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Modifiable risk factors for coronary artery disease in the Indonesian population: a nested case-control study

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Background: There is a lack of data on modifiable coronary artery disease (CAD) risk factors in the Indonesian population, hindering the implementation of assessments and prevention programs in this population. This study investigated modifiable risk factors for CAD among Indonesians by comparing them between CAD-proven patients and healthy subjects from a similar population.
Methods: In this nested, matched case-control study, the cases were patients from a referral hospital in Yogyakarta, Indonesia and the controls were respondents in a population surveillance system in Yogyakarta, Indonesia. The cases were 421 patients who had undergone coronary angiography, showing significant CAD. The sex- and age-matched controls were 842 respondents from the Universitas Gadjah Mada Health and Health and Demographic Surveillance System Sleman who indicated no CAD presence on a questionnaire. The modifiable CAD risk factors compared between cases and controls were diabetes mellitus, hypertension, central obesity, smoking history, physical inactivity, and less fruit and vegetable intake. A multivariate regression model was applied to determine independent modifiable risk factors for CAD, expressed as adjusted odds ratios (AORs).
Results: A multivariate analysis model of 1,263 subjects including all modifiable risk factors indicated that diabetes mellitus (AOR, 3.32; 95% confidence interval [CI], 2.09–5.28), hypertension (AOR, 2.52; 95% CI, 1.76–3.60), former smoking (AOR, 4.18; 95% CI, 2.73–6.39), physical inactivity (AOR, 15.91; 95% CI, 10.13–24.99), and less fruit and vegetable intake (AOR, 5.42; 95% CI, 2.84–10.34) independently and significantly emerged as risk factors for CAD.
Conclusions: Hypertension, diabetes mellitus, former smoking, physical inactivity, and less fruit and vegetable intake were independent and significant modifiable risk factors for CAD in the Indonesian population.

Keywords: Coronary artery disease; Heart disease risk factors; Life style; Sedentary behavior; Dietary fiber

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INTRODUCTION

Cardiovascular diseases, especially ischemic heart disease, make a major contribution to mortality and disability-adjusted life years worldwide [1,2]. As in many developing countries, the burden of cardiovascular diseases and their risk factors are increasingly apparent in Indonesia, where coronary artery disease (CAD) is the second leading cause of death and disability [3]. A cross-sectional population study in Indonesia indicated that the prevalence of increased 10-year cardiovascular risk was higher than in other developing countries [4,5]. To reduce disabling morbidity and premature deaths from cardiovascular diseases, understanding the specific risk factors of CAD in the Indonesian population is of paramount importance.

The identification of risk factors, particularly modifiable risks, for CAD could direct the implementation of lifestyle changes and measures to control risk factors, which would be cost-effective in population-based approaches [6]. The modifiable risk factors for CAD include clinical factors (namely, hypertension, diabetes mellitus, and dyslipidemia) and lifestyle factors (namely smoking, overweight or obesity, lack of physical activity, and an unhealthy diet). In developed countries, the major modifiable CAD risk factors have been identified and systematic risk assessments have been developed, as well as thorough CAD prevention programs [7,8]. However, in less developed countries, including Indonesia, there is a lack of data on modifiable CAD risk factors related to the diverse populations of Indonesia, hindering the implementation of such assessments and programs in these populations. Identifying specific modifiable risk factors for CAD in Indonesia is important because doing so would enable steps to control them more accurately based on population characteristics. Recent demonstrative Indonesian national level data released by the Indonesia Ministry of Health through a cross-sectional study of basic health research (or Riset Kesehatan Dasar [RISKESDAS]), last conducted in 2018, identified several modifiable CAD risk factors particular to the Indonesian population [9]. However, the self-reporting of cardiovascular disease diagnoses underestimates its prevalence, thereby leading to inaccuracies in reports of its risk factors [5,9].

In the current study, we conducted a nested case-control study in the Special Region of Yogyakarta, which is located in south-central Java island and is the fourth most populated province in Indonesia [10]. Based on data from RISKESDAS 2018, Yogyakarta is among the provinces with the highest rates of high cardiovascular disease morbidity and mortality [9]. It consists of four regencies and one municipality. Since it is a hub of education and culture, diverse populations from various regions of Indonesia live in Yogyakarta. To date, no studies have directly compared modifiable CAD risk factors between healthy Indonesians and patients with established CAD. Thus, it is important to obtain reliable estimates of major modifiable CAD risk factors in this population. Therefore, this study aimed to obtain representative estimates of modifiable CAD risk factors by comparing major modifiable CAD risk factors between the apparently healthy population in Yogyakarta and patients with angiographically proven CAD who visited a tertiary referral hospital for cardiovascular disease in Yogyakarta, Indonesia.

METHODS

Ethical statements

This study protocol was approved by the Medical and Health Research Ethics Committee of Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada and Dr. Sardjito Hospital (No. KE/FK/0434/EC/2018 and No. KE/FK/0526/EC/2019). All subjects provided written informed consent to participate in the Health and Demographic Surveillance System (HDSS) Sleman survey, which included consent for the use of the data from the UGM HDSS Sleman database for research purposes.

Design and subjects

The study design was a nested case-control study. The study was conducted in 2019, and it enrolled patients with CAD from Dr. Sardjito Hospital as cases and respondents from the UGM HDSS Sleman as controls. Subjects with CAD were enrolled consecutively from patients admitted to Dr. Sardjito Hospital, a tertiary referral hospital for cardiovascular diseases in the region, who underwent elective coronary angiography (CAG) with or without percutaneous coronary intervention and were proven to have CAD. The age- and sex-matched control group, with a 1:2 ratio, consisted of subjects who were selected from the respondents of the

UGM HDSS Sleman. The UGM HDSS Sleman is a longitudinal and community-based survey that was established in 2014 in the Sleman Regency, Special Region of Yogyakarta, Indonesia by the Faculty of Medicine, Public Health and Nursing, UGM (https://hdss.fk.ugm.ac.id/) [8]. By the end of 2020, the UGM HDSS Sleman survey had completed its sixth wave, which included interviews to monitor risk factors for noncommunicable diseases (NCDs) among the individual panel population. The UGM HDSS Sleman individual panel population included one adult (≥25 years old) household member per household selected using Kish grid sampling in each wave [9].

Selection of cases

The cases consisted of subjects with angiographically proven CAD. The subjects were patients with a diagnosis of stable angina pectoris or history of acute coronary syndrome who underwent elective CAG at Dr. Sardjito Hospital. The inclusion criteria for cases were age 30 to 75 years, angiographically proven CAD, and signed an informed consent form. The exclusion criteria were patients with chronic heart failure (reduced ejection fraction), patients with chronic kidney disease (estimated glomerular filtration rate using the Modification of Diet in Renal Disease equation, <30 mL/min/1.73 m^2), patients with known hepatic cirrhosis, patients with ongoing treatment of malignancy, and patients with coronary anatomy anomalies (namely, congenital coronary anomalies and/or myocardial bridging). In total, 421 cases were enrolled.

Selection of controls

A control was defined as a UGM HDSS Sleman individual panel member who matched a case in terms of age (±2 years) and sex. Two controls were recruited per case. The inclusion criteria for controls were age 30 to 75 years; no indication of cardiovascular disease (angina pectoris or history of myocardial infarction) on a standardized approved questionnaire based on the Rose angina questionnaire, adopted by the HDSS Sleman survey [10]; and signing an informed consent form. The exclusion criteria were the absence of appropriate answers on the standardized UGM HDSS Sleman questionnaire; incomplete data about risk factors for NCDs; the presence of chronic diseases (chronic heart failure, chronic kidney disease, and/or hepatic cirrhosis); and active malignancy, derived from the UGM HDSS Sleman data based on self-reported diagnosis.

The controls were taken from the 4,855 UGM HDSS Sleman respondents who completed the fourth wave survey at the end of 2018. Other variables on chronic diseases were taken from the second and third waves (Table 1). Some of the variables included in the dataset are described in Table 1. A total of 123 respondents with positive responses for coronary heart diseases and angina on the questionnaire, and a total of 1,176 respondents with no adequate or incomplete records of risk factors for NCDs were excluded. Therefore, the number of respondents eligible for inclusion as controls was 3,553. Finally, with a 1:2 ratio of 421 cases, 842 matched controls were randomly selected from the eligible respondents considering age-and sex-matching to the cases (Fig. 1).

Anthropometric measurements

The waist and hip circumference were measured in both groups, as previously described [11]. A standard body tape was used to measure waist circumference to the closest 0.1 cm in the horizontal plane at the midpoint between the lowest rib and the iliac crest [11]. The hip circumference

Table 1. Variables recorded for controls from the Universitas Gadjah Mada Health and Demographic Surveillance System Sleman respondents

Variable	Wave	Inclusion
Sex	Fourth	Matched
Date of birth	Fourth	Matched
Age	Fourth	Matched
Highest/current education level	Fourth	No
Main occupation	Fourth	No
Consumption of fruit	Fourth	Yes
Consumption of vegetables	Fourth	Yes
Physical activity	Fourth	Yes
Blood pressure measurement	Fourth	Yes
Waist and hip circumference measurements	Fourth	Yes
Smoking	Fourth	Yes
Diabetes mellitus	Second and third	Yes
Hypertension	Second and third	Yes
Coronary heart disease	Second	Yes
Angina	Third	Yes

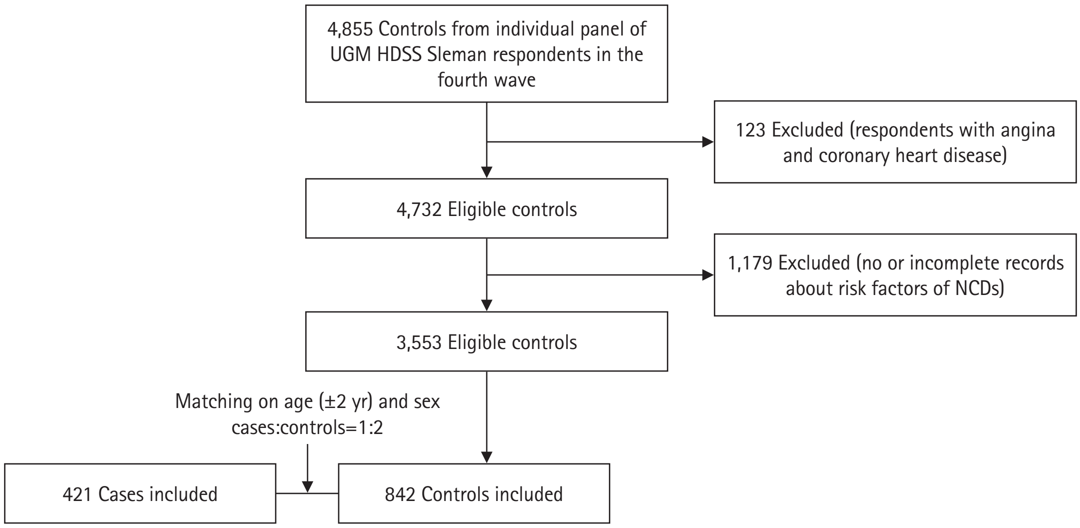

Fig. 1. Flowchart depicting the selection process of controls, where controls were matched for age (±2 years old) and sex with the cases. The ratio of cases to age- and sex-matched controls was 1:2. HDSS, Health and Demographic Surveillance System; NCD, noncommunicable disease.

(cm) was measured at the maximum protrusion of the hip [11]. In the cases, anthropometric measurements were conducted after the CAG procedure by the trained investigator in the morning, after 8 hours of fasting. In the control group, the measurements were conducted during home visit interviews. Central obesity based on waist circumference was determined by waist circumference (>90 cm in men and >80 cm in women) [12].

WHO-approved questionnaires

The CAD risk factors were measured using a standardized questionnaire recording several habits, including smoking behavior, physical activity, and fruit and vegetable consumption. The same questionnaire was administered to both cases and controls. Subjects' history of recent smoking behavior or use of any tobacco product, including its duration and quantity of daily smoking, was recorded using the World Health Organization (WHO) STEPS Questionnaire [13]. Smoking behavior was defined as current, former, and never smoking [14]. Former smokers included subjects who smoked regularly and then stopped, current smokers were those who smoked regularly at the time of the survey, and never smokers were those who had never smoked at all [14]. For fruit and vegetable consumption, subjects were asked about the frequency of fruit and vegetable intake, as well as the serving size, in a typical week. The subjects were divided into two groups according to their daily fruit and vegetable intake based on the WHO recommendation (at least 400 g/day) [15]. Subjects with less fruit and vegetable intake was defined as those who did not meet the WHO recommendation. Subjects were asked about their physical activity pattern, namely frequency and duration, in three different activities (at work, for transportation, and leisure time). Details concerning the physical activity analysis have been described elsewhere [16]. The subjects' physical activity was classified based on the WHO-recommended physical activity level of ≥600 metabolic equivalent of task (MET)-min/wk [14]. Subjects with physical inactivity was defined as those with physical activity level below WHO recommendation.

Statistical analysis

Stata ver. 13 (Stata Corp) was used for all data analysis. The descriptive analysis was presented as mean±standard deviation for continuous data and percentage for categorical data. Next, a bivariate analysis was conducted to evaluate the relationships between CAD and all independent variables using the chi-square test, with statistical significance set at $P<0.05$. Then, a multivariate analysis was performed for variables with $P<0.25$. We used logistic regression in each model for the multivariate analysis and then presented the results as odds ratios (ORs) with 95% confidence intervals (CIs). Two models were generated from the findings of the multivariate study to identify significant independent risk factors for CAD. Model 1 included demography (sex and age) and lifestyle risk factors (smoking, physical inactivity, and less fruit and vegetable intake); model 2 included demographic characteristics (sex and age), clinical risk factors (hypertension and diabetes mellitus), and lifestyle risk factors (smoking, physical inactivity, and less fruit and vegetable intake). P<0.05 was considered indicative of statistical significance.

RESULTS

Table 2 shows a comparison of the characteristics of 1,263 subjects according to the groups (cases vs. age- and sex-matched controls). Among the 421 cases, the mean age was 58.9±8.6 years, with 337 men (80.0%) and 84 women (20.0%). The 842 controls had a mean age of 58.9±8.8 years, 674 (80.0%) were men, and 168 (20.0%) were women. The most numerous age group was 51 to 60 years (cases, 38.2%; control, 36.9%). Several risk factors showed significant differences between the cases and the controls (P<0.001). Clinical risk factors (namely, diabetes mellitus, hypertension, and central obesity) and lifestyle risk factors (namely, smoking, physical inactivity, and less fruit and vegetable intake) were significantly associated with CAD.

The cases had a higher proportion of diabetes mellitus than the controls (29.5% vs. 9.4%), as well as more subjects with hypertension (63.2% vs. 31.8%). The proportion of central obesity was greater in the cases (51.3%) than in the controls (36.7%). The cases included more former smokers (60.7%), whereas in the controls, current smokers (36.7%) were still prevalent and former smokers (18.4%) formed a distinct minority. The cases had more physical inactivity and consumed less fruit and vegetables, which are fiber-rich foods. More cases (54.8%) failed to meet the WHO-recommended physical activity index of ≥600 MET-min/wk than

Table 2. Comparison of modifiable coronary artery disease risk factors between the cases and the sex- and age-matched controls (n=1,263)

Risk factor	Case (n=421)	Control (n=842)	P-value
Sex			>0.999
Male	337 (80.0)	674 (80.0)	
Female	84 (20.0)	168 (20.0)	
Age (yr)	58.9±8.6	58.9±8.8	>0.999
<51	77 (18.3)	170 (20.2)	
51–60	161 (38.2)	311 (36.9)	
61–70	146 (34.7)	279 (33.1)	
>70	37 (8.8)	82 (9.7)	
Diabetes mellitus	124 (29.5)	79 (9.4)	<0.001
Hypertension	266 (63.2)	268 (31.8)	<0.001
Central obesity[a]	210 (51.3)	305 (36.7)	<0.001
Smoking[b]			<0.001
Current	9 (2.2)	309 (36.7)	
Former	252 (60.7)	155 (18.4)	
Never	154 (37.1)	378 (44.9)	
WHO-recommended physical activity ≥600 MET-min/wk[c]			<0.001
Met recommendation	174 (45.2)	759 (95.1)	
Did not meet recommendation	211 (54.8)	39 (4.9)	
WHO-recommended fruit and vegetable intake ≥400 g/day			<0.001
Met recommendation	19 (4.5)	175 (20.8)	
Did not meet recommendation	402 (95.5)	667 (79.2)	

Values are presented as number (%) or mean±standard deviation.
WHO, World Health Organization; MET, metabolic equivalent of task.
[a]409 Cases, 830 controls; [b]415 cases, 842 controls; [c]385 cases, 798 controls.

controls (4.9%). In addition, we found a higher percentage of subjects meeting the WHO recommendation of fruit and vegetable intake ≥400 g daily in the controls (20.8%) than in the cases (4.5%).

The bivariate analysis showed the modifiable risk factors associated with CAD (Table 3). Diabetes mellitus (OR, 4.03; 95% CI, 2.91–5.58), hypertension (OR, 3.67; 95% CI, 2.85–4.73), central obesity (OR, 1.81; 95% CI, 1.41–2.32), physical inactivity (OR, 23.59; 95% CI, 15.95–35.34), and less fruit and vegetable intake (OR, 5.55; 95% CI, 3.38–9.58) were identified as modifiable risk factors that showed significant associations with CAD. Former smokers had a higher likelihood of CAD (OR, 3.99; 95% CI, 3.03–5.24) than never smokers. Fewer cases than controls were still current smokers.

The findings of the multivariate logistic regression models are presented in Table 4. In model 1, the lifestyle risk factors—namely, former smoking (adjusted OR [AOR], 4.14; 95% CI, 2.76–6.20), physical inactivity (AOR, 17.96; 95% CI, 11.66–27.64), and less fruit and vegetable intake (AOR, 5.24; 95% CI, 2.81–9.76)—were each independently and significantly associated with CAD. In model 2, with the inclusion of clinical risk factors, we found that diabetes mellitus (AOR, 3.32; 95% CI, 2.09–5.28) and hypertension (AOR, 2.52; 95% CI, 1.76–3.60) were each independently and significantly associated with CAD, whereas central obesity was not (AOR, 1.03; 95% CI, 0.71–1.50). As lifestyle risk factors, former smoking (AOR, 4.18; 95% CI, 2.73–6.39), physical inactivity (AOR, 15.91; 95% CI, 10.13–24.99), and less fruit and vegetable intake (AOR, 5.42; 95% CI, 2.84–10.34) each still independently and significantly emerged as risk factors for CAD after adjustment for clinical risk factors (Fig. 2).

DISCUSSION

Our study showed that the modifiable risk factors, both clinical and lifestyle-related, accounted for a significantly increased risk of CAD in the Indonesian population. Hypertension and diabetes mellitus were confirmed in our study as major diseases and clinical risk factors independently associated with CAD. Lifestyle-related risk factors—namely, smoking status, physical inactivity, and less fiber-rich food intake—were also confirmed to be independently associated with CAD. However, central obesity did not emerge as an independent risk factor for CAD. These identified modifiable CAD risk factors can become targets for primary prevention programs that promote healthy lifestyle modifications and the control of clinical risk factors to reduce CAD events and the burden of CAD in the Indonesian population.

In Indonesia, hypertension is the single leading risk factor in both younger and older age groups, accounting for 33% of all CAD [4,14,17]. The predominance of hypertension as a CAD risk factor is consistent with previous reports from cohort studies [18,19]. In addition, diabetes mellitus is considered to be a major health problem in Indonesia, where more than 10 million people live with diabetes and the prevalence is 6.2% [20]. Based on a cohort of 1.9 million people, diabetes mellitus is strongly associated with an increased

Table 3. Bivariate analysis and odds ratios for the associations between modifiable risk factors and coronary artery disease

Risk factor	Odds ratio	95% CI
Sex		
Male	1 (Reference)	
Female	1.00	0.73–1.35
Age (yr)		
<51	1 (Reference)	
51–60	1.14	0.82–1.59
61–70	1.15	0.82–1.61
>70	0.99	0.62–1.59
Diabetes mellitus		
No	1 (Reference)	
Yes	4.03	2.91–5.58
Hypertension		
No	1 (Reference)	
Yes	3.67	2.85–4.73
Central obesity		
No	1 (Reference)	
Yes	1.81	1.41–2.32
Smoking		
Never	1 (Reference)	
Former	3.99	3.03–5.24
Current	0.07	0.03–0.14
WHO-recommended physical activity ≥600 MET-min/wk		
Met recommendation	1 (Reference)	
Did not meet recommendation	23.59	15.95–35.34
WHO-recommended fruit and vegetable intake ≥400 g/day		
Met recommendation	1 (Reference)	
Did not meet recommendation	5.55	3.38–9.58

CI, confidence interval; WHO, World Health Organization; MET, metabolic equivalent of task.

Table 4. Multivariate regression models and adjusted ORs for the associations between risk factors and coronary artery disease

Risk factor	Adjusted OR (95% confidence interval)	
	Model 1	Model 2
Sex		
Male	1 (Reference)	1 (Reference)
Female	1.2 (0.76–1.90)	1.09 (0.66–1.79)
Age (yr)		
<51	1 (Reference)	1 (Reference)
51–60	0.99 (0.62–1.57)	0.78 (0.47–1.27)
61–70	0.91 (0.56–1.47)	0.67 (0.40–1.12)
>70	0.73 (0.37–1.43)	0.58 (0.28–1.19)
Diabetes mellitus	NA	
No		1 (Reference)
Yes		3.32 (2.09–5.28)
Hypertension	NA	
No		1 (Reference)
Yes		2.52 (1.76–3.60)
Central obesity	NA	
No		1 (Reference)
Yes		1.03 (0.71–1.50)
Smoking		
Never	1 (Reference)	1 (Reference)
Former	4.14 (2.76–6.20)	4.18 (2.73–6.39)
Current	0.09 (0.04–0.21)	0.12 (0.05–0.28)
WHO-recommended physical activity ≥600 MET-min/wk		
Met recommendation	1 (Reference)	1 (Reference)
Did not meet recommendation	17.96 (11.66–27.64)	15.91 (10.13–24.99)
WHO-recommended fruit and vegetable intake ≥400 g/day		
Met recommendation	1 (Reference)	1 (Reference)
Did not meet recommendation	5.24 (2.81–9.76)	5.42 (2.84–10.34)

Model 1, ORs adjusted for demographic characteristics (sex and age) and lifestyle-related risk factors (smoking, physical inactivity, and less fruit and vegetable intake). Model 2, ORs adjusted for demographic characteristics (sex and age), clinical risk factors (hypertension, diabetes mellitus, and central obesity) and lifestyle-related risk factors (smoking, physical inactivity, and less fruit and vegetable intake).
OR, odds ratio; NA, not applicable; WHO, World Health Organization; MET, metabolic equivalent of task.

risk of many atherosclerotic cardiovascular diseases [21]. According to the geographic and socioeconomic analysis of RISKESDAS concerning cardiovascular risk factors, the prevalence of obesity, hypertension, and diabetes mellitus is higher among urban inhabitants and those in the richest and most educated districts, whereas physical inactivity and smoking are higher among rural residents and inhabitants of the least educated districts [6]. Our nested case-control study confirmed that hypertension and diabetes mellitus are important disease-related risk factors for CAD.

Physical activity is associated with a 6% reduction in CAD cases and a 0.68-year increase in life expectancy [22]. Moreover, among patients with established CAD, exercise-based cardiac rehabilitation has been shown to lead to reductions in CAD mortality and hospitalization [23]. Nevertheless, 33.5% of Indonesians engage in physical activity for less than 150 min/wk [24]. Physical inactivity and smoking are higher among rural residents and inhabitants of the least educated communities [6]. Our study showed that less physical activity had a stronger association with CAD than other risk factors. Of note, the questionnaire regarding the physical activity was performed during illness in the cases, which may account for the substantial disparity between groups. However, this still emphasizes the importance of promoting physical activity in adults to reduce CAD risk and as secondary cardiovascular disease prevention.

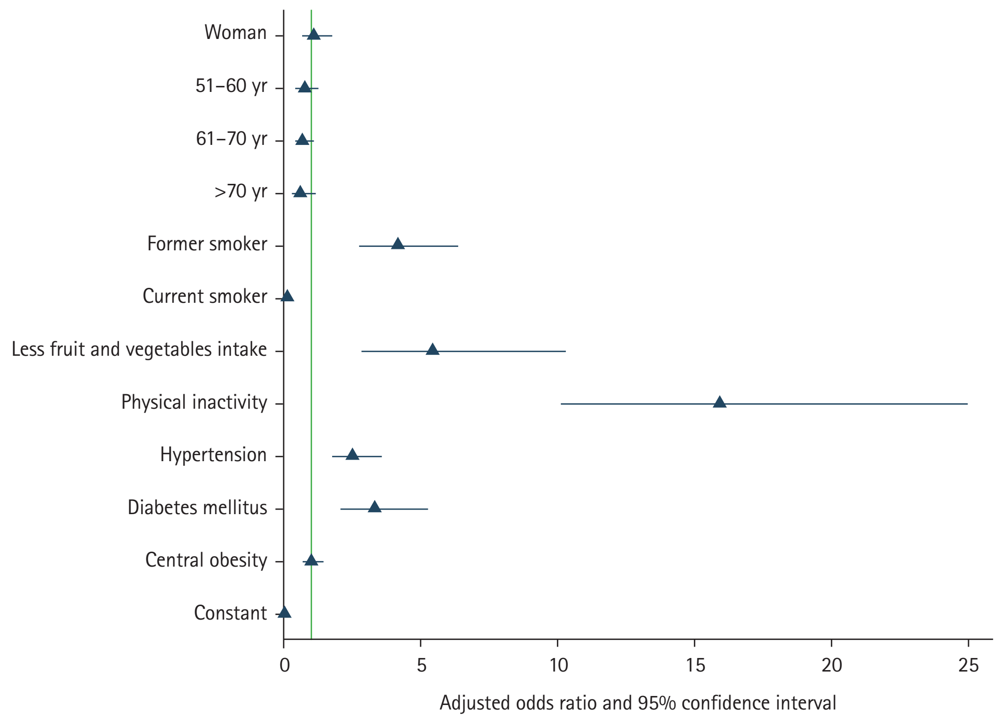

Fig. 2. Results of the multivariate analysis showing the associations between risk factors and coronary artery disease. Modifiable risk factors—namely, clinical risk factors (such as hypertension and diabetes mellitus, but not central obesity) and lifestyle-related risk factors (such as former smoking, physical inactivity, and less fruit and vegetable intake)—were independent and significant risk factors for coronary artery disease.

Plant-based and Mediterranean diets, along with higher levels of fruit and vegetable intake, have consistently been associated with lower risks of all-cause mortality than standard diets [25]. A recent meta-analysis showed that dietary fiber is inversely associated with CAD risk, especially for fiber from cereals and fruits, with a significant dose-response relationship observed between fiber intake and CAD risk [26]. A previous study among Indonesians showed that a large proportion consumed CAD high-risk foods and had insufficient fiber consumption, independent of the presence of cardiovascular disease [27]. Our study showed that the cases consumed significantly less fiber-rich diets, contained in fruits and vegetables, than the controls.

Our study showed that smoking behavior was still prevalent, as 62.9% of CAD cases had a history of smoking. Among them, 60.7% had already quit smoking and only 2.2% were still smoking. Meanwhile, 55.1% of the controls had a history of smoking. A previous study showed that among Indonesians, as many as 20% of individuals with known cardiovascular disease were current smokers, a proportion similar to that among apparently healthy individuals [27]. A case-control study of acute myocardial infarction in the INTERHEART study found that current smoking was associated with a greater risk of acute myocardial infarction than never smoking, with the risk increasing by 5.6% for every additional cigarette smoked [28]. Almost one-third of CAD deaths are attributable to smoking and exposure to secondhand smoke [29,30]. Our study indicated that CAD events drove patients to stop smoking.

This study has several limitations. Firstly, the questionnaire data were based on self-reported information, which may have caused potential bias due to recall issues. Secondly, associations measured in case-control studies may or may not represent causal relationships. Thereby, it is important to perform cohort studies to establish the causal relationships of risk factors of CAD. Nonetheless, this study has several strengths. Matching by age and sex was performed to control nonmodifiable risk factors. Matching ensures a similar number of cases and control in confounder strata, hence improving statistical precision and efficiency [31]. In addition, well-trained enumerators performed the interviews and physical examinations. This study also used standardized data collection tools to measure height, weight, and blood pressure.

In conclusion, clinical risk factors (namely, hypertension and diabetes mellitus) and lifestyle risk factors (namely, smoking, physical inactivity, and less fruit and vegetable intake), as major modifiable risk factors, were independent and significant risk factors for CAD among the Indonesian population. These identified modifiable CAD risk factors might become targets for public health primary prevention programs that promote healthy lifestyle modifications and steps to control clinical risk factors in order to reduce the cardiovascular disease burden among the Indonesian population.

ARTICLE INFORMATION

Ethical statements

This study protocol was approved by the Medical and Health Research Ethics Committee of Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada (UGM) and Dr Sardjito Hospital (No. KE/FK/0434/EC/2018 and No. KE/FK/0526/EC/2019). All subjects provided written informed consent to participate in the Health and Demographic Surveillance System (HDSS) Sleman survey, which included consent for the use of the data from the UGM HDSS Sleman database for research purposes.

Conflicts of interest

The authors have no conflicts of interest to declare.

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Author contributions

Conceptualization: ABH, JF, FSTD; Data curation: ABH, MPI, BWJ, PTR, RKW, FSTD; Formal Analysis: ABH, MPI, BWJ, JF, PTR; Funding acquisition: ABH; Investigation: MPI, RKW; Methodology: all authors; Project administration: FSTD; Resources: FSTD; Software: PTR, RKW; Supervision: ABH, JF, FSTD; Validation: ABH, JF, FSTD; Visualization: ABH, PTR; Writing–original draft: ABH, MPI, BWJ, PTR, RKW; Writing–review & editing: ABH, JF, FSTD. All authors read and approved the final manuscript.

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