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Correlation of Insulin Resistance with Blood Pressure in Indonesian Office Workers: A Cross-Sectional Observational Study

Christian Soesilo[1], Diani Nazma[1,*], Karlina Mahardieni[1], Lira Panduwaty[1], Antin Trilaksmi[1], Ade Dwi Lestari[2]

[1]Department of Anesthesiology, Faculty of Medicine, Universitas Trisakti, Jakarta, Indonesia
[2]Department of Occupational Medicine, Faculty of Medicine, Universitas Trisakti, Jakarta, Indonesia

Abstract— **Background:** Insulin resistance and hypertension is a tightly associated morbid-related disease through similar pathophysiological pathway. The increase of insulin resistance in sedentary office workers increase the risk of hypertension and cardiovascular disease. This study aimed to investigate the profile and correlation of insulin resistance and blood pressure in office workers in Indonesia. **Methods:** Participants were recruited and obtained informed consent for the study. The participants were first asked regarding smoking and physical activity. The participants were then measured for their blood pressure and extracted venous blood for evaluation of fasting blood glucose and fasting insulin level. The data were statistically analyzed with univariate analysis and bivariate analysis of correlation using Spearman test. **Results:** A total of 93 participants were included in the study. The mean age of the participants were 38.73±1.12 years. The participants' data were centered in the profile of obese grade I, normal profile of insulin resistance, and normal profile of blood pressure. There was a significant weak correlation of insulin resistance with systolic blood pressure ($r=0.361$; $p<0.001$) and diastolic blood pressure ($r=0.289$; $p=0.005$). **Conclusion:** Insulin resistance shows a weak significant correlation with elevated blood pressure.

Keyword: blood pressure, hypertension, insulin resistance, office worker.

Introduction

Insulin resistance is a pathological condition found in group of various pathological conditions known as metabolic syndrome. The metabolic syndrome consists of various pathological conditions including hyperglycemia, hypertension, dyslipidemia, and obesity. These various pathological conditions increase the risk of developing type 2 diabetes and cardiovascular diseases as they confer common pathways of chronic inflammation, increased oxidative stress, endothelial damage, defective glucose regulation, lipid metabolism, and hypercoagulability.[1,2]

A study conducted in Iran as a developing country by Rad et al (2020) found that hypertensive patients in non-diabetic community is associated with a higher prevalence hyperinsulinemia and insulin resistance.[3] Moreover, cardiovascular diseases and diabetes have also become a global health concern as it continues to increase particularly in developing countries. Not only does the incidence continue to increase, morbidity and mortality are continuing to increase. With increasing morbidity and mortality, the International Diabetes Federation (IDF) have estimated that 537 million people worldwide suffered diabetes in 2021 causing health expenditures

of US$966 billion globally which is estimated to increase to over US$1045 billion by 2045.[4,5] This is concerning as most of the burden were held responsible by developing countries with higher prevalence. Indonesia, as a lower-middle-income developing country, is one of the developing countries burdened by both cardiovascular and metabolic diseases with the national prevalence continuing to increase.[6,7]

To prevent further increasing burden, knowledge of understanding of correlation regarding insulin resistance and blood pressure, particularly in individuals with low physical activity such as office workers, is required.[8,9] Therefore, this study is aimed to investigate the profile and correlation of insulin resistance and blood pressure in office workers in Indonesia.

Methods

Study Design

This study was a cross-sectional observation study assessing the association of insulin resistance with systolic and diastolic blood pressure conducted in office workers of Faculty of Medicine, Trisakti University from January to March 2024. This study has obtained ethical clearance approval from Trisakti University with ethical clearance letter no. 048/KER/FK/II/2024. Informed consent was obtained from all participants in the study.

Patient Selection

The inclusion criteria for patient selection were: (1) active office worker of Faculty of Medicine, Trisakti University; (2) willing to participate in the study with informed consent; (3) aged 20-55 years old. The exclusion criteria for patient selection were: (1) not participating until the end of the study; (2) diabetic patients consuming routine oral drugs or using insulin.

Blood Pressure Assessment and Laboratory Test

Participants were interviewed regarding smoking and physical activity, continued by physical examination to evaluate systolic and diastolic blood pressure with digital blood pressure monitoring device (OMRON, Kyoto, Japan). Blood pressure measurement results were inserted into a spreadsheet for statistical analysis. Participants were also extracted cubital venous blood by a health professional to be tested for blood laboratory test consisting of fasting blood glucose (mg/dL) and fasting insulin (µIU/mL) using ELISA method to calculate homeostatic model of assessment for insulin resistance (HOMA-IR). The formula to calculate HOMA-IR is as follows:

$$HOMA - IR = \frac{Glucose\ x\ insulin}{405}$$

Fasting blood glucose, fasting insulin level, and HOMA-IR were also inserted into a spreadsheet for statistical analysis.

Criteria for Participants with Insulin Resistance

As there are no available criteria to diagnose insulin resistance in clinical guidelines, participants were regarded to have insulin resistance if they have HOMA-IR index of 1.7 or above.[10]

Statistical Analysis

Data analysis was conducted using IBM SPSS Statistics version 24 program (IBM Corp., Armonk (NY), USA) (RRID:SCR_002865). Univariate analysis was done to describe characteristics of age, gender, body mass index (BMI), active smoker, physically active, fasting blood glucose, fasting insulin, HOMA-IR, systolic blood pressure, and diastolic blood pressure to obtain the proportion. The variable will be shown in Mean±SD if the distribution of data is normal through Kolmogorov-Smirnov test ($p>0.05$), while the variable will be shown in Median (Range) if the data distribution is not normal through Kolmogorov-Smirnov test ($p<0.05$). Bivariate analysis was conducted to analyze the correlation of HOMA-IR with systolic and diastolic blood pressure using the Spearman correlation test with significance indicated by $p<0.05$.

Results

Demography of Participants

A total of 93 participants were included with 31 male and 62 female. The average age of all participants was 38.73±1.12 years. The average BMI of all participants was 26.05±0.63 kg/m^2 which is classified as obese grade I for Asian patients. Only 13.98% of all participants were active smokers which dominantly were male participants. Around 50.54% of all participants were physically active. The median of fasting blood glucose was 90 (71-298) mg/dL and fasting insulin level of 7.5 (2.2-68.8) µIU/mL with a median of homeostatic model assessment for insulin resistance (HOMA-IR) of 1.7 (0.5-17.3). The median systolic blood pressure was 129 (93-198) mmHg and mean diastolic blood pressure was 78.61±1.23 mmHg. Table 1 shows the full demography and baseline measurements of all participants and each gender.

Table 1. Demography and baseline measurements of participants.

Characteristics	Male (n=31)	Female (n=62)	All (n=93)
Age (years)	41.06±2.33	37.56±1.20	38.73±1.12
BMI (kg/m^2)	23.93±0.93	27.13±0.80	26.05±0.63
Active smoker (n [%])	12 (38.71)	1 (1.61)	13 (13.98)
Physically active (n [%])	16 (51.61)	31 (50)	47 (50.54)
Fasting blood glucose (mg/dL)	92 (74-165)	90 (71-298)	90 (71-298)
Fasting insulin (µIU/mL)	6.5 (2.2-68.8)	8.2 (2.8-30.5)	7.5 (2.2-68.8)
HOMA-IR	1.6 (0.5-17.3)	1.8 (0.5-9.5)	1.7 (0.5-17.3)
Systolic blood pressure (mmHg)	128 (97-198)	129.08±2.21	129 (93-198)
Diastolic blood pressure (mmHg)	79.29±1.90	78.28±1.61	78.61±1.23

Association of Insulin Resistance and Blood Pressure in Office Workers

A total of 43 participants had insulin resistance and 24 participants had hypertension. There were 14 participants (15.1%) with hypertension and insulin resistance. The details for the number of participants with hypertension and insulin resistance is shown in table 2. Association of insulin resistance indicated by HOMA-IR and blood pressure showed a significant correlation. Correlation coefficient showed weak correlation of HOMA-IR with both systolic blood pressure (r=0.361; p<0.001) and diastolic blood pressure (r=0.289; p=0.005) (table 3).

Table 2. Frequency table of insulin resistance and hypertension.

Variables	Hypertension (n [%])	No hypertension (n [%])
Insulin resistance (n [%])	14 (15.1)	29 (31.2)
No insulin resistance (n [%])	10 (10.8)	40 (43.0)

Table 3. Correlation analysis of HOMA-IR with systolic and diastolic blood pressure.

Variables	SBP	DBP
HOMA-IR	0.361	0.289
p	<0.001	0.005

Note: HOMA-IR, homeostatic model of assessment for insulin resistance.

Eight factors (BMI, HOMA-IR, fasting glucose, fasting insulin, physical activity, smoking status, gender, and age) were analyzed using binary logistic regression to predict their outcome towards hypertension (table 4). Upon analysis, none of the factors were considered as statistically significant predictors of lung function abnormality. Moreover, the Nagelkerke R2 for lung function abnormality was 31.7% with a good model fit of Hosmer-Lemeshow test value of 0.288.

Table 4. Logistic regression analysis on hypertension.

	Blood Pressure (Hypertension/No Hypertension)	
	Adjusted OR (95% CI)	p-value
HOMA-IR	0.561 (0.079-3.99)	0.564
Smoking (Ref: Non-smoker)	0.822 (0.100-6.785)	0.856
Physical activity (Ref: Active)	0.838 (0.278-2.524)	0.754
Age	1.058 (0.992-1.130)	0.088
BMI	1.083 (0.973-1.204)	0.138
Gender (Ref: Female)	0.832 (0.180-3.841)	0.813
Fasting insulin	1.131 (0.686-1.866)	0.629
Fasting glucose	1.063 (0.990-1.142)	0.091

Note: BMI, body mass index; HOMA-IR, homeostatic model of assessment for insulin resistance.

Discussion

Metabolic syndrome including obesity, insulin resistance, particularly diabetes mellitus, and hypertension is a tightly morbid-associated disease through the same pathophysiological pathway. The high levels of glucose and hyperinsulinemia damage the kidney and cause vascular stiffness which leads to hypertension. Advanced glycation end products deposition, reactive oxygen species (ROS) production, and activation of protein kinase C were found in chronic hyperglycemic conditions that damage the kidney and arterial wall. On the other hand, activation of sympathetic nervous system and renin-angiotensin-aldosterone system (RAAS) were known to happen in hyperinsulinemia, especially in insulin resistance, causing kidney and vascular damage. These pathophysiological pathways lead to hypertension through volume expansion by impaired sodium excretion and activation of RAAS due to damaged kidney; and increased systemic vascular resistance due to impaired arterial elasticity.[11,12]

Our study consisted of 93 study participants with 31 male and 62 female office workers with mean age of 38.73±1.12 years and mean BMI of 26.05±0.63 which is classified as obese grade I in Asian population. The participants' median fasting blood glucose and fasting insulin were 90 (71-298) mg/dL and 7.5 (2.2-68.8) mIU/L, respectively. Both fasting blood glucose and fasting insulin were still in the normal range. However, HOMA-IR value shows a risk of insulin resistance with value of 1.7 (0.5-17.3). A study conducted by Yamada et al (2012) have found the cutoff value of 1.7 to discriminate insulin resistance in non-diabetic Japanese subjects. As there are no available study in Indonesia yet, with similar population from Asian country, we referred to Yamada et al (2012) study to discriminate insulin resistance.[10,13] The participants' median systolic blood pressure and mean diastolic blood pressure were still in the normal range of below 130 mmHg and 80 mmHg, respectively. From these findings, it can be concluded that the participants' data were mostly centered in the profile of obese grade I, normal profile of insulin resistance, and normal profile of blood pressure. Current findings show that the participants were obese which is known to be a risk factor to develop metabolic syndrome in the future.[14,15]

Several studies have reported the association of insulin resistance with hypertension,[16–19] while some found no association.[20] A cohort study of North American Multi-Ethnic Study of Atherosclerosis (MESA) with a total participant of 3513 participants have reported that HOMA-IR

value above the 50th percentile (1.1-1.7) (RR: 1.33; 95% CI: 1.08-1.63) and 75th percentile (>1.7) (RR 1.44; 95% CI: 1.16-1.80) was associated with hypertension.[19] Moreover, the Brazilian Longitudinal Study of Adult's Health (ELSA-Brasil) with 4717 participants free of diabetes and cardiovascular disease at baseline reported an increased risk of hypertension in normotensive individuals with insulin resistance.[18] In our current cross-sectional observation study, there was a significant weak correlation of HOMA-IR with systolic and diastolic blood pressure. A similar report of significant weak correlation was reported in obese children in Indonesia.[21] An explanation of our current finding is the median HOMA-IR value in our study was 1.7 (0.5-17.3) which was located in the 75th percentile based on the MESA study that reported a significant correlation. This explains the significance of correlation between insulin resistance and increased blood pressure, but remained a weak correlation due to the effect of insulin resistance not reaching the statistical threshold of HOMA-IR above 1.7 to cause a larger effect on blood pressure.[19]

Our current study has several limitations and strengths. Our study shows the profile of insulin resistance, blood pressure, and BMI in office workers, a population of study where studies are not often conducted in Indonesia. Moreover, we report the profile of insulin resistance in office workers which is also not often conducted due to the limited resource of fasting insulin testing laboratories. However, we realize our studies are not free of limitations. The first limitation of our study is we conducted a cross-sectional study which is unable to observe the effect of insulin resistance and hypertension over time. We also only studied office workers in only one city and place, Faculty of Medicine, Universitas Trisakti. Thus, this explains the limited interpretation of the study result and should not be generalized. Further multicenter longitudinal studies with larger sample size is required to confirm our findings.

Conclusion

Insulin resistance shows a weak significant correlation with elevated blood pressure.

Conflict of Interests

All the authors declare that they have no conflict of interests.

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