Original Article

Risk factors for the metabolic syndrome in non-obese older Indonesians

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Background and Objectives: The problem of metabolic syndrome among non-obese older people is often ignored. This study examines the risk factors for metabolic syndrome in non-obese older people in Indonesia. We analyzed information collected from 3323 non-obese older respondents interviewed in the 2018 Basic Health Research program. **Methods and Study Design:** The outcome variable was the metabolic syndrome consisting of three components: high lipid profile, diabetes mellitus, and hypertension. The potential predictors analyzed were socio-demographic and behavioral factors consisting of psychomotor (cigarette smoking + physical activity) and dietary behavior (consumption of fat + fruit/vegetable). Multinomial logistic regression analysis was employed to assess metabolic syndrome risk factors in non-obese older people. **Results:** We found that the proportion of non-obese older people in Indonesia with metabolic syndrome was 83.8% (95%CI: 82.4-85.2%). The odds of developing 2-3 components of metabolic syndrome increased in respondents from rural areas (aOR=1.26, *p*=0.033) and those with moderate psychomotor behavior problems (current smoker/ex-smoker with sufficient physical activity) (aOR=1.48, *p*=0.002). **Conclusions:** Health promotion activities are vital to improve awareness and promote healthy behaviors, specifically for those living in rural areas and smoking cigarettes.

Key Words: metabolic syndrome, psychomotor behaviors, non-obese, older people, Indonesia

INTRODUCTION

The number of older people (aged 60 years and above) is projected to reach 77.4% of the world's population by 2025.[1] According to the United Nations, in 2019, 703 million people aged over 65 years in the world could be doubled by 2050.[2] The largest older people population was found in the East and Southeast Asia (260.6 million people) region.[2]

In 2020, the number of older people in Indonesia was 26.8 million (9.92%),[3] showing the country's transition period to an aging population as the proportion of older people is above 10%.[3] The increased proportion of older people generally occurs along with the improvement of the health sector resulting in increased life expectancy and reduction of mortality rates.[3]

One of the public health challenges in Indonesia, particularly amongst older people, is the occurrence of metabolic syndrome, related to a group of cardio-metabolic risk factors. Metabolic syndrome is associated with impaired blood glucose, hypertension, dyslipidemia, and obesity.[4] Metabolic syndrome increases the risk of diabetes, heart attack, stroke, dementia, kidney disease, fatty liver, visual impairment, and other diseases.[5,6] Data showed that the prevalence of several cardio-metabolic problems in Indonesia has increased over time.[7-11] In 1995, the prevalence of hypertension was 8.2%,[7] then increased to 28% in 2001,[8] 31.7% in 2007, and 34.1% in 2018.[11] In 2007, the prevalence of diabetes mellitus was 5.7%, obesity was 19.1%, and central obesity was 18.8 %.[9] In 2018, the prevalence of diabetes mellitus was 8,6%, obesity was 21,8%, and central obesity was 31,0%.[11]

The issue of metabolic disorders among non-obese individuals is often ignored, as they are considered healthy.[12] Consequently, they were at high risk for chronic disease associated with increased body mass index, even though the increased body weight did not reach the threshold for obesity. Previous literature reported that even normal-weight individuals could experience metabolic disorders.[12] Therefore, this study examines the risk factors for metabolic syndrome in non-obese older people in Indonesia. The findings could provide input to program managers in designing and implementing metabolic syndrome prevention programs in older people, especially amongst the non-obese population.

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METHODS

Data used in this analysis were derived from the 2018 Basic Health Research conducted by the National Institute of Health Research and Development, Ministry of Health Republic of Indonesia.[11] The 2018 Basic Health Research was conducted in 514 districts/cities in 34 provinces, representing Indonesia's district/city level. The biomedical examination (blood sample) was a subset of the survey carried out in 19,533 households of 2498 census blocks. A detailed explanation of the Basic Health Research is presented elsewhere.[11]

The sample used in this analysis were all household members aged 60+ years interviewed in this survey[13] who did not experience obesity, including central obesity, and without any physical and mental disabilities. Non-obese was defined as individuals with BMI <25 kg/m^2 and abdominal circumference of <90 cm and <80 cm for men and women. The body weight was measured using a digital weighing scale with an accuracy of 0.1 kg calibrated daily. Height was measured with a height measuring instrument "Multifunctional" with a capacity of two meters and an accuracy of 0.1 cm. The total number of respondents analyzed after correcting for extreme values of the anthropometric measurements was 3323 non-obese older people.

Research ethics and informed consent

The 2018 Basic Health Research of Indonesia was conducted according to the guidelines of the Declaration of Helsinki and approved by the Health Research Ethics Committee of the National Institute of Research and Development, Ministry of Health of the Republic of Indonesia No.: LB.02.01/2/KE.024/2018, July 28, 2017). Informed consent was obtained from all subjects involved in the study. All respondents were asked to sign an informed consent form before conducting the interview, and blood samples were collected.

Research data

Restrictions apply to the availability of these data. Data were obtained from the National Institute of Health Research and Development, Ministry of Health Republic of Indonesia and are available from the authors with the permission of the National Institute of Health Research and Development, Ministry of Health Republic of Indonesia.

Variables

Metabolic syndrome

The outcome variable in this analysis is metabolic syndrome, a combination of increased high lipid profile, diabetes mellitus, and hypertension. The lipid profile consists of (1) the total cholesterol; (2) high-density lipoprotein (HDL); (3) low-density lipoprotein (LDL); and (4) triglycerides. The cut-off point used for high lipid profile was the total cholesterol ≥200 mg/dL, or HDL <40 mg/dL, LDL ≥130, or triglycerides ≥150 mg/dL. Respondents were categorized as having diabetes mellitus if, at the interview, respondents reported that health professionals had ever made a medical diagnosis.

The hypertension variable was based on the blood pressure measurement performed at the time of the survey. The blood pressure was measured using a digital blood pressure monitor, calibrated before data collection. Each respondent was measured at least twice. A third measurement was carried out if the blood pressure difference between the first and second measurements was more than or equal to 10 mmHg. The average of two measurements with the slightest difference was calculated and determined as the final blood pressure. The hypertension criteria used were based on the 2003 JNC VII diagnostic criteria: systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg.[14]

The dependent variable (metabolic syndrome) in the analysis was divided into four categories: 1) Do not have any component of metabolic syndrome, i.e., normal lipid profile, did not have diabetes mellitus, and did not have hypertension (never been diagnosed with hypertension, did not take any hypertension drugs and showed normal blood pressure measurement); 2) Had one component of metabolic syndrome (high lipid profile, or diabetes mellitus, or hypertension), 3) Had two components of metabolic syndrome (high lipid profile and had diabetes mellitus, or high lipid profile and hypertension, or had diabetes mellitus and hypertension); and 4) Had three components of metabolic syndrome (high lipid profile, diabetes mellitus, and hypertension).

Potential predictors of metabolic syndrome

Socio-demographic factors included as independent variables in this analysis were the area of residence (urban and rural); sex (male and female); marital status (married and not married/divorced); age (60-70 years and 71 years and over); and level of education (low level referring to those graduating from junior high school or lower, while high level referring to graduating from high school or higher).

Behavioral variables analyzed in this study included psychomotor and dietary behavior. Psychomotor behavior relates to skills, or the ability gained after a person receives a cognitive and affective learning experience.15 In this analysis, psychomotor behavior consisted of cigarette smoking and physical activity. Cigarette smoking was grouped into four categories: 1) never smoking, 2) ex-smoking, 3) sometimes smoking, 4) daily smoking. The physical activity variable is a composite variable calculated based on the type and duration (days per week and minutes per day), including physical exercise. Each type and duration of physical activity was multiplied by a weighting factor (eight for vigorous physical activity, including strenuous exercise; four for moderate activity; and two for high activity). Some images were used to assist respondents in categorizing the type of activity they performed during the interview. The total physical activity score was calculated and ranked based on the Global Physical Activity (GPA) guidelines.16 Subjects were categorized as insufficient if the total activity was less than 600 MET (metabolic equivalent) per week and sufficient if the total activity was 600 MET or above.16 Psychomotor behavior was divided into four categories: 1) Very severe problem: current smoker/ex-smoker with insufficient physical activity; 2) Severe problem: never smoke with insufficient physical activity; 3) Moderate problem: current smoker/ex-smoker with sufficient physical activi-

ty, and 4) No problem: never smoke with sufficient physical activity.

The dietary behavior was based on the consumption of fat, fruit, and vegetable. The consumption of fat was categorized into 1) Daily (once or more per day), 2) Often (at least 3-6 times per week), 3) Rarely/never (1-2 times per week or <3 times per month or never). Based on the WHO guidelines,[17] the fruit and vegetable consumption was grouped into 1) Sufficient (at least five servings) and 2) Insufficient (less than five servings). The dietary behavior was then categorized into two groups: 1) High risk, referring to daily/frequent consumption of fat and insufficient consumption of fruit/vegetable; and 2) Moderate risk, referring to daily/frequent consumption of fat but sufficient consumption of fruit/vegetable, or rarely consumption of fat but insufficient consumption of fruit/vegetable, or rarely consumption of fat and sufficient consumption of fruit/vegetable.

Data analysis

Data analysis, initially, was carried out by examining the distribution of each risk factor against the occurrence of metabolic syndrome. Several composite variables were constructed based on previous literature and the data distribution. Factors associated with metabolic syndrome in non-obese older people were examined using multinomial logistic regression analysis. Multivariable analysis was employed to assess the association between various risk factors simultaneously. All variables used in the analysis were entered into the multivariable analysis. The stepwise method was performed to identify the final model consisting of variables significantly related to the study outcome using the significance level of 0.05. All analyses used statistical software SPSS v.24, suitable for analyzing complex sample data. All estimates were weighted by the sampling probabilities.

RESULTS

Our analysis shows that the proportion of non-obese older people respondents who had metabolic syndrome was 83.8% (95%CI: 82.4-85.2%). Around 47.4% had one component of metabolic syndrome, and 36.4% had 2-3 components of metabolic syndrome (Table 1). Almost 56.1% (95%CI: 54.2-58.0%) of respondents had hypertension (Supplementary Figure 1).

Table 1 shows the socio-demographic characteristics of non-obese older people respondents included in our analysis by metabolic syndrome status. In this crude analysis, there was a significant association between respondents' level of education (p=0.003), marital status (p=0.002), sex (p<0.001), and area of residence (p<0.001) (Table 1). The frequency distribution of respondents' behavior by the status of metabolic syndrome is presented in Table 2. Only the problem of psychomotor behavior was significantly associated with metabolic syndrome (p<0.001) (Table 2).

Table 3 shows the results of the multivariable analysis. The odds of developing one component of metabolic syndrome was significantly higher in non-obese older people with a very severe psychomotor problem (current smoker/ex-smoker with insufficient physical activity) than in those without any problems (aOR=1.54, 95% CI: 1.11-2.14, p=0.010). The odds of developing 2-3 components of metabolic syndromes in respondents living in rural areas was 26% higher than in urban areas (aOR=1.26, 95% CI: 1.02-1.55, p=0.033). The odds was also significantly higher in respondents with moderate psychomotor behavior problems (current smoker/ex-smoker with sufficient physical activity) than in those without any problems (aOR=1.48, 95% CI: 1.16-1.90, p=0.002) (Table 3). A higher percentage of respondents smoking cigarettes was found in rural than urban areas (Table 4).

DISCUSSION

Main findings

We found a high proportion of non-obese older people in Indonesia with the metabolic syndrome. An increased likelihood of having the metabolic syndrome was associated with non-obese older people who lived in rural areas. The older population with moderate psychomotor behavioral problems (current smoker/ex-smoker with sufficient physical activity) had an increased likelihood of developing metabolic syndrome than those with no psychomotor behavioral problems. Our study indicates the need to target not only obese but also non-obese older people in different health interventions addressing the issue of metabolic syndrome. Our findings might be used by program managers to design appropriate interventions for older people in Indonesia.

Metabolic syndrome in Indonesia

Our study found a high proportion of metabolic syndrome amongst non-obese older people in Indonesia. Lifestyle, defined as daily behavior patterns,[18] is changing in modern society. This includes a shift from traditional food consumption habits to instant and unhealthy food at all levels of society, potentially leading to increased degenerative disease.[19]

Residence and the metabolic syndrome

Non-obese older people living in rural areas of Indonesia were more likely to develop 2-3 metabolic syndrome than those living in urban areas. This is supported by previous literature showing a higher metabolic syndrome occurrence in rural areas than in urban areas.[20,21] This difference might be due to behavioral factors related to obesity,[21] indicating the need to conduct health education programs to improve community awareness of different risk factors of metabolic syndrome and the importance of having a healthy lifestyle.[22] Additionally, our finding might reflect the greater access to health services in urban areas than in rural areas.[11] Efforts to improve the availability, access, and coverage of health care services addressing the need of older people in rural areas, are essential.

Lifestyle and the metabolic syndrome

We found that smoking cigarettes increased non-obese older people's likelihood of having metabolic syndrome. This supports other findings that the prevalence of the metabolic syndrome is higher in cigarette smokers than non-smokers.[23] Heavy smokers (1.4%) are reported to be more at risk of developing metabolic syndrome than non-smokers.[24] Tobacco exposure, directly or indirectly, is associated with the emergence of the various features

Table 1. Percentage distribution of potential predictors of metabolic syndrome in non-obese older people by the status of metabolic syndrome

Characteristics	Metabolic Syndrome												p	Weighted N
	None		One component					Two-three components						
	%	SE	%	SE	p	OR	CI (95%)	%	SE	p	OR	CI (95%)		
Education													0.003	
High	16.6	2.3	38.9	3.1	0.148	0.78	0.56-1.09	44.4	3.3	0.267	1.21			315
Low	15.1	0.7	48.3	1.0				35.6	0.9					3006
Marital status													0.002	
Single/divorced	14.7	1.2	44.2	1.7	0.814	1.03	0.82-1.29	41,1	1.7	0.011	1.35			933
Married	16.7	0.8	48.7	1.1				34.6	1.1					2387
Sex													<0.001	
Female	13.7	1.0	44.6	1.4	0.207	1.15	0.92-1.44	41.7	1.5	<0.001	1.54			1029
Male	17.3	0.9	48.7	1.2				34.1	1.2					2291
Area of residence													<0.001	
Urban	15.1	1.1	44.4	1.6	0.956	1.00	0.82-1.23	40.6	1.6	0.004	1.36			1375
Rural	16.9	0.9	49.6	1.1				33.5	1.1					1946
Age (years)													0.085	
60-70	16.3	0.9	48.5	1.1	0.677	1.05	0.85-1.29	35.2	1.1	0.227	0.87	0.70-1.09		2266
71+	15.8	1.2	45.1	1.7				39.1	1.6					1055
Total	16.2	0.7	47.4	0.9				36.4	0.9					3323

Table 2. Percentage distribution of psychomotor and dietary behavior in non-obese older people by the status of metabolic syndrome

Variable	Metabolic Syndrome												p	Weighted N
	None		One component					Two-three components						
	%	SE	%	SE	p	OR	CI (95%)	%	SE	p	OR	CI (95%)		
The problem of psychomotor behavior													<0.001	
No psychomotor problem	13.5	1.3	18.5	1.1	0.317	1.16	0.87-1.53	26.8	1.5	<0.001	2.19			712
Moderate psychomotor problem	16.2	1.1	32.4	1.3	0.529	1.08	0.85-1.36	34.5	1.5	0.001	1.50			1107
Severe psychomotor problem	13.0	1.9	52.6	2.8	0.011	1.53	1.11-2.13	34.4	2.7	<0.001	2.19			453
Very severe psychomotor problem	19.3	1.4	50.9	1.8										1048
Dietary behavior													0.644	
High risk	17.4	1.6	47.0	2.1	0.367	1.14	0.88-1.41	35.6	2.0	0.317	1.13	0.89-1.45		707
Moderate Risk	15.8	0.8	47.6	1.0				36.6	1.0					2614
Total	16.2	0.7	47.4	0.9				36.4	0.9					3323

Table 3. Factors associated with metabolic syndrome in non-obese older people

	B	*p*	Exp(B)	95% confidence interval for exp(B)	
				Lower	Upper
One metabolic syndrome					
(Intercept)	0.979	<0.001			
Urban	ref				
Rural	-0.27	0.793	0.973	0.794	1.139
No psychomotor problem	ref				
Moderate psychomotor problem	0.149	0.305	1.160	0.873	1.542
Severe psychomotor problem	0.077	0.522	1.080	0.854	1.366
Very severe psychomotor problem	0.433	0.010	1.541	1.108	2.143
Two-three metabolic syndrome					
(Intercept)	0.356	<0.001			
Urban	ref				
Rural	0.230	0.033	1.258	1.019	1.553
No psychomotor problem	ref				
Moderate psychomotor problem	0.741	<0.001	2.098	1.568	2.808
Severe psychomotor problem	0.395	0.002	1.484	1.156	1.904
Very severe psychomotor problem	0.499	0.005	1.647	1.019	2.337

Table 4. Frequency distribution of components of psychomotor and dietary behavior in non-obese older people

Variable	Area of residence	
	Rural (%)	Urban (%)
Physical activity		
Sufficient	71.0	56.3
Insufficient	29.0	43.7
Cigarette smoking behavior		
Daily smoking	41.5	35.7
Sometimes smoking	6.2	6.0
Ex-smoking	8.2	15.7
Never smoking	44.2	42.6

of the metabolic syndrome, including reduced insulin sensitivity and increased insulin resistance.[25]

Indonesia is the world's largest male smoking country, with two out of three men being cigarette smokers, including teenagers and young adults.[26] Therefore, health promotion activities are required to raise community awareness about the dangers of smoking and its long-term effects after cessation. Health education should begin early for school-aged children and their parents to encourage healthy personal behaviors.

Some studies reported a reduced likelihood of developing metabolic syndrome with moderate to vigorous physical activities.[27–29] The type of physical activity in older people analyzed in our study tended to be low intensity on account of age or health. This could lead to a relationship between physical activity and the risk of metabolic syndrome that may be less identifiable in older people, as found in this study.

Our study emphasises the importance of detecting and monitoring non-communicable risk factors irrespective of age and obesity. Indonesia has a health program that monitors risk factors for non-communicable diseases, known as the Integrated Development Post for non-communicable diseases (*Posbindu PTM*). The main targets of the *Posbindu PTM* activity are healthy, at-risk groups and people with non-communicable diseases aged 15 years or above.[30] Although the screening for the risk factors for non-communicable diseases, such as blood pressure, blood glucose, and body mass index, could be initiated individually, the wider promotion of *Posbindu PTM* services would be advantageous.[30]

Strengths and limitations

Our study analyzed the risk factors for metabolic syndrome amongst the non-obese. Little research has been conducted in this field, especially in Indonesia. We accessed a national survey with a large sample size, providing adequate power. However, several limitations should be considered when interpreting the findings. In this cross-sectional survey, the information provided by respondents was not validated and was based on respondents' recollections. However, a family member knowledgeable about the respondent's condition accompanied the respondent at the interview. The survey also used real-size images to show types of physical activity and the type and serving size of fruit and vegetable consumed. Diagnosis of diabetes mellitus was based on a health professional report. The corollary was that those not yet diagnosed were categorized as non-Diabetes Mellitus respondents. Regarding fat consumption, the food frequency methodology did not distinguish type.

Conclusions

There is a high proportion of non-obese older people in Indonesia who have metabolic syndrome and require attention. Health promotion should target non-obese older people in rural areas and those who smoke cigarettes. Greater effort to improve accessibility and availability of services for early detection of risk factors and their man-

agement among older people, notably in rural areas, is required.

AUTHOR DISCLOSURES

The authors declare no conflict of interest.

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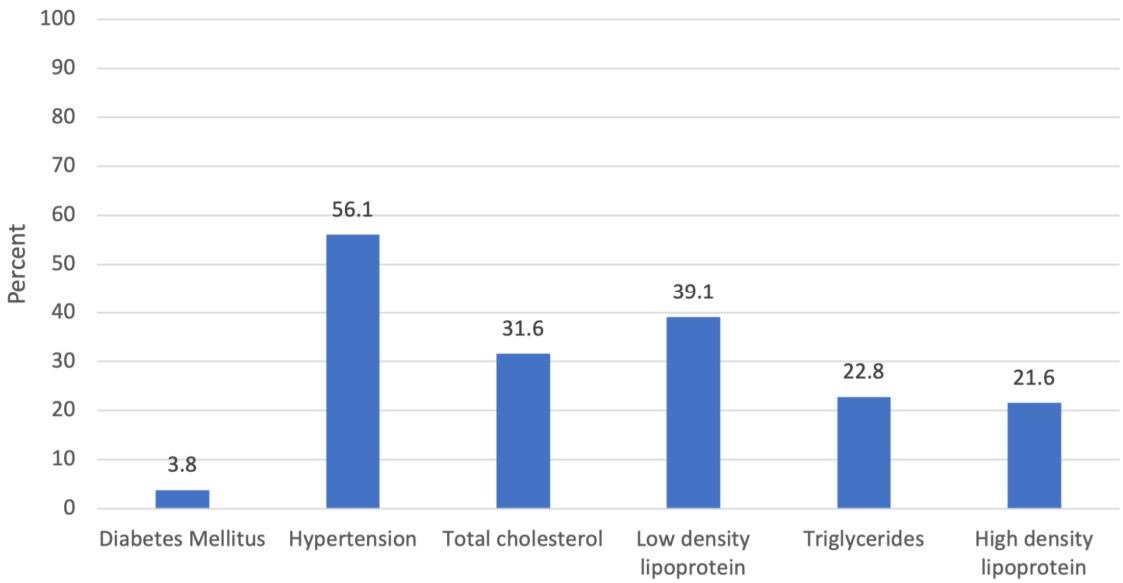

Supplementary figure 1. Frequency distribution of each symptom of metabolic syndrome in non-obese older people. LDL: low density lipoprotein; HDL: high density lipoprotein.