Higher BMI Increased the Risk of Complications among Pre-Elderly with Type 2 Diabetes Mellitus

Chatarina Anugrah Ambar Purwandari¹, Clara Cahyaning Wishesa¹, Bambang Wirjatmadi¹, Trias Mahmudiono¹*

¹Department of Nutrition, Faculty of Public Health, Airlangga University

*Corresponding author:
TriasMahmudiono
PerumMerpatiKehutanan
JI Ebony B-2 Rt32 Rw12 DesaPabean
KecamatanSedati, KabupatenSidoarjo (61253)
Phone Numbers: +62-815-5421-9427
E-mail Address: trias-m@fkm.unair.ac.id

Abstract

Background: Diabetes mellitus is a group of metabolic diseases with hyperglycemia due to abnormal insulin secretion, insulin action, or both. Risk factors for complications of diabetes mellitus are age, sex, duration of suffering, drug consumption, and BMI. Aims: This study aims to analyze anthropometric parameters of BMI that influence the occurrence of complications of Type 2 Diabetes Mellitus in the pre-elderly in Klampis Ngasem Health Center, Surabaya. Settings and Design: This study used a case-control design with patients registered at outpatient and pre-elderly Integrated Service Postmembers as the population. The sample size was 30 pre-elderly aged 45-59 years. Case group criteria are diagnosed with Type 2 Diabetes Mellitus with complications, while criteria for the control group are diagnosed with Type 2 Diabetes Mellitus without complications. Methods and Material: Data collection techniques used anthropometric measurements and were carried out during the Elderly Integrated Service Post in March 2020. Statistical analysis used: Data analysis used logistic regression. Results: The significance value of anthropometric parameters of BMI is 0.029, smaller than the significance level of 0.05 and it can be concluded that the BMI has a significant effect on the risk of developing Type 2 diabetes mellitus. The Odd Ratio value of 1.911 indicates that each increase in BMI of 1 unit (in kg/m²) will increase the chance of complications of Type 2 Diabetes Mellitus complications by 1,911 times, assuming other variables are constant. Conclusions: Based on the multivariate analysis, BMI influenced the risk of Type 2 Diabetes Mellitus.

Keywords: BMI, Complications, Type 2 Diabetes Mellitus, Pre-elderly
Key Messages:

Body Mass Index above 25 kg / m2 has the risk of poor glycemic control so that it is also at risk of complications of Type 2 Diabetes Mellitus. Weight management is important to prevent complications related to Type 2 Diabetes Mellitus at a productive age (45-59 years).

How to cite this article: Purwandari CAA, Wishesa CC, et al  (2021): Higher BMI increased the risk of complications among pre-elderly with type 2 diabetes mellitus, Ann Trop Med & Public Health; 22(S01): SP24124. DOI: http://doi.org/10.36295/ASRO.2021.24124

Introduction

Diabetes mellitus is a group of metabolic diseases with hyperglycemia that occurs due to abnormalities in insulin secretion, insulin action, or both. Diabetes mellitus causes an increased incidence of morbidity and mortality worldwide due to complications of hyperglycemia. Long-term complications of hyperglycemia are associated with the risk of thrombosis, atherosclerosis, and cardiovascular disease (1). Risk factors for complications of Diabetes Mellitus include age, gender, duration of suffering, drug consumption, and Body Mass Index (BMI) and abdominal obesity (2).

According to statistics from the Global Burden of Disease study in the Atlas of Diabetes Mellitus, the number of people with Diabetes Mellitus in the world reached 382 million people in 2013 at the age between 45-59 years, which is predicted that it will increase by 55% or become 592 million people in 2035. In the population aged 20 - 79 years, Indonesia ranks seventh in the world in the top ten countries with Diabetes Mellitus with 8.5 million sufferers (3).

Weight gain can increase insulin resistance and chronic hyperglycemia, so that both are associated with microvascular complications (2). Research conducted by the International Diabetes Management Practices Study (IDMPS) in 2011 with 674 patients with Type 2 Diabetes Mellitus showed that more than 50% of respondents had neuropathic complications, and more than 30% of respondents experienced retinopathy and nephropathy (4).

The case of Diabetes Mellitus in 2018-2019 at the Klampis Ngasem Health Center was ranked third among the top ten diseases in the Health Center. A preliminary study conducted in January-February 2020 found that pre-elderly with complications experienced an increase in high blood glucose levels (300-600 mg/dL) accompanied by clinical symptoms. Research on risk factors that affect complications in pre-elderly has never been done, so it is interesting to study. Based on this description, a study was conducted and aimed to analyze anthropometric parameters of BMI that influence the occurrence of complications of Type 2 Diabetes Mellitus in pre-elderly in Klampis Ngasem Health Center, Surabaya.
Subjects and Methods

Setting

This study was held in Klampis Ngasem Health Center, Surabaya, East Java Province, Indonesia. Measurement of body weight used electric scales with an accuracy of up to 0.1 kg. Measurement of height used a microtoice with an accuracy of up to 0.1 cm. Measurement of body weight and height was carried out at the Elderly Integrated Service Postin March 2020.

Sampling and Data Collection

This was a case-control study with a quantitative approach. The case group in this study was pre-elderly patients diagnosed with diabetes mellitus with complications based on the respondents’ Medical Data in Health Center (15 people), and the control group was pre-elderly patients diagnosed with diabetes mellitus without complications based on the respondents’ Medical Data in Health Center (15 people). The data used in this study were both primary and secondary data. The secondary data were medical data on pre-elderly with and without complications in Klampis Ngasem Health Centre. The primary data were collected through anthropometric measurements conducted in March 2020.

Data Management and Analysis

Univariate analysis was performed to describe the respondents’ characteristics such as age, education, and occupation. Compare analysis using the Mann-Whitney test was conducted to analyze subjects’ Body Mass Index (BMI). Multivariate analysis was done using logistic regression with backward method to analyze risk factors that affect complications of Diabetes Mellitus in the 45-59-year age group.

Ethical Consideration

This study was ethically approved by Health Research Ethical Clearance Commission of Faculty of Dental Medicine, Airlangga University (Number: 154/HRECC.FODM/III/2020). Informed consent was obtained from all participants before the study was conducted.

Results

Subjects’ Characteristics

The mean age of the subjects in the case group was 56.47±2.20 with a maximum age of 59 years and a minimum age of 53 years. The subjects in the control group had a mean age of 53.27±4.28 with a maximum age of 59 years and a minimum age of 49 years. Most of subjects in the case group received a higher education with 60% of them graduated from high school, 6.67% of them received an associate diploma degree, and only 33.33% of them graduated from junior high school.

Whereas, in subjects in the control group, 53.33% graduated from high school and the remaining (46.67%) only graduated from junior high school. This study finds that both groups consist of working members of the society with most of the men work as farm workers, merchants, civil servants, and in
private sectors. Meanwhile, the women mostly work as housewives, merchants, farm workers, civil servants, and in private sectors.

### Table 1. Subjects’ Characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type 2 Diabetes Mellitus with complications</th>
<th>Type 2 Diabetes Mellitus without complications</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean±SD</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Age (years)</td>
<td>56.47±2.20</td>
<td>53</td>
<td>59</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type 2 Diabetes Mellitus with complications</th>
<th>Type 2 Diabetes Mellitus without complications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Age (years)</td>
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<td>0</td>
</tr>
<tr>
<td>51-55 years</td>
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<td>40</td>
</tr>
<tr>
<td>56-59 years</td>
<td>9</td>
<td>60</td>
</tr>
<tr>
<td>TOTAL</td>
<td>15</td>
<td>100</td>
</tr>
</tbody>
</table>

### Diabetes Complications

In people with type 2 diabetes mellitus, complications can occur at all levels of cells and all anatomic levels. Complications usually occur in five to ten years after diagnosis is made. This research
shows that the most common types of complications suffered by pre-elderly are nephropathy (33%) followed by neuropathy (27%), retinopathy (20%), coronary heart disease, and the least is peripheral arteries (7%).

**Figures 1. Diabetes Complications**

### Body Mass Index (BMI) Measurements

Body Mass Index is the result of calculating body weight (in kilograms) divided by the square of height (in meters) to monitor nutritional status in adults. Body Mass Index, in general, will also increase with age. The increase in Body Mass Index is influenced by food intake, decrease in height, and changes in the morphology of the vertebral column, reduced bone mass, increased fat stores, osteoporosis, and kyphosis (Dardano, 2014). The increase in Body Mass Index can also be caused by long use of oral anti-diabetes drugs and insulin use.

In this study, Body Mass Index is classified into normal, overweight, and obese. The mean result of the Body Mass Index in the type 2 Diabetes Mellitus group with complications (case group) was 24.80±2.80 with a maximum value of 29 kg/m² and a minimum value of 22 kg/m². Whereas, the mean result of the Body Mass Index in the type 2 Diabetes Mellitus group without complications (control group) was 22.27±3.05 with a maximum value of 29 kg/m² and a minimum value of 19 kg/m². The difference in Body Mass Index between the two groups was carried out statistically using the Mann Whitney test, and the result showed a significant difference in Body Mass Index values between the case group and control group (p=0.022) with a significance value α < 0.05.
Table 2. BMI Measurements on Subjects

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type 2 Diabetes Mellitus with complications</th>
<th>Type 2 Diabetes Mellitus without complications</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean±SD Min Max</td>
<td>Mean±SD Min Max</td>
<td></td>
</tr>
<tr>
<td>Body Mass Index (kg/m²)</td>
<td>24.80±2.80 22 29</td>
<td>22.27±3.05 19 29</td>
<td>0.022</td>
</tr>
</tbody>
</table>

Higher BMI and the Risk of Complications with Type 2 Diabetes Mellitus

The significance value of 0.029 is smaller than the significance level of 0.05, and it can be concluded that the Body Mass Index variable has a significant effect on the risk of complications of Type 2 Diabetes Mellitus. The Odd Ratio (Risk Factors) value of 1.911 indicates that each increase in Body Mass Index by 1 unit (in kg/m²) will increase the risk of complications of Type 2 Diabetes Mellitus by 1.911 times assuming other variables are constant.

Discussion

This study is in line with previous study conducted by Ganz et al. (2014) that pointed out the significance correlation between Body Mass Index (BMI) and the occurrence of Type 2 Diabetes Mellitus (5). People with overweight, obesity grade I, obesity grade II, and obesity grade III have a risk of suffering from Type 2 Diabetes Mellitus compared to people whose BMI is 1.5 times, 2.5 times, 3.6 times, and 5.1 times respectively. The mechanism that underlies the higher risk of Type 2 Diabetes Mellitus in obese
individuals is due to an increase in fatty acids, accumulation of intra-cell lipids, and the formation of cytokines by adipocytes which lead to impaired insulin function. In a state of obesity, there is also an inflammatory process due to an increase in pro-inflammatory cytokines and macrophage infiltration accompanied by the induction of a stress response that can lead to insulin resistance (6). This is similar to research conducted by Firouzi (2015) stated that respondents with a Body Mass Index of 26.9 kg/m^2 have a risk of poor glycemic control, so they are also at risk of complications of Type 2 Diabetes Mellitus (7).

Nutritional status that is not properly maintained according to the management pillars of Type 2 Diabetes Mellitus can increase the incidence of metabolic syndrome which can lead to complications (8). Yuliani (2014) also stated that there is significant relationship between BMI/obesity and the incidence of Coronary Heart Disease (CHD) (9). Obesity can increase the risk of cardiovascular disease associated with metabolic syndrome which consists of insulin resistance, dyslipidemia, diabetes mellitus, fibrinolysis disorders, hypertension, hyperuricemia, and hyperfibrinogenemia. Obese individuals (BMI ≥ 30 kg/m^2) were consistently at greater risk of developing complications of Type 2 Diabetes Mellitus regardless of gender differences. In addition, obese men have a greater risk of developing cardiovascular, renal, ocular, and lower limb complications compared to women with the same BMI level (10).

Research conducted by Kastelan (2013) shows that obesity is a risk factor involved in the development of diabetic retinopathy as a marker of inflammation. Obesity is associated with increased local adipose and systemic inflammation (11). Adipose tissue becomes a proinflammatory endocrine and active paracrine organ which releases large amounts of cytokines and bioactive mediators namely leptin, adiponectin, interleukin-6 (IL-6), tumor necrosis factor-α (TNF-α) which affect not only body weight homeostasis but also lipid levels, coagulation, atherosclerosis, diabetes incidence, and development of diabetic retinopathy. The incidence of endothelial dysfunction as an early marker of diabetic retinopathy is also present in obesity, which is characterized by increased levels of intracellular adhesion molecule-1 (ICAM-1) (12). Obesity and insulin resistance may increase the risk of developing diabetic retinopathy through several new mechanisms whose role needs to be clarified such as leptin, adiponectin, IL-6, TNF-α and ICAM-1 which lead to increased oxidative stress, endothelial dysfunction, and ultimately diabetic retinopathy (13).

Based on the results of a systematic review conducted by Manna et al., 2015, it is stated that there is a role for obesity-related oxidative stress that underlies the development of health risks such as insulin resistance and diabetes, cardiovascular complications, sleep disorders, asthma, oncological, medical, rheumatological problems, and liver failure (14). Followings are conditions that can cause oxidative stress in obese sufferers, including hyperglycemia; increased lipid levels; lack of vitamins and minerals; accessible low level; hyperleptinemia; increased muscle activity; endothelial dysfunction; mitochondrial dysfunction; the role of types of diets that cause oxidative stress in obesity.
Conclusions

The mean body mass index of the Diabetes Mellitus group with complications was classified as obese, while the diabetes mellitus group without complications was classified as normal. Increasing the Body Mass Index value increases the risk of complications. Therefore, the body mass index parameter could potentially be a simple indicator to detect the risk of complications of type 2 diabetes mellitus. The incidence of obesity in the past (retrospectively) will increase the risk of cardiovascular disease associated with the metabolic syndrome consisting of insulin resistance and Diabetes Mellitus. Obesity and insulin resistance may increase the risk of developing diabetic retinopathy which leads to increased oxidative stress, endothelial dysfunction, and ultimately diabetic retinopathy. This research can be supported by other anthropometric parameters and added bimomic parameters (to see the effect of oxidative stress on the incidence of complications).

Acknowledgement

Researchers would like to thank the pre-elderly in the working area of the Klampis Ngasem Health Center, Surabaya, who were willing to become respondents and took the time to participate, and thank you to the Faculty of Public Health, Diponegoro University for organizing ICOPH-TCD as a means for students like me to build and contribute to the development of public health

References


