one of them is obesity or Body Mass Index (BMI) ≥ 27.(2) Obesity is defined as abnormal or excessive fat accumulation with evidence BMI over 25 considered overweight and BMI over 30 is obese. Data from Riset Kesehatan Dasar Indonesia 2018 showed 13.6% adults over 18 years were overweight and 21.8% was obesity. (3) Obesity could be a risk factor for diabetes mellitus also, work has an important role to increase blood glucose levels.(4)

Security officer is a job that has different characteristics compared to a job as a civil servant or a private employee in an office. Several studies have shown that working as a security officer has a high risk of experiencing Diabetes Mellitus Type 2 (DMT2). This is because security officers have a higher level of stress because of the occupation they had. Security officers have a high responsibility to maintain the work area and the safety of people who are in the area. In addition, security officers also have an unhealthy lifestyle such as having an irregular diet such as skipping breakfast, lack of time to rest or sleeping and an unhealthy lifestyle, smoking and drinking soft drinks. An authors from research in Serbia in 2019 proved that there was a significant relationship between the level of job stress and the health status of security personnel. Furthermore, it was reported 399 security officers aged 25 to 65, 33.8% had DMT2 while 44.1% of them was

obesity.(5) Therefore, to determine the risk factors for diabetes, which is obesity, it is necessary to monitor the nutritional status of the security officer. Monitoring nutritional status can be done by anthropometric measurements such as Body Mass Index (BMI), neck circumference, waist circumference, Waist to Hip Ratio (WHR) and others.(6)

Neck circumference as example is anthropometric measurement that more easy to do. Subcutaneous fat in the neck is a fat store located separately from the visceral adipose tissue compartment. Visceral fat can be a marker for free fatty acids, but not as a major source of circulation. This shows that free fatty acids circulating in the hepatic portal vein are not only from visceral fat, but also from subcutaneous fat, one of which is in the neck.(7) Based on a 2016 study with student subjects, it proves that neck circumference has a more significant relationship with the incidence of pre-diabetes compared to BMI, waist circumference, and percent fat. A previous study concluded that there was a significant relationship between neck circumference and blood glucose levels or could be concluded the larger a person's neck circumference, the higher his blood glucose levels.(8)
In addition to neck circumference, anthropometric measurements of WHR would be a good indicator of abdominal obesity and the risk of metabolic syndrome for pre-diabetes patients.(9) A recent research in Korea showed WHR can be a better indicator of metabolic syndrome disease than other anthropometric indicators of obesity. Previous study in Aceh 2016, proving that the waist-to-hip ratio has a positive relationship with blood glucose levels. Researchers from this study stated that WHR is one of the factors that causes an increase in blood glucose levels but is not a very determining factor. (10)

Research that focuses on anthropometric measurements as an indicator of the risk of obesity and diabetes mellitus remains very rarely conducted on security officers who are at high risk of developing metabolic disease. Based on the research background that has been mentioned, this study aims to determine the correlation between anthropometric measurements within the sort of neck circumference and WHR related with blood glucose levels in security officers that are at high risk for Obesity and Diabetes Mellitus.

MATERIALS AND METHODS

A cross-sectional study was conducted at the Diponegoro University, Indonesia. Data were collected from July to September 2020 by carrying out the COVID-19 health protocol. It was already reviewed and approved by the Ethical Committee from Faculty of Medicine, Sultan Agung Islamic University and given approven number Indonesia No. 232 / VII / 2020 / Komisi Bioetik.

The subjects obtained were 92 people with inclusion criteria were male security officers aged 20-45 years, not currently taking oral hypoglycemic drugs, and willing to join as research subjects. The study exclusion criteria were not attending when data collection and resigning during the study.

The dependent variable of this study is fasting blood glucose levels. Measurement of blood glucose levels is done by taking blood through a vein and examined by the hexokinase method. Fasting blood glucose levels are classified as normal if less than 110 mg / dl. The results of measuring fasting blood glucose levels are mg / dL with a ratio scale.(11)

The independent variables of this study were neck circumference and WHR. Neck circumference is measured using a measuring tape or metline with an accuracy of 0.1 cm, subject standing with calm position and the head facing straight ahead. Measurement of neck circumference in male subjects just below the laryngeal prominence (Adam's Apple). Neck circumference is categorized as normal if less than 38 cm. Measurement results of neck circumference in centimeters (cm) and ratio scale.(12) The waist circumference ratio is arranged by measuring the waist circumference and hip circumference using a metline with an 0.1 cm accuracy, then calculated using the formula for waist circumference in centimeters (cm) divided by hip circumference in centimeters on a ratio scale. WHR is categorized as normal if less than 0.90. The measurement of neck circumference, waist circumference, and hip circumference obtain two times repeated to find the mean values.(13)

Confounding variables of this study were the amount of energy intake, carbohydrate, protein, fat intake, stress factor scores, and physical activity. Data intake of energy, carbohydrate, protein, and fat obtained from questionnaires recall 3x24 hours with a pattern of one day morning shift, night shift, and break time. The result of measuring the adequacy of food intake for energy, carbohydrates and fat is a percentage (%) with a ratio scale. Physical activity variables were assessed based on filling out the IPAQ-short form questionnaire, classified score was low less than 900, moderate between 900 - 1500, and high more than 1500.(14) The unit of the physical activity variable was MET-minutes/ week with a ratio scale. Stress factors were assessed using the OSI-R questionnaire containing 25 questions with a ratio scale. The categorized of stress factor are low score is 25 - 58, moderate 59 - 92 and high above 93.(15)

The research procedure began with filling informed consent and personal identity containing the name, address, date of birth and age and whether there is a history disease. Furthermore, anthropometric measurements in the form of weight, height, neck circumference, waist circumference and hip circumference were carried out

directly. Laboratory test of fasting blood glucose levels began with the subject fasting for at least 8 hours. The final stage in this research was interviewing subject using a 3x24 hour recall questionnaire interview, IPAQ short-form and OSI-R with the help of google form during pandemic.

Data analyses was performed using a computer program called SPSS. Simply enter data into the frequency table to describe age, neck circumference, BMI, WHR, fasting blood glucose levels, amount of food intake (energy, carbohydrates, protein, and fat), physical activity, and stress factor scores. Since there are more than 50 subjects and the significant difference $p > 0.05$ so we decided to use Kolmogorov Smirnov as the normality test. Because the data are not normally distributed, we used Rank Spearman's bivariate to analyze the correlation between dependent and independent variables. (12)

RESULT

Characteristics of the research participants

The nutritional status of research subjects belonging to the obesity or BMI more than 25 kg/m^2 category was 9.8% or 9 security officers and the category overweight or BMI 23 – 24.9 kg/m^2 was 35.9%. Most of the subject had a normal nutritional status based on BMI 18.5 – 22.9 kg kg/m^2 about 52.2 % or 48 security officers. (13) In total, 92 security officers, 38 of them had neck circumference more than 38 cm (at risk) and 27 subjects had WHR more than 0.90 (at risk). Male securities who had high glucose levels were only 4.3% or 4 subjects. (Table I) Subject with normal blood glucose levels less than 110 mg/dl was found 95.7% or 88 security officers. From Table II, it can be summary that the security officers have adequate levels of energy, carbohydrate, protein and fat intake which are classified as deficits. The median value of the stress factor variable of 73 is still classified as a moderate stress level. Physical activity variable was also classified as moderate. (Table II)

Table I Prevalence independent variables

Category	WHR	Neck Circumference
Normal (<0,9)	70.7 % (65)	58.7 % (54)
Obesity (≥ 0,9)	29.3 % (27)	41.3 % (38)

Table II Characteristics of research participants

Characteristics	Median (Min – Max)
Age (years)	28 (20 – 45)
BMI (kg/m^2)	23.93 (18,21 – 40,88)
Neck circumference (cm)	38.05 (31 – 44)
Waist to Hip Ratio (WHR)	0.88 (0.8 – 1.07)
Fasting Blood Glucose (mg/dL)	84.5 (68 – 117)
Adequacy levels of energy intake (%)	58.97 (18.9 – 117.4)
Adequacy Level of Carbohydrate Intake (%)	56.6(20.8 – 138.3)
Adequacy of Protein Intake (%)	53.9 (15.8 – 132.7)
Adequacy of Fat Intake (%)	63.8 (18.5 – 130.6)
Stress factor (score)	73 (29 – 125)
Physical Activity (MET – minutes/week)	1423,5 (198 – 8106)

Neck circumference and WHR were the variables that significantly associated with blood glucose levels with p –value <0.001 and p –value 0.015 in bivariate analysis. But, no association was found between adequacy of energy intake, carbohydrates, fat, protein, BMI, stress levels, and physical activity with fasting blood glucose. (Table III)

Table III Bivariate Analysis between variable and Fasting blood glucose levels

Variable	R	p – value
Neck Circumference	0,454	< 0,001**
WHR	0,254	0,015*
BMI	0,032	0,761
Adequacy levels of energy intake	-0,037	0,730
Adequacy levels of carbohydrate intake	-0,049	0,646
Adequacy levels of protein intake	-0,016	0,883
Adequacy levels of fat intake	0,040	0,706
Stress factor	0,023	0,830
Physical Activity (MET – minutes/week)	0,101	0,340

*p – value <0.01

** P – value <0.05

DISCUSSION

Most of the security guards from the research had an obese as their nutritional status. Obesity is the most important risk factor for diabetes mellitus. A person with an obese nutritional status has a 2.9 higher risk of developing diabetes mellitus.(10) According to a 2012 study cases, report that someone with an obese nutritional status has a greater risk of diabetes mellitus than other diseases. The number of type 2 diabetes mellitus has a significant relationship with the increasing prevalence of obesity where about 80% of DM sufferers have obesity nutritional status.(16)

Neck circumference found to be a better indicator of upper body subcutaneous fat than BMI. This is supported by the results of the study which did not find a significant connection between Fasting Blood Glucose and Body Mass Index since the p-value was>

CONTINUE

0.05. According to the results of the study, 4 subjects with high fasting blood glucose levels all had normal nutritional status according to BMI. However, 4 subjects who had high blood glucose levels, 3 of whom had high neck circumference ≥ 38 cm followed by an increase value both neck circumference and fasting blood glucose levels. A 2019 study in Thailand, determined neck circumference ≥ 38 cm as one way to identify patients with central obesity in pre-diabetic patients.(17) Recent research in 2019 in Chilean has proven that neck circumference features a significant relationship with blood glucose, insulin resistance, diastolic systolic blood pressure, Free Fatty Acids (FFA), LDL (Low-Density Lipoprotein) cholesterol, and triglycerides were inversely regarding HDL (High-Density Lipoprotein) cholesterol.(18) Another study in China in 2019 also exposed that neck circumference might be used as another anthropometry regarding to metabolic disorders such as insulin resistance. Additionally this China study cases states that neck circumference has a stronger relation with the risk of metabolic disease than BMI.(19) There are several types of fat found in the neck circumference including subcutaneous neck circumference (NATsc), posterior neck circumference (NATpost), and perivertebral neck circumference (NATperivert). NATsc is a storage area for excess fat in adults who are overweight and obese. NATsc and NATpost are a sign of someone who has an increase BMI, it can be a marker or predictor of an increasing level of their metabolic profile. Subcutaneous fat or NATsc has a major role in the incidence of metabolic disease, the accumulation of fatty acids in NATsc affects the incidence of insulin resistance, hepatic VLDL production and endothelial dysfunction. The increase in free fatty acids will inhibit insulin work affecting failure blood glucose entering cells and triggers hepatic glucose production through the process of gluconeogenesis.(20) The accumulation of subcutaneous fat in the neck can also occur due to the inability of other subcutaneous fats to protect internal organs such as the internal organs, heart, kidneys and pancreas. Therefore, neck circumference measurement can be an alternative anthropometric measurement to determine obese security guards with a high risk of fasting blood glucose levels compared to nutritional status measurements using BMI.(21)

WHR is a measuring tool to measure the distribution between subcutaneous fat and inner-abdominal fat or we can say visceral fat which indirectly be used as a predictor of glucose intolerance. Based on this study, it was found that the higher WHR, the higher the blood glucose level at the security officers.(16 p. 100) A 2016 study explained that the higher WHR of employees at Puskesmas Sakti Pidie, the higher their blood glucose levels. This proves that the amount of body fat can describe the state of carbohydrate metabolism in the body. Increasing the amount of fat in the body can lead to insulin resistance, which is one of the main factors causing high level of blood glucose levels. However, this study cases report a weak correlation between WHR and blood glucose levels in the health center employees. This is because there are other factors that influence the research. However, another study in 2013 proved that WHR had a more significant relationship when compared to BMI with fasting blood glucose levels in female students. WHR is an anthropometric measurement that can describe the distribution of body fat to determine abdominal obesity.(10)

Waist Circumference most likely represents a high level fat deposits in the body whereas hip circumference represents a protective factor against cardiovascular events. Pelvic circumference itself has a negative relationship with the incidence of diabetes, hypertension and metabolic disease, which means that any decrease in subcutaneous fat in the pelvic circumference will increase WHR and also possibility future disease like diabetes, hypertension and cardiovascular disease. An increase hip circumference is closely related to a great bone skeleton and reflects an increase muscle mass. Hip circumference can also reflect accumulated femoral fat mass.(10)

Cardiovascular risk factors will appear if WHR ≥ 0.90 in men. Therefore, fat accumulation in WHR is 3 times more likely to reflect the presence of fat distribution in the abdomen compared to BMI.(22) So it can be said that the use of BMI as an anthropometric measuring tool has a small sensitive to describe or define abdominal obesity when it came with other anthropometric methods likely WHR and neck circumference. The result of bivariate analysis of this study confirm a weak relationship with p-value = 0.015, which means that the higher the security guard's WHR, the higher the fasting blood glucose level.

However, in this study, the correlation coefficient of WHR with fasting blood glucose levels was still smaller when compared to neck circumference. A meta-analysis study in 2007 showed a little correlation coefficient of WHR rather than waist circumference. This is because several studies from the meta-analysis state that the use of WHR as an indicator of obesity has a confusing biological interpretation, and has a lower sensitivity to weight gain and different variability for each age, sex and ethnic group of the study. Although WHR has a lower correlation, WHR is still considered to have the same role as waist circumference and BMI as a predictor of DM disease.(23)

The level of adequate food intake which was the confounding variable in the study was found to have no significant relationship because the p-value > 0.05. This can be because food intake does not directly affect fasting blood glucose levels but directly affects blood glucose levels at any time. The results food recall for 3 days have not been able to describe the food intake

directly which can affect fasting blood glucose levels. Fasting blood glucose levels are not only influenced by the quantity of energy, carbohydrate, fat and protein intake but also by the type of food intake with a high glycemic index and the adequacy of the intake for what it should be.(24) This is in contrast to research in China which states that carbohydrate intake and fat intake affect glucose metabolism in the blood. This study in China proves that patients suffering from diabetes have a history of high intake of energy, carbohydrates, fats and protein. Patient with abnormal diet history to be expected has a higher issue risk of obese and metabolic syndrome.(24)

This also happened to the physical activity variable which had minor relationship with blood glucose levels or p-value > 0.05. The results of this study are in line with research in Jakarta in 2018 which assessed insignificant correlation between physical activity and blood glucose levels in the elderly.(25) Based on the research results, it was found that of the 88 security guards who had normal blood glucose levels, 52.8% of the security officers had physical activity that was classified as low - moderate. The absence of a relationship might be because of the fact that the majority of fasting blood glucose levels and homogeneous security guard physical activity were classified as normal. Diabetes Mellitus patients could act on their blood glucose level with a high levels of physical activity. A Study in 2018 found that moderate – high intensity physical activity may possibly affects blood glucose levels by increasing insulin sensitivity than glucose intake which carried into cells increases and reduces blood glucose levels in diabetic patients. (26)

Stress factor is one of the variables that can affect fasting blood glucose levels. The stress factor is meant to come from a person's work load. Security guards have job responsibilities to guard their work area to avoid any possible security incidents that may occur. The workload and responsibility of the security guard are risk factors for increased blood glucose levels.(5) However, the study result was no consequential connection between stress factors and fasting blood glucose levels in security guards because the p-value was > 0.05. This is because stress factors cannot directly affect a person's fasting blood glucose levels but are also influenced by workload. Security guards in this study have different workloads because they are divided into different group, morning-shift and night-shift. The difference in the division of this shift system can be one of the causes of the difference in stress levels for security guards. This contradicts research in Manado in 2017 which proved that high levels of stress can trigger blood glucose levels in the body to increase, so that the higher the level of stress experienced by a diabetic patients, the worse the DM will be.(27)

CONCLUSION

From the research, we can find that there is a weak correlation between neck circumference and WHR with fasting blood glucose levels among security officers. Further research is required to assess the sensitivity and accuracy of neck circumference and WHR as obesity predictors. A Male security guard can measure neck circumference and waist-to-hip ratio to monitor their nutritional status and diabetes mellitus screening test.

ACKNOWLEDGEMENTS

This project was funded by Research and Development Grant, Faculty of Medicine, Universitas Diponegoro 2020. The authors of this research would like to reveal their best gratitude to all security officers and the participants for their cooperation and contributions towards this study.

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