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Original Article

Relationship between Serum 25-Hydroxyvitamin D Levels and Cardiovascular Disease Risk among Road Sanitations Workers

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Abstract

Background: Road sanitation workers are frequently exposed to sunlight during outdoor work, which may influence vitamin D status. Although several studies suggest that outdoor workers have a lower risk of vitamin D deficiency than indoor workers, evidence regarding the association between 25-hydroxy vitamin D [25-(OH)D] levels and cardiovascular disease (CVD) risk among sanitation workers remains limited. This study aimed to examine the relationship between serum 25(OH)D levels and CVD risk among road sanitation workers.

Methods: This analytical cross-sectional study included 105 road sanitation workers in West Cengkareng District, Jakarta, Indonesia selected using consecutive random. The 10-year cardiovascular risk was calculated using the World Health Organization/International Society of Hypertension (WHO/ISH) risk charts. Serum 25-(OH)D levels were measured from peripheral venous blood samples. Data were analyzed using the chi-square test and Fisher's exact test, with statistical significance defined as $p<0.05$.

Results: Vitamin D deficiency was observed in 59.05% of participants, whereas 85.7% had low-to-moderate CVD risk. No significant association was found between 25(OH)D levels and CVD risk ($p=0.582$). However, significant associations were identified between age ($p=0.001$), body mass index ($p=0.003$), blood pressure ($p=0.037$), smoking status ($p=0.037$) and cardiovascular disease risk.

Conclusions: Vitamin D deficiency is not associated with increased CVD risk among road sanitation workers. However, regular monitoring of vitamin D status may support occupational health and overall well-being.

Keywords: Cardiovascular disease risk, occupational health, road sanitation workers, vitamin D

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Introduction

The mortality rate due to cardiovascular disease (CVD) has been increasing in many developing countries.[1] In Indonesia, about 37% of deaths are caused by cardiovascular disease, especially stroke, followed by coronary heart disease.[2] The number of CVD-related deaths has more than doubled, increasing from 292,000 cases in 1990 to 659,000 cases in 2019. During the same period, the mortality rate increased from 346.4 to 387.2 deaths per 100,000 population, while the prevalence of CVD increased by 6.1%.[3]

Cardiovascular disease also contributes substantially to the global burden of disease. In 2012, CVD accounted for approximately 18,000 disability-adjusted life years (DALYs), of which around 17,500 DALYs were attributed to premature mortality, while the remainder resulted from years of healthy life lost due to disability.[2] Among ASEAN countries, Indonesia has the second-highest DALYs burden from CVD after Laos. At the provincial level, the highest DALYS rates have been reported in Bangka Belitung, followed by South Kalimantan and

Yogyakarta.[3]

A study conducted in Malang among adults aged 40 years and older reported that the 10-year CVD risk was lowest in rural areas (26.2%) and highest in urban areas (31.6%). By occupation, the highest risk was observed among unemployed individuals, while the lowest was among private-sector employees.[4] In addition, sanitation workers were reported to have a higher risk of CVD than hotel housekeepers across several cardiovascular risk prediction models.[5]

Major risk factors for cardiovascular disease include hypertension, smoking, obesity, and diabetes mellitus (DM).[6,7] The World Health Organization (WHO) Global Burden of Disease (GBD) report in 2013 noted that the prevalence of hypertension, hypercholesterolemia, and smoking has increased in low- and middle-income countries, while declining in high-income countries.[8] According to the Indonesian National Health Survey, approximately one-quarter of the population suffers from hypertension, around 30% were overweight with hypercholesterolemia, 7% had diabetes, most men (65%) were smokers, and 23% of the population had low physical activity levels.[2]

Another condition that may raise the risk of CVD is deficiency of vitamin D. Several studies have reported associations between serum 25-hydroxyvitamin D [25(OH)D] and various CVD risk factors, including hypertension, dyslipidemia, and diabetes mellitus.[9] A case-control study conducted in Kansas City revealed that individuals with vitamin D deficiency and no previous myocardial infarction experienced a notably reduced risk of mortality when their (25-OH)D levels increased above 20 ng/mL and 30 ng/mL compared to those who did not receive such supplementation. Individuals who maintained (25-OH)D levels ≥30 ng/mL also had a lower risk of myocardial infarction.[10] However, a study conducted in New Zealand found no significant difference in CVD incidence between groups receiving vitamin D supplementation and those receiving placebo.[11]

Governor Regulation of the Special Capital Region of Jakarta No. 196/2015 outlines the responsibilities of road sanitation workers, who maintain road infrastructure and sidewalks across two shifts (07:00–15:00 and 15:00–23:00 WIB).[12] Given these outdoor working hours, higher levels of ultraviolet B (UVB) exposure and subsequent vitamin D synthesis might be expected. However, research among Korean fishermen, another outdoor-working cohort, revealed that 78% had suboptimal vitamin D levels, highlighting a discrepancy between outdoor exposure and actual serum levels.[13]

Since data on serum 25(OH)D levels and cardiovascular risks among road sanitation workers remains limited, further investigation is required. Therefore, this study aimed to assess the relationship between serum 25(OH)D levels and CVD risk among sanitation workers in West Cengkareng district, Jakarta, Indonesia.

Methods

This cross-sectional analytical study was performed in West Jakarta, Indonesia in August 2025. The population of the study consisted of Public Facilities and Infrastructure Management officers, commonly known as road sanitation workers, in the West Cengkareng district, Jakarta. Eligible participants were male sanitation workers aged 40–64 years who had worked for at least one year and provided written informed consent to participate in the study. Respondents with a history of consuming cholesterol-lowering medications, anti-diabetic drugs, heart disease medication, or vitamin D supplements were excluded. Individuals with a history of stroke, coronary heart disease, or kidney failure were also excluded. Participants were recruited using a consecutive non-random sampling technique.

Sociodemographic and clinical data, including age, employment status, length of employment, history of comorbidities, and medication use, were collected through structured interviews using a standardized questionnaire.

Blood pressure was measured twice using an automatic sphygmomanometer (OMRON M3, Omron Healthcare Co., Ltd., Kyoto, Japan) after the participants had rested for at least 10 minutes. The final recorded value was used for analysis. Hypertension was defined as systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg. Participants receiving antihypertensive therapy were also classified as having hypertension.

Body weight and height were measured using a SECA model 700 scale and a SECA 220 stadiometer (SECA GmbH, Hamburg, Germany). Body mass index (BMI) was calculated as weight in kilograms (kg) divided by the square of height in meters (kg/m^2).

The 10-year CVD risk was stratified based on the WHO non-laboratory-based cardiovascular risk charts for the South East

Asia region. Risk stratification was evaluated by determining age, gender, smoking status, systolic blood pressure, and BMI. The predicted 10-year cardiovascular risk was categorized into five groups: low risk (<5%), moderate risk (5–<10%), high risk (10–<20%), very high risk (20–<30%), and extremely high risk (≥30%). For analytical purposes, participants were further grouped into low-to-moderate risk (<10%) and high risk (≥10%).[14]

Serum 25-(OH)D levels were measured from peripheral venous blood samples. A serum level ≥30 ng/mL was considered normal, while levels <30 ng/mL was considered vitamin D deficiency.

Statistical analysis was performed using the chi-square statistical test, Fisher's exact test, and logistic regression analysis. Data processing was carried out using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). A p-value <0.05 was considered statistically significant. Ethical approval for this study was obtained from the Ethics Review Committee of the Faculty of Medicine, Trisakti University (No. 047/KER/FK/08/2024).

Results

Table 1 summarizes the sociodemographic and clinical characteristics of the respondents (n=105). Most participants were aged 40–49 years (67.6%) and had a normal body mass index (53.4%). A high proportion of respondents presented with elevated blood pressure (79.0%) and a history of smoking (81.0%). The majority had worked for less than 10 years (93.3%). More than half of the respondents had low 25-(OH)D levels (59.1%). Despite these clinical risk factors, most participants were classified as having a low-to-moderate risk of cardiovascular disease (85.7%), while a smaller proportion were categorized as high risk (14.3%).

The analysis revealed that age (p=0.001), smoking habits (p=0.037), BMI (p=0.003) and blood pressure (p=0.037) were significantly associated with CVD risk. Individuals aged 50–59 yearshad significantly higher odds of high CVD risk compared with those aged 40–49 years (OR=9.10; 95% CI: 2.32–35.65). Overweight individuals were also more likely to have high CVD risk compared with those with normal or underweight BMI (OR=5.50; 95% CI: 1.62–18.73). Smoking habits and blood pressure were significantly associated with cardiovascular disease risk; however, the distribution showed a higher proportion of high-risk cases among non-smokers compared

Table 1 Sociodemographic and Clinical Characteristics of Respondents (n=105)

Characteristic	n	%
Age (years)		
40–49	71	67.6
50–59	34	32.4
Body mass index (BMI)		
Underweight (≤18.49 kg/m^2)	8	7.6
Normal (18.5–24.9 kg/m^2)	56	53.4
Overweight (≥25 kg/m^2)	41	39.0
Blood pressure		
Normal (<120/<80 mmHg)	22	21.0
High (≥120/≥80 mmHg)	83	79.0
Smoking history		
No	20	19.0
Yes	85	81.0
Length of employment		
1–9 years	98	93.3
10–24 years	7	6.7
25-Hydroxyvitamin D		
Normal	43	40.9
Low	62	59.1
Cardiovascular disease risk		
Low–moderate risk	90	85.7
High risk	15	14.3

Table 2 Association Between Respondent Characteristics, 25-Hydroxyvitamin D Levels, and Risk of Cardiovascular Disease

Variable	Low–Moderate Risk n (%)	High Risk n (%)	p-value	OR	95% CI
Age (years)					
40–49	67 (94.4)	4 (5.6)	0.001^	9.10	2.32–35.65
50–59	23 (67.6)	11 (32.4)			
Smoking habits					
No	14 (70.0)	6 (30.0)	0.037^	0.28	0.09–0.90
Yes	76 (89.4)	9 (10.6)			
Length of employment (years)					
1–9	83 (84.7)	15 (15.3)	0.590^	N/A	N/A
10–24	7 (100.0)	0 (0.0)			
Body mass index					
Underweight–normal	60 (93.8)	4 (6.2)	0.003*	5.50	1.62–18.73
Overweight	30 (73.2)	11 (26.8)			
Blood pressure					
Normal	22 (100.0)	0 (0.0)	0.037^	N/A	N/A
High	68 (81.9)	15 (18.1)			
25-hydroxyvitamin D (ng/mL)					
Normal (30–100)	38 (88.4)	5 (11.6)	0.582*	–	–
Low (<30)	52 (83.9)	10 (16.1)			

Notes: CVD = cardiovascular disease; OR = odds ratio; CI = confidence interval; N/A = not applicable. ^ Fisher's exact test; * Chi-square test

with smokers. In contrast, no significant association was observed between length of employment or 25-hydroxyvitamin D levels and cardiovascular disease risk (Table 2).

Discussion

In this study, 67.6% of the 105 respondents were aged between 40 and 49 years old, placing the majority in middle adulthood, a stage associated with increasing vulnerability to CVD. The incidence of CVD events, including ischemic heart disease (IHD) and stroke, generally remains low before the age of 40 but increases steeply thereafter, particularly among male.[15]

Aging is widely recognized as a major risk factor for CVD such as atherosclerosis, stroke, and myocardial infarction in both male and female.[16] Numerous studies have shown that increasing age is associated with a higher risk of CVD. Research conducted in New Zealand found that the heart age gap decreases with advancing age; individuals aged 65–74 years have approximately half the heart age gap observed in individuals aged 35–44 years.[17] Although the heart age gap decreases with age, the absolute risk of short-term heart disease events continues to increase.[17] Thus, age remains an unmodified and independent risk factor for atherogenesis and also further CVD.[17]

This study also demonstrates an association between BMI and cardiovascular disease risk. A higher proportion of overweight individuals are classified as having high CVD risk compared with respondents with underweight or normal BMI, with an odds ratio greater than five. These findings are consistent with previous study, which reported a concomitant rise in atherosclerotic CVD prevalence with increasing BMI, along with other CVD risk factors such as insulin resistance and lipoprotein(a).[18] Similarly, data from an American cohort study indicated that a one-standard deviation increase in BMI variability was correlated with an 8% higher risk of adverse events of CVD.[19]

Smoking habits are also significantly associated with CVD risk. In this study, the majority of the non-smoking group are classified as having low-to-moderate CVD risk. The analysis demonstrated that non-smokers had lower odds of experiencing adverse cardiovascular outcomes compared to smokers. Previous evidence supports the strong association between smoking and cardiovascular disease. The Cross-Cohort Collaboration study found that smoking 2–5 cigarettes per day increases the risk of CVD by 26–57% than non-smokers, whereas smoking cessation for more than 20 years reduces the risk by over 80%.[20]

Blood pressure is also associated with cardiovascular disease risk in this study. All respondents with normal blood pressure are classified as having low-to-moderate CVD risk. Findings from a randomized controlled trial conducted in China indicate that targeting a systolic target of <120 mm Hg reduces major vascular events in high-risk hypertensive patients (independent of diabetes or stroke status) compared with a target of <140 mmHg, although with a slightly increased risk of adverse effects.[21] These findings highlight the importance of blood pressure control in reducing cardiovascular risk.

Sunlight exposure is the primary natural source of vitamin D, as ultraviolet radiation stimulates vitamin D synthesis in the skin.[22] However, previous study among road sanitation workers have shown that many individuals still have vitamin D levels below normal despite frequent outdoor exposure. In this study, 11.6% of respondents with normal 25-hydroxyvitamin D levels had a high risk of CVD compared with 16.1% among those with low vitamin D levels. However, no significant association was found between vitamin D levels and cardiovascular disease risk in this population. These findings are consistent with the study conducted in New Zealand, which reported no significant difference between monthly high-dose vitamin D supplementation and placebo in preventing CVD.[11] Similar results were reported in a meta-analysis evaluating vitamin D supplementation and major adverse cardiovascular events.[23]

However, another study has reported conflicting findings. An Australian study found that participants receiving vitamin D supplementation had a lower risk of myocardial infarction and coronary revascularization compared with those receiving placebo.[24] Another study also suggested that vitamin D deficiency may increase the likelihood of coronary artery disease.[25]

Vitamin D plays a vital role in maintaining calcium and phosphorus homeostasis. More recently, vitamin D receptors have been identified in various extra-skeletal tissues, suggesting broader physiological effects beyond bone metabolism.[9,26] Vitamin D may influence cardiovascular health by regulating the renin–angiotensin–aldosterone system (RAAS), endothelial function, and vascular smooth muscle cell activity. Vitamin D deficiency has also been associated with increased mortality and a higher incidence of cardiovascular disease.[26] Although no universal consensus exists regarding optimal vitamin D levels for preventing CVD, serum concentrations above 30 ng/mL are generally considered adequate.[27]

Vitamin D deficiency may contribute to vascular inflammation through activation of the NF-κB pathway, promoting inflammatory processes in blood vessel walls and epicardial adipose tissue that contribute to atherosclerosis.[26,28]

Furthermore, vitamin D deficiency has been linked to increased arterial stiffness, endothelial dysfunction, and vascular inflammation, all of which may accelerate atherosclerosis.[29] Several studies have suggested that vitamin D may support cardiovascular health by influencing blood pressure regulation through its effects on blood vessel cells. Vitamin D deficiency has also been associated with increased incidence of myocardial infarction, stroke, and peripheral artery disease.[9]

In this study, other risk factors such as length of employment were not significantly related to CVD risk. This may be due to the relatively small number of respondents who had worked for more than nine years. Further studies with larger sample sizes are needed to provide more accurate estimates.

One limitation of this study is the lack of homogeneity among respondents, particularly in terms of age and cumulative exposure to ultraviolet-B radiation, which may influence 25-hydroxyvitamin D levels. These factors could potentially affect the interpretation of the relationship between vitamin D status and cardiovascular risk.

In conclusion, this study demonstrates that vitamin D deficiency is not a factor that increases cardiovascular risk in road sanitation workers. However, age, BMI, blood pressure and smoking habit are associated with increased cardiovascular risk. Public health education remains important to encourage individuals to maintain adequate vitamin D levels and adopt healthy lifestyles to reduce the risk of cardiovascular and other extra-skeletal diseases.

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Authors' Contributions

MW conceived the research idea, conducted the study, contributed to manuscript drafting, and performed revisions and proofreading. TDS participated in conducting the study, analyzed the data, drafted the manuscript, and assisted with revisions. AK contributed to the research concept and assisted with data collection and data analysis. DM participated in data collection and provided education to respondents.

Conflict of Interest

The authors declare no conflict of interest.

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Generative AI Disclosure Statement

During the preparation of this work, the authors used Perplexity AI to identify and verify relevant references and Google Gemini to improve English translation. The authors reviewed and edited all generated content as needed and take full responsibility for the final manuscript.

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