Body Mass Index and Risk for Hypertension of Adults with Type 2 Diabetes Mellitus Body Mass Index and Risk for Hypertension of Adults with Type 2 Diabetes Mellitus

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Abstract

Obesity has been proven to significantly increase the prevalence of hypertension and limiting the effectiveness of antihypertensive drug therapy. Several different studies have reported an increase in risk of rising blood pressure in individuals with higher BMI. Multiple studies claim the independent correlation between sex, age, and race towards the changes in onset risks. A multicenter observational study was conducted with cross-sectional approach on 153 GLD controlled T2DM patients. Data on GLD, doses, HbA1c, the first time being diagnosed T2DM, symptoms of heart failure, weight and BMI will be extracted from the medical record. Correlative Analysis of Hypertension and BMI with Chi Square and Spearman test. Stratum analysis of Hypertension, BMI, and diabetes was conducted with Chi Square. The results showed that 98 (64.1%) respondents develop hypertension with 63 of them being overweight (BMI > 25). BMI and onset of hypertension showed a not significant yet positively linear relation compared to the normoweight counterpart (OR 1.39, 95% CI 0.71 – 2.74; p = 0.39).

Keywords: Body Mass Index, Hypertension, Diabetes.

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INTRODUCTION

High individual body mass index (BMI) has been widely agreed upon to be a precipitating factor towards multiple health risks. Obesity has been proven to significantly increase the prevalence of hypertension[1,2] and limiting the effectiveness of antihypertensive drug therapy[1,3]. An increased blood pressure by itself is already a confounding factor of various vascular diseases such as cardiovascular disease and cerebrovascular diseases. This causes a concern towards the potential of BMI affecting the onset of chronic systemic diseases. BMI has been reported to show significant association with cardiovascular disease but not with cerebrovascular disease.[4,5] Additionally, individuals with hypertension (≥130/80 mm Hg) show a strong relationship between BMI with cardiovascular and cerebrovascular diseases, where the risk of disease multiplies up to 2-3 times higher.[6]

In the past 30 years, the prevalence of obesity and overweight has substantially increased, with marked variations across countries in the levels and trends in overweight and obesity with distinct regional patterns.[7] The global death and DALYs due to high BMI have more than doubled for both females and males since the year 1990 until 2017.[8,9]

Pathogenesis of obesity-related hypertension requires involvement from the sympathetic nervous system, renin-angiotensin-aldosterone system, and dysfunction towards the endothelial lining and the kidney. It is a complex process accumulated by dysfunctions in multiple systems. Activation of the sympathetic nervous system and impaired renal pressure natriuresis induced by hyperleptinaemia and hyperinsulinaemia combined with endothelial dysfunction caused by the free fatty acids and adipokines in centrally obese individuals are one of the mechanisms[1,2]. Abdominal fat storage is also hormonally active and strongly relates to insulin resistance and low-grade systemic inflammation due to the hormonal consequences it possess[10,11].

As such, it can be concluded that despite the advancements in clinical and scientific accomplishments that have ushered a clearer understanding of obesity pathogenesis and adapted better management of obese in patients with obesity, high BMI has not shown a declining pattern but rather an upward one in the last decades.[7,9] The more recent studies of BMI data collected up-to three decades ago has consistently affirm the increased mortality risk among severely obese persons (BMI >35 kg/m2), but mixed findings among overweight (BMI 25.0 – 29.9 kg/m2) and more mildly obese (BMI 30.0 – 34.9 kg/m2) individuals. [7,12]

As commonly reported in various studies, there is a marked increase in the risk of uncontrolled hypertension along with the rise BMI in both men and women.[1,13,14] Chudek et al reported that there is a 1.78 increased risk in men with a BMI range of 22.5–24.9 kg/m2, and 8.58 in those with BMI ≥35 kg/m^2. As for the women, 1.37 in the subgroup with values 25–27.4 kg/m^2 is noted while 3.63 was found in the subgroup ≥35 kg/m^2. The study also declared that uncontrolled hypertension noticed to increase in underweight subgroups.[1]

Recent studies has discussed that a difference in race, gender and lifestyle is also a factor when assessing the relevance of BMI towards physiologic changes.[1,7,13-16] Studies done to compare the change in BMI between Japanese subject, Japanese-American, and American shows that predisposing factors such as the difference in racial genes and cultural habits also plays a role when assessing the effect of BMI towards hypertension.[14] The World Health Organization has also recommended that the Asian population use an adapted version of BMI namely the Asian Body Mass Index, as it is found that the Asian population has a higher fat percentage and a relatively smaller build compared to their Caucasian counterpart. This causes an increase of health risk in lower BMIs for Asian population compared to others.

Specifically, a study in china has shown that a change value of BMI has positive linear correlation towards the value of systolic blood pressure, diastolic blood pressure, triglyceride, and LDL Cholesterol while presenting a negatively linear correlation towards HDL Cholesterol (P<0.05). This study also reported that overweigh and obese patients will develop adverse changes in blood glucose and heighten the risk of cardiovascular disease .[17] In contrast, other studies has concluded that despite the increase of alarming health risk factors caused by the increase of BMI, diabetes in lean individuals are more critical towards cardiovascular disease related deaths compared to their obese counterpart.[18]

Various anthropological indicators are used to determine one's nutritional and health status. Some of which includes BMI, Body Adiposite Index (BAI), Waist Circumference (WC), Waist to Hip Ratio (WHR), Waist to Height Ratio (WHtR), etc. All of these indicators takes into account the accumulation of excess adiposity in the body. Some even more specific than the rest, such as waist measurements and ratio that is aimed to assess central obesity. Previous studies have shown that adiposity rate assessed by BAI or through MRI does not perform a significantly positive correlation towards hypertension, diabetes, or other CVD risks compared to BMI, WHtR, and WC.[19-22] In that respect, BMI would be used as an indicating factor in this study to further asses the relation between anthropometrical measurements and onset of hypertension.

METHODS

Research Design

This study was a multicentre and observational study with cross-sectional design approach. A total of 153 T2DM enrolled from three internal medicine clinics in Bogor, West Java, between January 2018 and March 2018, who diagnosed with T2DM, been controlled, and treated with their routine Glucose Lowering Drugs (GLD) that have been observed to evaluate their heart function in a real-world setting. Data will also be collected from the integrated retrospective data in electronic or written medical records of each clinic.

Study Population

The subject population that was observed in this study, must fulfil all the following criteria: Provision of subject informed consent, Female, or male aged 18 years and over, diagnosed with type 2 diabetes mellitus, tested with echocardiography. Patients was not be eligible to participate if any of the following exclusion criteria are present: Diagnosed with type 1 diabetes mellitus, Chronic obstructive pulmonary disease (COPD), Patient is pregnant, Current treatment with chemotherapy, oral or iv steroids, Participation in an interventional trial, Presence of any condition/circumstance which in the opinion of the investigator could significantly limit the follow up of the patient (e.g., life- threatening co-morbidities, tourist, non-native speaker or does not understand the local language where interpreter services are not reliably available, psychiatric disturbances, dementia, alcohol, or drug abuse), not willing to sign the informed consent. The sample size calculation method on this study used the total sampling method who enrolled all eligible subjects to the study within the period of 3 months' observations.

Study Protocols, measurements, and calculations

Patients has undergone assessments as standard medical care determined by the treating physician. The source data was medical record of all T2DM patient's that was collected in

Bogor, West Java, between January 2018 and March 2018. Inform consent was taken and agreed data set comprised of patient demographic, Body Mass Index (BMI), blood pressure and HbA1c readings.

All measurement was taken at routine visit, where participants had been on treatment for diabetes mellitus (DM) with their routine GLD from the internal medicine clinic, the time they visit clinic.

Data Collection and Statistical Analysis

Data Collection

Data was collected at the Investigator's site. The Investigator was responsible for entering data into the personal computer system. Data entered will be immediately saved to a central database and collected per sites. All CRFs was validated to ensure that they were properly completed with adequate quality. This check did not necessarily need to be performed at the study sites. A copy of the CRF was archived at the Investigator's site for a period agreed in the site contract. The CRF linked at a patient level to the records generated from electronic medical records and/or registries in accordance with local patient privacy guidelines if technically feasible.

Statistical Analysis

The numerical data are expressed as mean ± standard deviation (SD), median, mode, minimum and maximum value. Categorical variables are shown as number (n) and expressed in percentages (%). Then, Corelative Analysis Between Hypertension and BMI Symptoms was analysed using Chi Square while the strength of corelation were analysed using Spearman test. Finally, the stratum analysis between Hypertension, BMI and DM Type II was also conducted using Chi Square. All the statistical analysis used the significance p value of <0.05.

Subject Informed Consent

The Investigator at each site ensured that the subject was given full and adequate oral and written information about the nature and purpose of this study. Subjects must also be notified that they are free to disagree giving permission of the collecting data. The subjects should be given the opportunity to ask questions and allowed time to consider the information provided.

The signed and dated subject informed consent must be obtained before any specific procedure for the study including Interview with the investigator, CRFs completion, use of other possible sources of health information such as electronic medical record

The Investigator also stored the original, signed Subject Informed Consent Form. A copy of the signed Subject Informed Consent Form must be given to the subject. Subjects will also be asked to complete and sign a Contact Order Form, with their own contact details as well as those of a relative or close person (preferably a person living in the same household), and authorization to be contacted by the study site if they do not attend routine visits or remain unreachable after several attempts (to check vital status).

Ethical Approval

This study has obtained the ethical approval from the Ethics Committee of the Faculty of Medicine Universitas Indonesia (No. 0154/UN2.F1/ETIK/2018).

Results

There were 153 eligible adults aged 18 to 90 years treated for T2DM that are included in this study. Table 1 and 2 shows the general characteristics of our study population. Elderly patients accounted for 45.1% of subjects in the study, whereas the remaining 54.9% subjects (n= 84) are adult patients ranging from the aged of 18 to 60 years. Female respondents (n= 85) were more noticeable in number compared to the male (n=68) respondents of this study. It is reported globally that high-BMI-related death and DALY rates are found to be lower in females within the age group ≤75 years than in males in the same age groups, whereas the rates were higher in females than in males in age groups >75 years.[8] The difference in sample size between genders in this study is to be noted during the interpretation of results.

Table 1. Respondent Characteristics (N=153)

Characteristics	Frequency (n)	Percentage (%)
Age		
<=60 years old	84	54.9
>60 years old	69	45.1
Gender		
Male	68	44.4
Female	85	55.6
Body Mass Index		
Normal BMI (<=25)	59	38.6
Overweight (>25)	94	61.4
HbA1c		
<9	118	77.1
>=9	35	22.9

The WHO BMI classification for general population is used for BMI interpretation in this study. Nutritional status of subjects based on their body mass index in this study are categorized as either overweight (>25) or as normal (≤25). Subjects with underweight or obese BMIs are included as either normal or overweight, a separate category for these BMI groups are not provided. As previously reported in different studies, cardiovascular disease, diabetes, and kidney diseases were among the leading causes of high-BMI-related death and DALYs.[9] As such, it is imperative that more attention is given to patients with higher BMI considering the interrelated risks towards chronic diseases.

HbA1c profile of each subject is recorded and categorized as <9 (n=118) or ≥9 (n=35). A cut-off of 9% for HbA1c is used to differentiate between patients that have controlled blood sugar, and those that do not to the point of requiring insulin treatment. A diabetic patient presenting with the classic diabetic triad symptoms (polyuria, polyphagia, polydipsia) and a HbA1c concentration of >9 is included in the temporary indication towards treatment using insulin, as recommended by the national endocrine association.[23] A common cut-off of HbA1c cannot be agreed in between countries as gender, race and age plays a part in its effect towards the body.[24]

The mean distribution of the respondent characteristics is elaborated on table 2. The mean age of respondents is at 59.60 with standard deviation of 10.19 years. The majority of the subjects are not elderly. The youngest subject is aged 36 years old, while the eldest is 85 years of age. The BMI distribution shows that the majority of subjects as well as the median number of BMI is at 25.3 and 25.7 respectively. The mean BMI and its standard deviations resides at 26.52 ± 4.79. The smallest BMI within the subjects belongs the underweight category at 15.60, whilst the largest BMI belongs to the Obese category at 44.10. HbA1c percentage of the subjects shows a mean of 8.15 ± 1.76 with both the median and mode at 8. Although the majority of subjects have a HbA1c <9, the highest HbA1c found between the subjects is at 13.10.

All respondents included in this study are adults above the age of 18 with a prior underlying diagnosis of T2DM that has been given therapeutic interventions. A risk analysis correlation between the score of BMI towards the onset of Hypertension in patients with T2DM is reported on Table 3. It is described on the table that 98 (64.1%) out of 153 respondents develop hypertension. 63 respondents that underwent hypertension belongs to the overweight category (BMI > 25). The relation of BMI towards onset of hypertention is positively linear and incidence are significantly greater than patients with a normal BMI (OR 1.39, 95% CI 0.71 – 2.74; p = 0.39).

DISCUSSION

It is widely discussed through different studies that an increase in BMI or any other anthropometric indices causes a significant increase in systolic and diastolic blood pressure.[12,15,19] Multiple anthropometrical indicators such as BMI, Ponderal Index, Waist Circumference, Waist-height ratio also plays a predictive role in the prognosis of other chronic diseases.[7-9] Obesity has been proven to be an important contributor towards global disease burden.[8] It is of paramount importance that individual BMI are regularly measured to ensure early modification towards unhealthy behavioral risk factors.

Several studies have concluded that BMI is and independent factor towards blood pressure. However, other studies have claimed that the changes in blood pressure cannot be concluded just by the BMI of a patient. Explained that the effect of BMI towards blood pressure decreases as the with the individual's increase of age. Elderly, specifically those >68 years of age have a lower risk.[8,15] The difference in gender and race also becomes a cause of variation, as females have a fat percentage higher than men and the Asian population has a higher fat percentage compared to Caucasians.

In this study, the onset of hypertension in adults with T2DM is shown to be influenced by the individual BMI. Corresponding with previous studies, our findings has shown a positive linear relationship towards the onset of hypertension (OR 1.39, 95% CI 0.71 – 2.74; p = 0.39). and shows a risk ratio of 1.130 for incidence of hypertension.

A similar study of evaluating the effects of BMI towards diabetic patients also attests that BMI stresses an added risk towards the development of hypertension. The risk of hypertension progressing increases with the obesity level, and notably higher in patients with diabetes compared to those without. Individuals with diabetes also demonstrate an inverse relation between age at hypertension onset with their respective BMI. The same relationship was seen to be stronger between men compared to women. Furthermore, a pre-existing diabetic condition was reported to double the impact of obesity on age at onset of hypertension in women.[25]

Table 2. Respondent Characteristics (N=153)

Characteristics	**Mean ± S.D**	**Median**	**Mode**	**Min**	**Max**
Age (years)	59.60 ± 10.19	59.00	52.00	36.00	85.00
Body Mass Index (kg/m²)	26.52 ± 4.79	25.70	25.30	15.60	44.10
HbA1c	8.15 ± 1.76	8.00	8.00	5.00	13.10

Table 3. Risk Analysis of Body Mass Index and Hypertension

	Hypertension		**Total**	**OR (CI 95%)**	***p**
Body Mass Index	**Yes**	**No**			
Normal BMI (<=25)	63 (41.2%)	31 (20.3%)	94 (61.4%)	1.394 (0.710 – 2.735)	0.388
Overweight (>25)	35 (35.7%)	24 (43.6%)	59 (38.6%)		
Total	98	55	153		

	(64.1%)	(35.9%)	(100%)		

Conclusion

The findings by using stratum analysis of hypertension, BMI, and diabetes was conducted with Chi Square. The results showed that 98 (64.1%) respondents develop hypertension with 63 of them being overweight (BMI > 25). BMI and onset of hypertension shows a not significant yet positively linear relation compared to the normoweight counterpart (OR 1.39, 95% CI 0.71 – 2.74; p = 0.39).

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