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Article

# Is there a Relationship Between Cardiorespiratory Fitness Levels and Cardiometabolic Risk Factors?

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**Abstract:** Objectives: This study explores the relationship between cardiorespiratory fitness (CRF) and cardiometabolic risk factors (CMRF) in metro police officers (MPOs) from a municipality in Gauteng province. Methods: A cross-sectional study includes 187 officers (116 males, 71 females) aged 23–63 years. Biochemical profiles, body mass index (BMI), waist circumference (WC), and blood pressure (BP) are assessed. CRF is evaluated using a modified Harvard Step Test. Data are analyzed using the Statistical Package for Social Sciences (SPSS) version 27.0. Results: Of the participants, 42% exhibit poor CRF, 35% are hypertensive, and 61% present with high fasting glucose (FG). Males demonstrate poorer CRF (51%) than females (28%), and 42% of females have very high-risk WC. CRF negatively correlates with BMI, WC, diastolic BP, and triglycerides (TG). Conclusion: Male metro POs reveal lower CRF than females. CRF is inversely associated with abdominal fat, diastolic BP, and TG, underscoring the need for targeted interventions.

**Keywords:** cardiorespiratory fitness; cardiometabolic risk factors; metropolitan police; physical fitness index

## 1. Introduction

Cardiorespiratory fitness (CRF) is defined as the ability of the cardiovascular and respiratory systems to withstand physical exertion for prolonged periods [1] and is often considered the most important marker of the health and efficiency of the cardiorespiratory system [2]. Low levels of CRF have been associated with a markedly increased risk of premature deaths from all causes, particularly from cardiovascular diseases (CVDs). Increases in CRF are linked to a reduction in deaths from all causes, while high levels of CRF correlate with levels of habitual physical activity, which in turn provides many health benefits [3]. This is supported by another study, which states that CRF is related to all-cause mortality and the development of CVDs, regardless of known cardiovascular risk factors (CVRF) [4]. Maximal oxygen uptake ( $VO_2$  max) is widely recognized as the measure of CRF and is expressed clinically as milliliters of oxygen consumed in one minute per kilogram of body weight ( $mL \cdot kg^{-1} \cdot min^{-1}$ ) [3]. Behavioral factors, such as engagement in physical activities (PA) and sedentary patterns, affect this measure [5]. It has been reported that low CRF is associated with obesity, physical inactivity, metabolic syndrome (MetS), low levels of high-density lipoprotein cholesterol (HDL-C), elevated systolic blood pressure (SBP), triglycerides (TG), non-HDL cholesterol, and TG/HDL ratio [6,7].

Many African countries are heavily burdened by CVDs, especially in sub-Saharan Africa [8]. In South Africa, the prevalence of CVDs or MetS is exacerbated by an increasing burden of CVRFs, such as cigarette smoking, hypertension, dyslipidemia, diabetes, and a sedentary lifestyle [9]. Most affected individuals are young adults in their most productive years, constituting the most significant workforce sector, including firefighters [10]. Additionally, the prevalence of metabolic syndrome in South Africa ranges from 5% to 62% [11]. Countries worldwide are undergoing major

epidemiological, demographic, nutritional, and economic transitions that significantly affect populations [12] South Africa, a sub-Saharan country, is no exception. South Africa is undergoing rapid urbanization and experiencing typical consequences of a transitioning society, such as rising levels of physical inactivity and obesity [13]. Physical inactivity is the fourth leading cause of death from non-communicable diseases (NCDs) worldwide; each year, it contributes to over 41 million preventable deaths [14] and has been identified as a risk factor for mortality and reduced quality of life [15]. A study examining the reduction of chronic disease risk through physical exercise identified a link between engaging in physical activities and the reduction and management of NCDs [16]. Physical exercise may mediate improvements in cardiometabolic (CMet) health and CRF [17]. The work environment has gradually become a focus for interventions targeting the reduction of the risk of chronic disease risks, because most employed adults spend a substantial amount of their time at work [18,19]. Studies have explored different occupations and their associations with mortality [20], while others have investigated lifestyle behaviors and their effect on work productivity.

Worldwide, police are identified as a community with a high prevalence of obesity, CVRFs, and a shorter life expectancy than the general population [21]. In a study conducted in the USA on police officers (POs), it was reported that this occupational group is at high risk for developing NCDs and experiencing CVD events at an earlier age, with significantly shorter lifespans compared to other groups [22]. This increased risk might be due to lifestyle behaviors, environmental stress, rotating shifts, and poor nutrition [21]. POs have reported more subjective health complaints than the general population, which may indicate that POs do not prioritize physical activity after police education and training [23,24]. Ironically, a group initially selected for their physical fitness levels fails to maintain these standards and succumbs to relatively preventable lifestyle diseases [25]. Recent studies among workers suggest that CRF is a stronger indicator of cardiometabolic risk and mortality than self-reported levels of PA [4]. Consequently, the measurement of CRF should be prioritized whenever possible, rather than relying on self-reported physical activity, to more accurately predict health status and its associations with risk factors [1].

Other studies found that increased CRF is associated with the prevention of atherosclerotic cardiovascular disease [26]. Most studies on the relationship between PA levels, CRF, and metabolic risk factors have primarily focused on children and adolescents. Several studies examining the association between CRF and clustered metabolic risk factors in youth reported an inverse relationship, indicating that as CRF increases, the risk of having an unfavorable metabolic risk profile decreases [27]. POs require a certain level of CRF to carry out their daily job activities; their engagement in PA is crucial for three reasons: it prepares them to handle physically demanding work-related situations, maintains their health, and enhances their psychological well-being [28]. Studies assessing the association between CRF and cardiometabolic risk factors (CMRF) among workers are limited [1], and research into this association among members of the police force in South Africa is particularly scarce [29].

Therefore, this study primarily aims to determine the relationship between CRF levels and CMRF among Metropolitan Municipality POs in the Gauteng Province of South Africa. A secondary aim of the study is to undertake sex comparisons regarding the relationship between CRF and CMRF among POs.

## 2. Materials and Methods

### 2.1. Participants

The research utilized a cross-sectional design that adopted a quantitative approach. Data were gathered from a purposive sample of Metropolitan Municipality POs in Gauteng Province, South Africa. Slovin's method, with a margin of error of 0.05, was applied to determine the exact percentage of healthy male ( $n = 116$ ) and female ( $n = 71$ ) metro police officers (MPOs), totaling 187 participants of varying ranks. These officers, aged between 23 and 63 years, had a mean age (standard deviation) of  $39.26 \pm 8.24$ , ensuring adequate representation. The calculation yielded a sample size of 187

Metropolitan Municipality POs, who were subsequently included in the study. The law enforcement officers represented different ranks, including warrant officers, constables, and top management. The latter encompassed MPOs, deputy chief police, inspectors, superintendents, and colonels.

The aim of the study was thoroughly explained to the participants. They were also informed that their data would remain confidential and coded to ensure it could not be linked to their names and would solely be used for research purposes. The participants completed an informed consent form and Physical Activity Readiness Questionnaire (PAR-Q) before participating in the study. The researcher was supported by well-trained research assistants responsible for conducting measurements. The research received ethical approval from the Faculty Committee for Research Ethics, Faculty of Science, at the Tshwane University of Technology (REC Ref #: REC2020/09/006) and approval from a gatekeeper at the level of senior management in a municipality Metropolitan Police Department in the Gauteng Province of South Africa.

## 2.2. Measures

This study used four clinical preceptors from the Faculty of Sports, Rehabilitation and Dental Science, Tshwane University of Technology, to assist in data collection. On each day of data collection, participants were welcomed and allowed to ask questions or raise concerns regarding their participation in the study. Any questions or concerns that arose were addressed accordingly. Following the briefing, data collection began by completing the PAR-Q to determine the participants' readiness to engage in physical exercise testing or identify any contraindications to exercise. Data collection was organized into stations, which participants progressed through in the following order: 1) Blood pressure (BP) station, 2) Anthropometry station (height, weight, and waist circumference (WC)), 3) Biochemical profile station (total cholesterol (TC), TG, low-density lipoprotein cholesterol (LDL-C)/high-density lipoprotein cholesterol (HDL-C), and fasting glucose (FG)) and 4) CRF (step test) station. BP and resting heart rate (RHR) measurements were taken after 5 minutes of sitting, and body composition measurements were taken with participants wearing minimal clothing. Biochemical profiles were collected after a 10-hour fast, followed by a CRF test (step test). All measurements were conducted daily from 08:30 to 15:00, with anthropometric and physiological measurements preceding the fitness test. On average, there were intervals of 15- 30 minutes between the anthropometric, physiological, and fitness measurements. The study was conducted from 1 to 12 September 2022. Feedback was immediately shared with individual participants, who were advised on improving their health and maintaining a healthy lifestyle.

### 2.2.1. Anthropometry

The participants' standing height was recorded to the nearest 0.1 cm, measured barefoot using a standard portable stadiometer (Holtain Limited, Crymych, Dyfed, UK). Their body mass was measured to the nearest 0.5 kg using a portable digital scale (Dismed, USA), with participants barefoot and wearing minimal clothing [3]. WC was measured while participants stood upright and relaxed, using a standard tape measure, and horizontal measurements were taken 1cm above the umbilicus. The circumferences were subsequently classified according to the American College of Sports Medicine (ACSM) risk criteria for WC in adults. For males: <80 cm is classified as very low, 80-99 cm as low, 100-120 cm as high, and >120 cm as very high. For females: <70 is classified as very low, 70-89 cm as low, 90-110 cm as high, and >110 cm as very high. The participants' BMI was calculated as body mass (kg) divided by height (m) squared ( $\text{kg}/\text{m}^2$ ). The BMI scores were classified according to the ACSM classification for BMI in adults.

### 2.2.2. Biochemical Profile for Metabolic Risk Factors

After five minutes of seated rest, BP measurements were taken using a Rossman digital BP analyzer. Readings were taken twice, and the mean of the two measures was recorded. The BP readings consist of two numbers: one on top (systolic) and one on the bottom (diastolic). BP was

classified according to the ACSM BP classification as follows: normal (<120/<80 mmHg), pre-hypertension (120-139/80-89 mmHg), stage 1 hypertension (140-159/90-99 mmHg), and stage 2 hypertension ( $\geq$ 160/100 mmHg). TC, FG, TG, HDL-C, and LDL-C were measured from capillary blood samples using a finger prick after a 10-hour fasting period. The samples were placed on a Polymer Technology Systems (PTS) panel glucose and cholesterol test strips and analyzed using a calibrated Cardiocheck® PA Analyzer (Polymer Technology Systems, Inc, USA). The Cardiocheck analyzer was regularly calibrated following the manufacturer's instructions. The blood glucose and lipid profile were measured in millimoles per liter (mmol/ l) and classified using the sex specific ACSM, ATP III classification.

### 2.2.3. Cardiorespiratory Fitness

CRF was assessed using a modified version of the Harvard Step Test. For the test, women and men used exercise steps measuring 30 cm and 40 cm, respectively. Participants stepped up and down at a rate of 30 steps per minute for five minutes, guided by a metronome. HR was recorded at one-minute intervals during the exercise. Immediately after completing the exercise, participants sat quietly in a chair while their HRs were monitored for 30 seconds at 1-, 2-, and 3-minutes post-exercise.

The physical fitness index (PFI) score from the Harvard Step Test was used to classify the CRF levels of participants for both sexes. The classification for men was as follows: (1) poor (<55), (2) below average (55–64), (3) average (65–79), (4) above average (80–90), and (5) excellent (>90). For women, the classification was: (1) poor (<50), (2) below average (50–60), (3) average (61–75), (4) above average (76–85), and (5) excellent (>85).

### 2.3. Data Analysis

All data were analyzed using the Statistical Package for Social Sciences (SPSS) version 27.0 for Windows (SPSS Inc, Chicago, IL, USA). The data's normality was assessed using the Shapiro-Wilk test and Quantile-Quantile plots. Variables that were not normally distributed, including TG, LDL, HDL, TC, and FG, were log-transformed. Descriptive statistics, including means, standard deviations (SDs), minimums, and maximums, were calculated for CRF and CMRF measurements. Frequencies and percentages were calculated for the categorical variables related to CRF levels and CMRF.

An independent t-test was used for normally distributed data, and Pearson Chi-square ( $\chi^2$ ) was applied for the categorical variables to examine significant differences in CRF levels and CMRF between males and females, as well as across categories. Differences in clustered risk factors were assessed using ANOVA between low and good CRF groups. Spearman Rho correlation coefficients ( $r$ ) were calculated to determine the relationship between CRF and CMRF for the total sample and by sex.

The following classifications were applied for interpreting correlation coefficients: <0.10 = indicates a small correlation, 0.30–0.50 indicates a medium correlation, and  $\geq$ 0.50 indicates a large correlation [30]. A significance level was set at  $p \leq 0.05$ .

## 3. Results

Table 1 below shows the descriptive characteristics of the total sample, categorized by rank and sex. The sample included 187 participants, with 116 (62%) males and 71 (38%) females. The participants comprised 34% ( $n = 63$ ) of warrant officers, 54% ( $n = 102$ ) constables, and 12% ( $n = 22$ ) of top management metro officers.

**Table 1.** Descriptive characteristics of participants by rank and sex.

Rank	Total (n)	Male (n)	Female (n)
Warrant Officers	63 (34%)	39 (62%)	24 (38%)
Constables	102 (54%)	63 (62%)	39 (38%)
Top Management Metro Officers	22 (12%)	14 (64%)	8 (36%)

Total	187 (100%)	116 (62%)	71 (38%)
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Table 2 presents the percentage distribution of CMRF for the total participants, categorized by sex. Overall, the results indicate that 42% of participants were pre-hypertensive, and 19% were hypertensive. Male MPOs had significantly higher percentages of pre-hypertension (47% vs. 34%) and hypertension (26% vs. 7%) compared to their female counterparts ( $\chi^2 = 22.132$ ,  $df = 2$ ;  $p < 0.001$ ). The prevalence of overweight and obesity in the total group was 31% and 45%, respectively. Females were significantly more likely to be obese (63% vs. 33%) than males ( $\chi^2 = 19.312$ ,  $df = 2$ ;  $p < 0.001$ ). Regarding abdominal fat (WC), 28% of the participants were classified as being at high risk and 7% at very high risk. Female MPOs had significantly higher rates of high risk (42%) and very high risk (14%) WC compared to males (20% high risk and 2% very high risk) ( $\chi^2 = 24.478$ ,  $df = 3$ ;  $p < 0.001$ ). The results also show that 52% of participants were classified as pre-diabetic and 9% as diabetic. Furthermore, 38% of participants had low HDL-C levels, with males being significantly more likely to have low HDL-C (46% vs. 27%) than females ( $\chi^2 = 5.665$ ,  $df = 1$ ;  $p = 0.01$ ).

**Table 2.** Cardiometabolic risk factors (CMRF) distribution by sex (n = 187).

Variables	Total (n = 187)	Male (n = 116)	Female (n = 71)	p-value for sex differences	
BP** (mmHg)	Normal	73 (39%)	31 (27%)	42 (59%)	<0.001*
	Pre-hypertension	79 (42%)	55 (47%)	24 (34%)	
	Hypertension	35 (19%)	30 (26%)	5 (7%)	
BMI** (kg/m <sup>2</sup> )	Underweight	-	-	-	<0.001*
	Normal weight	46 (25%)	38 (33%)	7 (10%)	
	Overweight	57 (31%)	38 (33%)	19 (27%)	
	Obese	84 (45%)	39 (34%)	45 (63%)	
WC** (cm)	Low risk	12 (6%)	10 (9%)	2 (3%)	<0.001*
	Low	109 (58%)	80 (69%)	29 (41%)	
	High risk	53 (28%)	23 (20%)	30 (42%)	
	Very high risk	13 (7%)	3 (2%)	10 (14%)	
FG** (mmol/l)	Low	-	-	-	0.26
	Normal	73 (39%)	40 (35%)	33 (46.5%)	
	Pre-diabetic	98 (52%)	65 (56%)	33 (46.5%)	
TC** (mmol/l)	Diabetic	16 (9%)	11 (9%)	5 (7%)	0.17
	Desirable	166 (89%)	103 (89%)	63 (89%)	
	Borderline high	13 (7%)	6 (5%)	7 (10%)	
HDL-C** (mmol/l)	High	8 (4%)	7 (6%)	1 (1%)	0.01*
	Low	72 (38%)	53 (46%)	19 (27%)	
	High	115 (62%)	63 (54%)	52 (73%)	
LDL-C** (mmol/l)	Optimal	130 (69%)	77 (66%)	53 (75%)	0.54
	Above optimal	30 (16%)	19 (16%)	11 (16%)	
	Borderline high	20 (11%)	14 (12%)	6 (8%)	
	High	4 (2%)	3 (3%)	1 (1%)	
	Very high	3 (2%)	3 (3%)	-	
TG** (mmol/l)	Normal	121 (65%)	71 (61%)	50 (70%)	0.43
	Borderline high	42 (22%)	29 (25%)	13 (18%)	
	High	24 (13%)	16 (14%)	8 (11%)	
	Very high	-	-	-	

\*  $p < 0.05$ , p-values determined using Pearson Chi-square tests; \*\* BP: blood pressure; BMI: body mass index; WC: waist circumference; FG: fasting Glucose; TC: total cholesterol; HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein; TG: triglycerides.

Table 3 presents the percentage distribution of CRF levels among male and female participants. The results show that 42% of participants have poor levels of PFI. There were significant differences in CRF levels between males and females in ( $\chi^2 = 12.161$ ,  $df = 4$ ;  $p = 0.01$ ), with a higher percentage of poor fitness levels in males (51%) compared to females (28%)

**Table 3.** Physical fitness index (PFI) distribution by sex (n = 187).

PFI categories	Total (n = 187)	Male (n = 116)	Female (n = 71)
Poor	79 (42%)	59 (51%)	20 (28%)
Below average	70 (37%)	36 (31%)	34 (48%)
Average	29 (16%)	18 (15%)	11 (16%)
Above average	7 (4%)	2 (2%)	5 (7%)
Excellent	2 (1%)	1 (1%)	1 (1%)

Table 4 indicates the total participants' descriptive data (minimum, maximum, mean, and SD) for age, CMRF, and PFI. The mean age for the total participants was  $39.26 \pm 8.24$  years, with no significant age differences between male and female MPOs. Male participants were significantly taller ( $173.68 \pm 6.92$  cm) compared to female participants ( $160.07 \pm 8.62$  cm;  $p = 0.30$ ). Female participants were insignificantly heavier ( $85.61 \pm 24.41$  kg vs.  $83.80 \pm 16.90$  kg;  $p = 0.55$ ) and had significantly higher body fat percentages than the male participants ( $33.05 \pm 8.03\%$  vs.  $27.68 \pm 5.05\%$ ). Male POs were significantly more hypertensive, with higher SBP ( $131.73 \pm 18.74$  mmHg) and DBP ( $86.74 \pm 11.64$  mmHg) compared to their female counterparts (SBP:  $119.20 \pm 14.57$  mmHg; DBP:  $84.86 \pm 10.43$  mmHg;  $p < 0.001$ ). The mean RHR for the total participants was  $81.82 \pm 14.60$  bpm, with females having a significantly higher mean RHR ( $367.27 \pm 71.79$  bpm) compared to males ( $336.42 \pm 70.22$  bpm;  $p = 0.004$ ). Regarding overall PFI, males significantly outperformed females ( $92.73 \pm 18.95$  vs.  $84.51 \pm 15.57$ ;  $p = 0.002$ ).

**Table 4.** Descriptive characteristics of age, CMRF, and PFI by sex (n = 187).

Variables	Total participants			Male (n = 116)	Female (n = 71)	p-value of sex differences
	Min	Max	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	
Age (Years)	23	63	$39.26 \pm 8.24$	$39.74 \pm 8.69$	$38.46 \pm 7.43$	0.30
Height (cm)	113.0	195.5	$168.52 \pm 10.07$	$173.68 \pm 6.92$	$160.07 \pm 8.62$	<0.001*
Body weight (kg)	38.50	165.80	$84.49 \pm 20.04$	$83.80 \pm 16.90$	$85.61 \pm 24.41$	0.55
BMI (kg/m <sup>2</sup> )	17.60	65.30	$29.72 \pm 6.84$	$27.68 \pm 5.05$	$33.05 \pm 8.03$	<0.001*
WC (cm)	65	134	$92.54 \pm 12.61$	$91.75 \pm 11.38$	$93.82 \pm 14.39$	0.28
SBP** (mmHg)	100	207	$126.97 \pm 18.28$	$131.73 \pm 18.74$	$118.19 \pm 14.59$	<0.001*
DBP** (mmHg)	60	134	$86.03 \pm 11.21$	$86.73 \pm 18.74$	$84.86 \pm 10.43$	<0.001*
FG (mmol/l)	4.30	18.30	$5.98 \pm 1.42$	$5.95 \pm 0.80$	$6.02 \pm 2.07$	0.77
TC (mmol/l)	2.59	7.16	$4.18 \pm 0.93$	$4.21 \pm 0.97$	$4.13 \pm 0.87$	0.58
HDL-C (mmol/l)	0.61	4.36	$1.33 \pm 0.37$	$1.30 \pm 0.43$	$1.38 \pm 0.26$	0.12
LDL-C (mmol/l)	0.00	5.65	$2.20 \pm 0.92$	$2.30 \pm 0.97$	$2.04 \pm 0.84$	0.06
TG (mmol/l)	0.56	5.65	$1.64 \pm 0.92$	$1.72 \pm 0.97$	$1.52 \pm 0.81$	0.16
RHR** (bpm)	53	171	$81.82 \pm 14.60$	$80.78 \pm 15.34$	$83.50 \pm 13.22$	0.22
Total HR** (bpm)	180	776	$348.13 \pm 72.20$	$336.42 \pm 70.22$	$367.27 \pm 71.79$	0.004*
Overall PFI Score	38.66	166.67	$88.61 \pm 18.15$	$92.73 \pm 18.95$	$84.51 \pm 15.57$	0.002*

\*  $p < 0.05$ ; \*\* SBP: systolic blood pressure; DPB: diastolic blood pressure; RHR: resting heart rate; HR= heart rate.

Table 5 presents the correlation matrix for overall PFI score and BP, BMI, WC, FG, and lipids profiles, including TC, LDL-C, HDL-C, and TG for all participants. The results show a small but significant negative correlation between the PFI scores and DBP ( $r = -0.15$ ;  $p = 0.05$ ), BMI ( $r = -0.30$ ;  $p < 0.0001$ ), WC ( $r = -0.22$ ;  $p = 0.003$ ), and TG ( $r = -0.15$ ;  $p = 0.03$ ). A borderline significant and positive association was also observed between PFI scores and HDL-C ( $r = 0.13$ ;  $p = 0.06$ ).

**Table 5.** Correlation matrix for overall PFI score and cardiometabolic variables (n = 187).

Correlation variables	<i>r</i>	<i>p</i>
PFI score vs.:		
SBP	0.02	0.73
DBP	-0.15	0.05*
BMI	-0.30	<0.0001**

WC	-0.22	0.003**
FG	0.04	0.56
TC	-0.02	0.48
HDL-C	0.13	0.06
LDL-C	0.05	0.51
TG	-0.15	0.03*

\* $p \leq 0.05$ ; \*\*  $p \leq 0.01$ .

Table 6 presents the correlation matrix for BP, BMI, WC, FG, lipids profiles (TC, LDL-C, HDL-C, TG), and the overall PFI score, analyzed separately for male and female participants. The results show that, among men, overall PFI scores were negatively and significantly correlated with BMI ( $r = -0.21$ ;  $p = 0.02$ ), WC ( $r = -0.19$ ;  $p = 0.04$ ), and TG ( $r = -0.25$ ;  $p = 0.01$ ), with the magnitude of the correlation being small. Among women, PFI scores were negatively and significantly correlated with DBP ( $r = -0.24$ ;  $p = 0.04$ ), BMI ( $r = -0.27$ ;  $p = 0.02$ ), and WC ( $r = -0.27$ ;  $p = 0.02$ ). Moreover, a significant positive correlation between PFI score and HDL-C ( $r = 0.19$ ;  $p = 0.04$ ) was observed in men, whereas in women, a borderline significant positive association was found ( $r = 0.21$ ;  $p = 0.07$ ). Despite their statistical significance, the magnitudes of these observed correlation coefficients were small.

**Table 6.** Sex-specific correlations between PFI and cardiometabolic variables (n = 187).

Correlation variables	Male (n = 121)		Female (n = 99)	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
<b>PFI Score Vs.:</b>				
SBP	-0.02	0.78	-0.13	0.29
DBP	-0.10	0.29	-0.24	0.04*
BMI	-0.21	0.03*	-0.27	0.02*
WC	-0.19	0.04*	-0.27	0.02*
FG	0.001	0.99	-0.001	0.99
TC	-0.14	0.12	0.09	0.44
HDL-C	0.19	0.04*	0.21	0.07
LDL-C	-0.03	0.77	0.08	0.28
TG	-0.25	0.01**	-0.09	0.47

\* $p \leq 0.05$ ; \*\*  $p \leq 0.01$ .

#### 4. Discussion

This study examines the relationship between CRF levels and CVD among MPOs in a municipality in Gauteng province, South Africa. The main findings reveal that fatness components (BMI and WC) and TG were negatively associated with the PFI performance. PFI shows a significant negative association with DBP, BMI, and WC in women. Additionally, male POs were taller than female officers but exhibited lower fatness percentage scores. Males were more hypertensive than females, with a higher prevalence of pre-hypertension (42%) and hypertension (19%) compared to their female counterparts (pre-hypertension: 34%; hypertension: 7%). These findings may be attributed to the high prevalence of overweight and obesity, as well as poor physical fitness levels among participants. The prevalence of hypertension observed in this study exceeded those of a similar study conducted in Kolkata, India, where the prevalence of hypertension among police officials was 32.5%, with males showing higher rates of elevated BP compared to females [31]. Hypertension is particularly concerning as it is often asymptomatic, with signs and symptoms remaining dormant and unnoticed for long periods, making it both fatal and irreversible if untreated [32]. The results of this study also show that female POs are more obese than males. For the total group, the prevalence of obesity among police officials was 76%, including 31% overweight and 45% obese. This high prevalence may be attributed to poor lifestyle behaviors and dietary habits, including excessive fast-food consumption associated with irregular work shifts. These findings exceed those of a study conducted in Riyadh City, which reported a combined prevalence of

overweight and obesity of 66.9% among POs [33]. Similarly, these results align with the observed prevalence rates of 43.9% overweight and 81.4% obese among Saudi adult soldiers in northern Saudi Arabia [34].

Females had a significantly higher WC than males and were more likely to present with a higher-risk WC classification than their male counterparts. The observed elevated WC in the sample population may be attributable to the body size genotype of indigenous African populations. The findings are consistent with a study that reported 51.9% of females had an increased WC compared to 4.6% of males in a black population in Ellisras, South Africa [35]. Based on these results, female officials should exercise greater caution regarding their weight. Indicators such as BMI, waist-to-hip ratio, WC, and being overweight have been associated with increased risk of all-cause and cardiovascular mortality in women [36]. In the present study, males had insignificantly higher TC levels ( $p = 0.09$ ) and presented with high-risk TC levels in 5.8% of cases. By contrast, their female counterparts reported a high-risk TC prevalence of only 1.0% ( $p = 0.97$ ).

The study also showed that 35% of the participants had low levels of HDL-C, with males (43.8%) showing a higher prevalence of low HDL-C compared to their female colleagues (24.2%). The findings align with a study conducted in Northwest China, which reported a higher prevalence of low HDL-C among males (67.7%) compared to females (55.4%) [37]. Low HDL-C is associated with atherosclerotic disease, not as a direct cause, but because it reflects an increased concentration of TG-rich lipoproteins [38]. The present study also reported that males were more likely than females to fall into a borderline high-risk category of LDL-C.

Additionally, this study indicated that males were more likely than females to present with a borderline high risk of TG. These findings exceed those reported in a study examining rural populations in Northwest China [37], which reported a prevalence of borderline high risk for LDL-C of 26% in males and 2.4% in females, and for TG of 11.5% in males and 10.5% in females. It is well-established that high HDL-C levels provide a protective effect against CVDs. In contrast, low HDL-C levels are associated with an increased risk for MetS and may directly correlate with elevated TG levels [38,40].

The study revealed that 42% of participants have poor CRF. In addition, when analyzed by sex, males (51%) demonstrated poorer CRF levels than females (28%). The observed poor CRF among male MPOs may be partially attributed to their higher mean values for body weight, BMI, and WC (Table 4), the high prevalence of overweight and obesity (Table 2), and the uneven sample size distribution. The findings contradict existing evidence, which generally indicates that males are more physically fit than females [41,42]. This study also identified a small but significant negative correlation between PFI scores and DBP, BMI, WC, and TG levels. When analyzed by sex, the overall PFI scores for men were negatively and significantly correlated with BMI, WC, and TG, though the magnitude of these correlations was small. However, among women, PFI scores were negatively and significantly associated with DBP, BMI, and WC. The observed negative association between PFI and DBP, BMI, and WC may highlight the potential benefits of physical fitness in improving BP and reducing fatness.

A non-significant positive correlation between the PFI score and HDL-C levels was observed in males, whereas in females, PFI scores were positively and significantly correlated with HDL-C. These findings are somewhat consistent with a review by Kodama et al. [43], which reported that regular aerobic exercise modestly increases HDL-C levels. Similarly, these findings also concur with a study that found negative correlations between PFI and BMI among young adults [28,44]. A related study investigated the fitness levels of POs shortly before the end of their training period and again three years after its completion, reporting a decline in their fitness status [44]. This is a concern as POs need to maintain high CRF levels to perform their daily duties effectively.

The present study has several limitations that should be considered and addressed in future research. These include omitting data on dietary and nutritional intake, lifestyle evaluations, and psychological assessment of the POs. Incorporating these factors could provide a more comprehensive understanding of the causal influence of increased CMRF within the force.

Furthermore, the study was limited to POs from a single municipality. Future research should involve participants from multiple municipalities to improve the generalizability of the findings.

## 5. Conclusions

The study highlights significant sex differences in health risk profiles among MPOs. Male officers demonstrated lower CRF than their female counterparts and had higher rates of hypertension, prediabetes, and diabetes. CRF was inversely correlated with key CMRF, such as BMI, WC, DBP, and TG. These findings suggest that lower CRF is closely associated with poor metabolic health and an increased risk of CMRF, particularly among male officers.

Future research could consider incorporating dietary and nutritional intake assessments and exercise interventions to reduce cardiometabolic risks among MPOs in developing countries. Based on the study's findings, it is recommended that the Metropolitan Police Department in Gauteng develop and implement a physical fitness policy and establish minimum fitness standards for the force. Additionally, conducting bi-annual fitness screenings for MPOs will enable the department to identify deficiencies, improve overall fitness levels, and better support effective law enforcement.

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