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The Prevalence and Impact of Body Mass Index Category in Patients with Acute Myocardial Infarction

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Abstract

Background: Body mass index is widely recognized as a tool to classify obesity and adiposity. In Asian population, body mass index category can be divided as underweight, normal, overweight and obese. The prevalence of this categorisation is varied among patients with acute myocardial infarction. Furthermore, there is a J and U curve relationship between body mass index category with outcome in acute myocardial infarction. This research aims to investigate the prevalence of body mass index category and its impact on patients with acute myocardial infarction.
Methods: The research design is a cross sectional study. The subjects of this research are patients hospitalised with acute myocardial infarction. Subjects are categorised as underweight, normal, overweight and obese, based on Asian body mass index categorisation. The demography, clinical and laboratory data is compared among categories and statistically analysed. The major adverse cardiac events occuring during hospitalisation are recorded and its incidence is compared among group. A p value < 0.05 is statistics limit for significance.
Results: We analyse 375 subjects hospitalised with acute myocardial infarction. The most prevalence BMI category is overweight (47.7 %), the second most common category is normal (33.1 %), followed by obese (15.5 %) and the least common category is underweight (3.7 %). No significant difference is observed in respect of gender and cardiovascular risk factors. The underweight subject is significantly older as compared to other categories. The glucose level and atherogenic lipid tend to be higher in underweight subject as compared with normal subject. There is no difference in the incidence of major adverse cardiac events among body mass index categorisation.
Conclusion: The overweight is the most common body mass index category in acute myocardial infarction. The underweight subject is significantly older and tend to have worse biochemical parameters as compared to other categories. The incidence of MACE is not associated with the body mass index category.

Keywords: body mass index; overweight; underweight; acute myocardial infarction

Introduction

Body mass index (BMI) has been widely recognised as a replicable tool to classify the degree of obesity. In Asian population, BMI ≥ 27 kg/m^2 is categorised as obese.[1] Obese individual is associated with increased risk and major determinant of cardiovascular diseases, such as coronary artery disease, heart failure, arrhytmia and sudden cardiac death.[1] Body mass index is also a measure of body adiposity.[2] Adipose tissue is located both in subcutaneous and visceral area, with their specific function and health implication, especially related to cardiovascular disease. Therefore, the measurement of BMI reflects both obesity and adiposity in general and more detail classification can be obtained such as underweight, normoweight, overweight and obese. This ubiquitous category has been accepted in various region and population.

The obesity paradox is an example of usefulness of BMI measurement to predict cardiovascular outcome in patients with various spectrum of cardiovascular diseases.[3] Individual with lean body constitution or underweight or BMI < 18.5 kg/m^2 has the worst cardiovascular

outcome among other categories based on BMI.[3] However, the association between BMI categorisation and cardiovascular adverse outcome is not that straightforward. Most studies found a J curve or U curve association in which the worst outcome occurs in individual who is very lean (underweigth) or very fat (obese), whereas the more linear association toward increasing risk among individual with increased BMI (overweight and obese) are observed after multivariable analysis.[4]

Acute myocardial infarction is an acute spectrum of coronary artery disease and viewed as an acute ultimate events of cardiovascular disease continuum. Additionally, individual suffering from acute myocardial infarction is threatened by continuum chain of events which eventually lead to terminal stage heart failure. In this scenario, acute myocardial infarction is the original event leads to other subsequent aftermath. The role of BMI categorisation in acute myocardial infarction has been extensively studied, resulting in the variability of impact in short term and long term outcomes.[5,6,7,8]

In this study, we investigate the distribution of BMI categorisation, by using modified BMI category for Asian population, in patients with acute myocardial infarction. Furthermore, we correlate the BMI categorisation with major adverse cardiac events (MACE) occuring during hospitalisation in patients with acute myocardial infarction.

Methods

The research design is a cross sectional study. The subjects of this research are patients hospitalised with acute myocardial infarction in ICCU of Dr. Sardjito Hospital Yogyakarta, Indonesia. The time of hospitalisation are between January 2014 and June 2016. Previous data and case report form containing the original data record are extracted and analysed for this research.[9] The inclusion criteria is (1) subjects diagnosed with acute myocardial infarction, (2) the age of subjects is between 30 and 75 years old and (3) the data regarding body weight (in kilogram) and height (in meter) is available in case report form. The exclusion criteria is (1) chronic organ failure from previous data exclusion criteria, (2) comorbidities of acute illnesess from previous data exclusion criteria, and (3) incomplete data of metabolic laboratory (glucose and lipid profile).

The diagnosis of acute myocardial infarction, both ST elevation acute myocardial infarction and non ST elevation acute myocardial infarction, is based on ACC/AHA criteria as previously published.[9] The data regarding body weight and height in the case report form is available in all subjects. Body mass index is calculated based on the standardised formula (bodyweight in kilogram (kg) divided by square of height in meter (m)) and categorised according to Joslin Asian American Diabetes Initiative (Joslin AADI), i.e. < 18.5 kg/m^2 is underweight, 18.5 – 22.9 kg/m^2 is normal, 23.0 – 26.9 kg/m^2 is overweight and ≥ 27.0 kg/m^2 is obese.[1]

The demography data (i.e. age and gender) and cardiovascular risk factors (i.e. diabetes mellitus, hypertension, current smoking behaviour and previous ischemic heart disease) are collected from case report form. The laboratory data are gathered from the case report form. The data of MACE are also extracted from the case report form. The major adverse cardiac events (MACE) are cardiac death, acute heart failure, cardiogenic shock, fatal arrhytmia, and reinfarction. We categorise MACE as the composite of these events. The ethical clearance has been obtained for this research from Ethics Committee of Faculty of Medicine Universitas Gadjah Mada, Yogyakarta.

For statistics analysis, the subjects are divided into four categories, i.e. underweight (BMI < 18.5 kg/m^2), normal (BMI between 18.5 and 22.9 kg/m^2), overweight (BMI between 23.0 and 26.9 kg/m^2) and obese (BMI ≥ 27.0 kg/m^2). The

comparison of continuous data among groups are analysed with one-way ANOVA (normally distributed data/parametric) or Kruskal –Wallis (not normally distributed data/non parametric) test and post hoc analysis if applicable. The comparison of categorical data among groups are analysed with chi-square test and post hoc analysis if applicable. A p value < 0.05 is considered as statistical significant limit.

Result

We analyse 375 subjects hospitalised with acute myocardial infarction. The male gender is predominant, which comprised of 82 % of all subjects. The mean age is 57.8 years. The prevalence of known diabetes mellitus is only 25 % and previous ischemic heart disease is only 13 %. The prevalence of hypertension is quite significant, which comprised of 65 % of subjects. More than half of all subjects have a current smoking behavior, i.e, 51 %. The mean of BMI in all subjects is 23.9. Table 1 shows the frequency and value of characteristics of subjects in this research.

Table 1. Demography, cardiovascular risk factors and BMI characteristics of subjects with acute myocardial infarction (n=375)

Characteristics	Frequency / Value
Gender, n (%)	
Male	307 (82 %)
Female	68 (18 %)
Years of age, mean±SD	57.8±9.3
BMI, mean±SD	23.9±3.2
Diabetes mellitus, n (%)	94 (25 %)
Hypertension, n (%)	243 (65 %)
Smoking, n (%)	192 (51 %)
History of ischemic heart disease, n (%)	48 (13 %)

BMI is body mass index, SD is standard deviation

The most prevalence BMI category is overweight subject, which comprise of 47.7%. The second most common category is normal

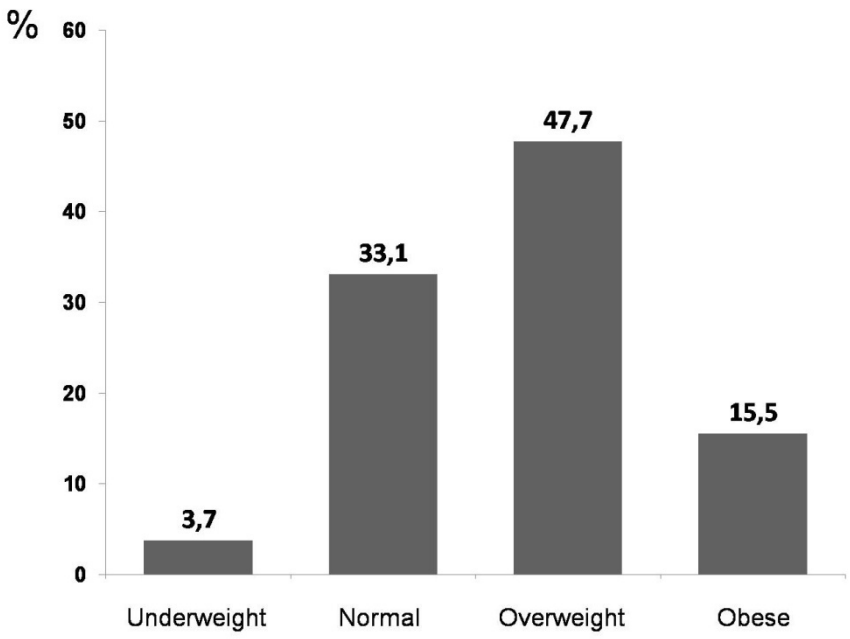

Figure 1. The prevalence of BMI category among patients with acute myocardial infarction. The overweight subject is the most prevalence BMI category, followed by normal subject and obese subject. The least prevalence is underweight subject.

Table 2. Comparison of demography, cardiovascular risk factors and BMI characteristics among subjects based on BMI category

Characteristics	Underweight	Normal	Overweight	Obese	p value*
Male gender , n (%)	12 (86%)	95 (77 %)	152 (85 %)	48 (83 %)	0.308
Years of age, mean±SD	60.8±8.5	59.7±9.6	57.3±8.7	54.3±9.3	0.001**
BMI, mean±SD	17.2±1.1	21.4±1.1	24.7±1.1	29.1±2.2	< 0.001
Diabetes mellitus, n (%)	3 (21 %)	28 (23 %)	47 (26 %)	16 (28 %)	0.840
Hypertension, n (%)	11 (79 %)	76 (61 %)	119 (67 %)	37 (64 %)	0.556
Smoking, n (%)	8 (57 %)	60 (48 %)	92 (51 %)	32 (55 %)	0.811
Previous IHD, n (%)	2 (14 %)	13 (11 %)	24 (13 %)	9 (16 %)	0.785

BMI is body mass index; IHD is ischemic heard disease

*Chi-square test for cathegorical comparison and one-way ANOVA test for numeric comparison
**Post hoc analysis: Underweight vs. obese (p=0.017), normal vs. overweight (p=0.024), normal vs. obese (p < 0.001), overweight vs. obese (p = 0.028).

subject, which comprise of 33.1 %. The prevalence of obese subject is 15.5 %. The least common category is underweight subject, which comprise of only 3.7 %. Figure I shows the bar chart depicting the prevalence of BMI category in subjects with acute myocardial infarction.

The characteristics of subjects based on BMI category is depicted in table 2. No significant difference is observed in respect of gender (p = 0.308), diabetes mellitus (p = 0.840), hypertension (p = 0.556), current smoking (p = 0.811) and history of ischemic heart disease (p = 0.785). The underweight subject is significantly older as compared to other categories (ANOVA p value < 0.001). Post hoc analysis reveals that compared with obese subject, the subject with underweight, normal and overweight are significantly older (LSD post hoc p value 0.017, < 0.001 and 0.028, respectively).

The metabolic data, which comprise blood laboratory value is shown in table 3. The glucose level tends to be higher in underweight subject as compared with normal subject. Obese subject also has a tendency toward higher glucose level than normal subject. This pattern tendency also occurs with total cholesterol, LDL cholesterol and triglyceride level. However, the statistics analysis shows that all difference in metabolic laboratory parameter is not significant.

The incidence of MACE and cardiac death is not significantly associated with BMI category. However, underweight subject has a tendency toward higher incidence of MACE as compared to normal, overweight and obese subjects. The normal subject has a tendency toward higher incidence of cardiac death as compared with other categories. Table 4 shows the incidence of major adverse cardiac events and death in each BMI category.

Table 3. Comparison of metabolic laboratory value of subjects based on BMI category

Laboratory parameter	Underweight	Normal	Overweight	Obese	p value
Glucose (g/dL), mean±SD	241.9±153.2	178.1±102.8	174.1±83.4	186.5±100.9	0.210*
Total cholesterol (mg/dL), mean±SD	203.3±42.4	187.6±46.7	180.3±43.4	191.3±52.2	0.145**
LDL cholesterol (mg/dL), mean±SD	136.6±34.1	125.7±39.4	118.6±35.4	129.5±40.0	0.092**
HDL cholesterol (mg/dL), mean±SD	48.2±17.3	45.5±12.7	45.3±17.9	42.7±15.5	0.590**
Triglyceride (mg/dL), mean±SD	144.6±147.1	121.2±64.8	122.7±60.7	139.3±67.7	0.133*

LDL is low density lipoprotein; HDL is high density lipoprotein; SD is standard deviation
* Kruskal-Wallis test for non parametric comparison, ** one way ANOVA for parametric comparison

Table 4. Association between BMI category and major adverse cardiac events

	Underweight	Normal	Overweight	Obese	p value
MACE, n (%)	5 (36 %)	27 (22 %)	39 (22 %)	12 (21 %)	0.662
Death, n (%)	0 (0 %)	12 (10 %)	13 (7 %)	3 (5 %)	0.483

MACE is major adverse cardiac events

DISCUSSION

The result of this study shows that overweight subject is the most common BMI category in acute myocardial infarction. Underweight individual is the minority which only accounts for less that 4 % of all subjects. Obese individual is found to be 15 % in prevalence. Underweight subject is significantly older as compared to normal, overweight and obese subjects. The metabolic parameter, i.e. blood glucose and lipid profile, tends to be worse in underweight subjects although no significance in statistics calculation. The incidence of MACE is not associated with the BMI category, however we observe that underweight subject has a tendency toward higher incidence of MACE as compared to normal, overweight and obese subjects.

Increased BMI is associated with increased risk to develop acute myocardial infarction in individual with cardiovascular disease.[10] Acute myocardial infarction is an accumulation of cardiovascular acute event due to ruptur or erosion of atherosclerosis plaque and subsequent thrombus formation in affected coronary artery. Increased body weight is related with increased adiposity and state of chronic inflammation, in which condition the enhance atherosclerosis plaque formation and development occurs as well as increase risk of plaque ruptur. In this respect, overweight and obese individuals have increased risk as compared with normal individual. However in patients with established coronary artery disease, there are several evidence indicating the apparent paradoxical impact of BMI categorisation on short and long term outcome. For instance, in patients with coronary artery disease undergoing elective percutaneous coronary intervention (PCI), those with worse adverse cardiac outcomes are patients with reduced BMI, whereas obese and overweight patients have improved survival even after comparing with normal BMI category.[11,12]

In the context of acute myocardial infarction, the survival benefit of higher BMI in short term and long term following acute myocardial infarction are reported by several studies. The term of obesity paradox, in which the overweight and obese individuals have better survival benefit as compared to normal and underweight individual, is invented to describe the phenomenon. The protective impact of increased BMI on outcomes after acute myocardial infarction has been detected in randomised trials involving subjects with NSTEMI and STEMI.[6,7,13,14] However, current research evidence, involving more subjects and more multivariable analysis shows that the obesity paradox is not consistently apparent in the overall analysis. In the short term, overweight and obese patients have beneficial impact in reducing the incidence of major adverse cardiovascular events.[15] However, in the long term follow up the benefit is loss and even inversely correlated.[15,16,17] In our study, involving NSTEMI and STEMI patients, there is no significant correlation between major adverse cardiac events with BMI category.

In this research, the most prevalent BMI category is overweight subject, although the proportion is less than 50% of all subjects. The prevalence of obese subjects and underweight subjects are lesser. This pattern is corroborated by previous cross sectional research. However, the variation occurs if compared with a study from other Asian country which is used BMI categorisation according to their consensus on BMI application.[17, 18.,19] In our study, the

BMI categorisation as underweight, normal, overweight and obese, is developed from previous standardized guideline from accepted authority by using subjects from Asian and Asian American.[1] Several Asian countries have modified the guideline value according to their requirement. In Indonesia, currently no consensus among clinicians regarding the BMI categorisation. Therefore, in this research, the BMI categorisation is obtained from international standard. In reality, the value and cut off point to differentiate each category is almost similar among consensus.

In this research, overweight and obese subjects are younger as compared to underweight subjects. It means that the appearance of both body habitus and coronary artery may differ in the overweight and obese subjects than in underweight, due to the difference of age. Previous studies reveal the similar observation that the patients with underweight BMI category are significantly older.[15,17,18] This, in part, explain the phenomenon of obesity paradox. This also indicates the obesity is a significant risk factor for acute coronary syndrome in relatively younger population, which is already proven from community study.[15] Furthermore, younger age with acute coronary syndrome may have lesser comorbidities and increased utilisation of medications and invasive procedure which will affect short term outcome.[15] In our result, only the prevalence of hypertension is tended to be higher in underweight subjects, whereas other risk factors are similar in prevalence among groups.

The metabolic parameter, indicated by laboratory result, shows that underweight subjects tend to have worse metabolic indicators. The glucose level and atherogenic cholesterol value tend to be higher in underweight subject as compared with overweight and obese subject. These observation indicate that underweight subjects have more comorbidities and worse metabolic disturbance which will affect the multivariable association with major adverse cardiac events in the episode of acute myocardial infarction.

In this study there is no significant association between BMI category with the incidence of major adverse cardiac events. This finding may be factual, because there are several variables need to be considered to consistently determine the independent association. Since there are still controversies regarding the role of BMI category in predicting short term and long term outcome after acute myocardial infarction, in light of the advancement of treatment strategy in acute myocardial infarction, the future studies from different population is still widely open.

Limitation of Study

The limitation of this study is because of its design by using secondary data, i.e. the case report form analysis of previous research, therefore the validity of BMI measurement need to be evaluated. The other limitation is the sample size to sufficiently obtain statistical power is not adequately provided.

Conclusion

The overweight subject is the most common BMI category in acute myocardial infarction. In contrast, underweight individual is the minority. The underweight subject is significantly older as compared to normal, overweight and obese subjects. The underweight subjects tend to have worse biochemical parameters as compared to other categories. The incidence of MACE is not associated with the BMI category.

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