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Original article

Higher cardiovascular risks and Atherogenic Index of Plasma found in police officers of developing country in Surabaya, East Java, Indonesia

Meity Ardiana [a,b,*], Primasitha Maharany Harsoyo [a], Hanestya Oky Hermawan [a], Inna Maya Sufiyah [b], Dwika Rasyid Firmanda [b], Saskia Ratna Desita [c], Annisya Dinda Paramitha [c], Arisvia Sukma Hariftyani [c], Farah Aisha Shabrina [c], Fita Triastuti [c]

[a] *Cardiology and Vascular Medicine, Faculty of Medicine, Airlangga University, 47 Mayjend. Prof. Moestopo, Surabaya, 60285, Indonesia*
[b] *Bhayangkara Hospital, 116 Ahmad Yani, Ketintang, Gayungan, Surabaya, 60231, Indonesia*
[c] *Faculty of Medicine, Airlangga University, 47 Mayjend. Prof. Moestopo, Surabaya, 60285, Indonesia*

A R T I C L E I N F O

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A B S T R A C T

Background: Police officers are known for fieldwork shifts, psychological stress, and prolonged physical activity that are associated with cardiovascular disease (CVD). We aim to determine the differences in CVD risks factor and Atherogenic Index of Plasma (AIP) profiles as a predictor of cardiac events between police officers and civilians in a developing country as an evaluation and strategic preventive measure for CVD.

Methods: 978 participants were enrolled as subjects in this cross-sectional study. Data used were obtained during medical check-ups using complete physical and laboratory examinations including blood pressure, body mass index (BMI), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), total cholesterol, fasting blood sugar, and AIP between 2019 and 2020 at Bhayangkara State Police Hospital Surabaya. Mann-Whitney *U* test was performed using IBM SPSS version 25.

Results: There are significant differences in systolic ($p = 0.000$) and diastolic blood pressure ($p = 0.003$), triglycerides ($p = 0.000$), LDL-C ($p = 0.006$), total cholesterol ($p = 0.000$), fasting blood glucose ($p = 0.001$), and the AIP ($p = 0.000$) between the police and civilian groups, with the latter showing a tendency of having higher rates.

Conclusions: CVD risk was found in both groups. Nevertheless, police officers have higher AIP and overall CVD risk compared to civilians, creating a necessity for aggressive CVD prevention strategies within the population.

1. Introduction

Cardiovascular disease (CVD) is a concerning non-communicable disease due to its mortality rate.[1] CVD is the number one cause of death globally according to WHO, reaching 17.9 million in 2019 and is predicted to increase by 2030.[2] The global prevalence of CVD has nearly doubled from 271 million in 1990 to 523 million in 2019.[3] In Indonesia, the number of CVD sufferers reached 1,017,290 in 2018,[4] with the fourth-highest number of deaths worldwide due to CVD.[3]

CVD can be prevented through lifestyle modification and avoiding risk factors such as hypertension, smoking, obesity, unhealthy diet, lack of physical activity, increased fasting blood sugar, and dyslipidemia. Dyslipidemia is an increase in total cholesterol, low-density lipoprotein cholesterol (LDL-C), triglycerides (TG) followed by a decrease in high-density lipoprotein cholesterol (HDL-C).[5,6] Although therapies for heart disease have developed rapidly, lifestyle modification and risk management play an essential role in reducing CVD incidence. Maharani et al., 2019 stated that Indonesian adults had a high-risk CVD but low preventive treatment.[7] A cohort study of a good lifestyle reduced by 40% the relative occurrence of CVD.[8] In the US, a national lifestyle change program was associated with a lower CVD incidence.[9]

The atherogenic Index of Plasma (AIP) has been widely reported as a strong predictor and biomarker of CVD. AIP, calculated with log (TG/HDL-C), has been used to measure blood lipids and an optimal indicator of dyslipidemia and CVD.[10] Another study stated that AIP is also a strong predictor of CVD in postmenopausal women.[11] An Iran study stated that AIP is closely related to physical activity and body mass index.[12] Moreover, A Chinese Population Study found that AIP was closely

* Corresponding author. 47 Mayjend. Prof. Moestopo, Surabaya, 60285, Indonesia.
E-mail address: meityardiana@fk.unair.ac.id (M. Ardiana).

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related to coronary artery disease.[13] Increased triglycerides and total cholesterol cause vasoconstriction and endothelial dysfunction in coronary arteries, thereby increasing the risk of coronary artery disease.[14] AIP strongly correlates with carotid intima wall thickening.[15] Meta-analysis states that lipid profile predicts cardiovascular outcome and mortality.[16]

Police officers are known for fieldwork shifts and prolonged physical activity. Job-specific risk factors are associated with sudden physical activity, psychological stress, and long work shifts.[17] Long working hours disrupt circadian rhythms, increasing cortisol. Chronic increases in the hormone cortisol cause hypertension, impaired vascular remodeling, increased TG, and insulin resistance which are risk factors for CVD. In addition, psychological stress leads to oxidative stress which causes vascular endothelial damage. Furthermore, stress also increases sympathetic nerves, releasing catecholamine hormones, increasing blood pressure and heart rate, and inflammatory cytokine response that causes CVD.[18] In vivo studies suggest that chronic stress mice have an increased immune response that exacerbates arterial inflammation with unstable plaque.[19] According to a study in the US, stressful police work is associated with the risk of sudden cardiac death, especially during an emergency, compared to non-emergency.[20] Therefore, the authors aim to determine the differences in CVD risks factor and Atherogenic Index of Plasma (AIP) profiles as a predictor of cardiac events between police officers and civilians in a developing country as an evaluation and strategic preventive measure for CVD.

2. Methods

489 police officers and 489 civilians were enrolled as participants in this cross-sectional study. All participants have given their informed consent and ethics for this study was approved by the Bhayangkara State Police Hospital ethics committee with decision number 10/IV/2021/KEPK/RUMKIT on April 7, 2021. Data used in this study was simultaneously obtained during medical check-ups between 2019 and 2020 at Bhayangkara State Police Hospital Surabaya.

All study samples met the inclusion criteria, namely 1) being an active field police officer (for police groups) and not working as field police officers (for civilian groups), 2) having completed the entire process of examination, 3) aged 21 or older, and 4) consented to being participants of study.

Independent variables examined in this study are blood pressure, BMI, TG, LDL-C, HDL-C, total cholesterol, fasting blood sugar, and atherogenic index plasma. Baseline characteristics including age and sex were recorded by interview and cross-checking with medical record.

Blood pressure measurements were carried out in a sitting position with the hands resting on the examination table and the cubital fossa at the same level as the heart. The measurements were taken after the patient had rested for 5 min, and repeated for the next 15 min. A digital blood pressure meter (model: HEM-8172, Omron Healthcare Co., Ltd., Kyoto, Japan) was used. The cut off value of blood pressure in this study refers to ESC 2018 guideline with the following criteria: normal systolic blood pressure <120 mmHg and diastolic blood pressure <80 mmHg; prehypertension 120–139 mmHg for systolic blood pressure and 80–89 mmHg for diastolic blood pressure; stage I hypertension 140–159 mmHg for systolic blood pressure and 90–99 mmHg for diastolic blood pressure; and stage II hypertension ≥160 mmHg for systolic blood pressure and ≥100 mmHg for diastolic blood pressure.

Measurements of weight and height were carried out to find BMI (body mass index). BMI measurement used in this study refers to the WHO criteria measuring weight (kg) divided by (height)2 (m2), resulting <18.5 classified as Underweight; 18.5–24.9 as Normal Weight; 25.0–29.9 as Overweight, and >30.0 as Obese. We used a mechanical weight scale (model: SMIC ZT-120, Gea Medical, Jakarta, Indonesia) for weight measurement. Height was measured by standing straight on the weight scale, barefooted, with the head facing straight ahead.

Dyslipidemia according to American Heart Association criteria is an increase in total cholesterol >200 mg/dl, LDL-C > 130 mg/dl, TG > 150 mg/dl followed by a decrease in HDL-C < 40 mg/dl. AIP was calculated with log (TG/HDL-C), resulting −0.3-0.1 as low risk, 0.1–0.24 as moderate risk, and >0.24 as high-risk occurrence of cardiovascular disease. Fasting blood sugar cut off value was categorized as < 6.1 mmol/L as normal and >6.1 mmol/L as high. Blood samples were collected after overnight (8 h) fasting and performed in the laboratory.

3. Statistical analysis

Statistical tests using SPSS version 25. All variables were tested for normality using Kolmogorov-Smirnov and Shapiro-Wilk. Abnormal distributions are shown as mean and compared with the Mann-Whitney rank-sum test. Variables were then processed using the Mann-Whitney and Wilcoxon methods. Comparative analysis to determine AIP and CVD risk in Police Officers and Civilian groups was carried out using the Mann-Whitney test.

4. Results

978 participants were obtained, consisting of 489 police and 489 civilians. The participants were predominantly male with a mean age of 45.95 ± 7.42. Nearly half of the participants appear in the pre-hypertension group. More than 70% of the participants were overweight and obese with a mean BMI of 26.34 ± 3.86. High total cholesterol, high LDL, low HDL, and a high-risk score of AIP are primarily found. In contrast, the majority of the participants have normal fasting blood glucose and normal TG. More details about the participants are presented in Table 1.

For comparison between police and civilian groups, the police group was predominantly by male while women were dominant in civilian groups. There is a significant difference in systolic and diastolic blood pressure, TG, LDL, total cholesterol, fasting blood glucose, and AIP with $p < 0.05$. Police tend to have higher results in those significant factors compared to civilian groups. However, there is no significant difference in BMI and HDL-C between police and civilian groups (Table 2).

5. Discussion

This study found that nearly half of the subjects had pre-hypertension, in the police and civilian groups. A study in Brazil reported that hypertension was the most common risk factor for CVD overall in both men and women. However, in each gender itself, pre-hypertension is mostly found in men (43.8%), while in women, normal blood pressure is mostly found (43.2%).[21] Our study showed a significant difference in systolic blood pressure ($p = 0.000$) and diastolic blood pressure ($p = 0.003$) between police and civilians. Police tend to have a high-stress work environment that leads to hypertension. A cohort study shows perceived stress and plasma oxidative stress is associated with hypertension in police officers.[22] In addition, a previous study stated that many police officers who worked for more than 6 years had hypertension, due to lack of activity outside of working hours.[23]

BMI is correlated to CVD risk. In a group of farmers in Brazil, overweight farmers tend to have CVD.[21] A study in military police stated that more than a half police have obesity.[22] Study in the US stated that police tend to have obesity compared to the general population.[23] There was no significant difference in BMI between police and civilians in this study. This is because many factors affect BMI, such as lack of sleep, length of works, and lifestyle.[24] According to a study in Brazil, there was no relationship between BMI in police officers who worked 6 h/day with 24 h/day.[25]

Dyslipidemia is an increase in total cholesterol, LDL-C, TG followed by a decrease in HDL-C.[26] This study showed significant differences in total cholesterol, LDL-C, and TG between police and civilian groups ($p < 0.05$). In the police group, most of them had high total cholesterol (61.8%) and TG (54.2%). This was in contrast to the civilian group,

Table 1
Frequency and Percentage of Variables in Police and Civilian groups.

Variable	Groups	
	Police N = 489	Civilian N = 489
Sex		
- Women	32 (6.5%)	301 (61.6%)
- Men	457 (93.5%)	188 (38.4%)
Age (years)		
- 26-35	2 (0.4%)	35 (7.2%)
- 36-45	261 (53.4%)	215 (44%)
- 46-55	112 (22.9%)	195 (39.9%)
- >55	114 (23.3%)	44 (9%)
Systolic blood pressure		
- Normal	109 (22.3%)	178 (36.4%)
- Pre-hypertension	232 (47.4%)	237 (48.5%)
- Hypertension stage I	100 (20.4%)	54 (11%)
- Hypertension stage II	48 (9.8%)	20 (4.1%)
Diastolic blood pressure		
- Normal	121 (24.7%)	139 (28.4%)
- Pre-hypertension	224 (45.8%)	235 (48.1%)
- Hypertension stage I	107 (21.9%)	93 (19%)
- Hypertension stage II	37 (7.6%)	**22 (4.5%)**
BMI		
- Underweight	2 (0.4%)	3 (0.6%)
- Normal	64 (13.1%)	89 (18.2%)
- Overweight	261 (53.4%)	239 (48.9%)
- Obese	162 (33.1%)	158 (32.3%)
Triglycerides		
- Normal	224 (45.8%)	321 (65.6%)
- High	265 (54.2%)	168 (34.3%)
LDL		
- Normal	91 (18.6%)	92 (18.8%)
- High	398 (81.4%)	397 (81.2%)
HDL		
- Normal	92 (18.8%)	91 (18.6%)
- Low	397 (81.2%)	398 (81.4%)
Total Cholesterol		
- Normal	187 (38.2%)	250 (51.1%)
- High	302 (61.8%)	239 (48.9%)
Fasting blood glucose		
- Normal	382 (78.1%)	420 (85.9%)
- High	107 (21.9%)	69 (14.1%)
AIP		
- Low Risk	8 (1.6%)	17 (3.5%)
- Medium Risk	34 (7%)	66 (13.5%)
- High Risk	447 (91.4%)	406 (83%)

which had normal total cholesterol (51.1%) and TG (65.6%). Police officers with a stressful environment and work level are at risk of high pressure tend to be at risk of dyslipidemia. Previous research showed an association between stress levels and hypertriglyceridemia in police officers.[27] This is supported by a study in Genoa that states a relationship exists between stress levels and increases in triglycerides and total cholesterol in police officers.[28]

The prevalence of high fasting blood sugar was found in 21.9% in the police group and 14.1% in the non-police group. There was a significant difference in fasting blood sugar between the police and non-police groups ($p = 0.001$). A study in Ethiopia stated that high-ranking police officers were more at risk of developing diabetes mellitus than low-ranking police officers (AOR = 3.8, 95% CI, 1.1–13.7).[29] This is because high-ranking police officers tend to have a higher stress burden, thereby increasing the risk of developing diabetes mellitus. Psychological stress leads to oxidative stress, thereby triggering insulin resistance.[18] Studies in India found that police officers were more likely to have impaired fasting glucose than other workers.[30] Another study in the military police population of Bahia, Brazil stated that 28.1% had impaired fasting glucose.[31]

AIP is an index consisting of TG and HDL-C and is a strong predictor of CVD and can be used as an alternative screening if all atherogenic parameters have normal results.[10] In this study, 91.4% of the police group were classified as high-risk groups. There is a significant difference in AIP between the police and civilian groups. Police tend to have

Table 2
Mann Whitney Test analysis results.

	Median (Min-Max)	Mean Rank	P
Systolic blood pressure			
- Civilian	120 (90–200)	429.05	0.000
- Police	130 (90–210)	549.95	
Diastolic blood pressure			
- Civilian	80 (70–120)	463.79	0.003
- Police	80 (60–120)	515.21	
BMI			
- Civilian	26.31 (15.7–50.96)	477.29	0.176
- Police	25.97 (17.78–48.83)	501.71	
Triglycerides			
- Civilian	120 (40–1378)	420.87	0.000
- Police	162 (41–980)	558.13	
LDL			
- Civilian	121 (59–280)	464.71	0.006
- Police	125 (43–230)	514.29	
HDL			
- Civilian	47 (29–83)	486.78	0.763
- Police	47 (30–158)	492.22	
Total Cholesterol			
- Civilian	200 (135–392)	447.23	0.000
- Police	216 (105–375)	531.77	
Fasting blood glucose			
- Civilian	92 (64–406)	460.52	0.001
- Police	96 (70–493)	518.48	
AIP			
- Civilian	0.42 (−0.08 – 1.66)	430.44	0.000
- Police	0.55 (−0.11 – 1.36)	548.56	

hypertriglyceridemia, low HDL-C, and high total cholesterol increasing CVD incidence. In addition, AIP showed an association between protective and atherogenic lipoproteins used to predict CVD.[32]

This study shows significant differences in systolic blood pressure, diastolic blood pressure, TG, fasting blood glucose, and AIP between police and civilian groups. Studies in India show that police tend to have a high risk of CVD. In addition, a previous study stated the police have a risk for metabolic syndrome.[23] Moreover, another study showed that operational police had a higher cardiovascular risk compared to non-operational police.[33] This is slightly different in the study by Strauss et al., 2020 which stated that there were no significant differences in HDL-C, TG, blood pressure, and BMI between female police officers and office workers.[34]

6. Study limitation

This study is of a relatively small sample size. The smoking habits, stress factor, and complete history of illness of subjects were not recorded. Furthermore, testings such as electrocardiogram, echocardiography, or CT-A calcium score may provide further valuable information. A cohort study design is recommended for future in order to describe risks factor of the disease.

7. Conclusion

CVD risk was found in both groups. Nevertheless, police officers have higher AIP and overall CVD risk compared to civilians, creating a necessity for aggressive CVD prevention strategies within the population. Early intervention is necessary for CVD prevention.

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Declaration of competing interest

The authors have no conflict of interest to declare.

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