Association between the number of steps performed during work and metabolic syndrome indicators in São Paulo city military police officers: The health promotion of Military Police (HPMP) study

Associação entre o número de passos realizados durante o trabalho e indicadores da síndrome metabólica em policiais militares da cidade de São Paulo: Estudo de promoção da saúde da Polícia Militar (HPMP)

Asociación entre el número de pasos realizados durante el trabajo y los indicadores de síndrome metabólico en policías militares de la ciudad de São Paulo: Estudio de promoción de la salud de la Policía Militar (HPMP)

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Abstract
We evaluated the working number steps (STEPS) of 25 military police officers (MPOs: day shift n = 14 and night shift n = 11) from the Military Police of São Paulo State (PMESP) while patrolling São Paulo city center and its association with metabolic syndrome (MetS) indicators. The participants' body composition and anthropometric parameters: body mass index (BMI), fat-free mass (FFM), skeletal muscle mass (SMM) and clinical and laboratory data: systolic (SBP) and diastolic (DBP) blood pressure, and fasting plasma levels of glucose, glycated hemoglobin A1c (HbA1c), insulin, HDL-cholesterol, triacylglycerol (TG), and C-reactive protein (CRP) were also measured. According to the number of steps taken during the daily 12 h working period, the MPOs were divided into three groups: 600-2,000, 2,001-8,000, and >8,000 steps. On average, each participant took 5169 ± 614 steps per 12 h shift. While MPOs from the night shift walked 25% more than the day shift (6188±1069 vs. 4367±664), this difference was not statistically significant. Notably, the BMI, FFM (13.4%), SMM (14.5%), plasma HDL-cholesterol levels (32.2%), and DBP (19.1%) were significantly higher in group 1 compared to the other two groups. Furthermore, reduced physical activity, age, BMI, and tenure at PMESP were associated with increased MetS indicators. Overall, MPOs performing less than 2,000 steps per shift presented marked changes in body composition and plasma measurements and a higher MetS prevalence (64%) than those who were more physically active.
Keywords: Body composition; Occupational medicine; Metabolic diseases; Cardiovascular diseases; Physical activity level.

Resumo
Avaliamos o número de passos (STEPS) de 25 policiais militares (PMs: diurno n=14 e noturno n=11) da Polícia Militar do Estado de São Paulo (PMESP) durante o patrulhamento no centro de São Paulo e sua associação com os indicadores de síndrome metabólica (SM). A composição corporal e os parâmetros antropométricos dos participantes: índice de massa corporal (IMC), massa livre de gordura (MLG), massa muscular esquelética (MME) e dados clínicos e laboratoriais: pressão arterial sistólica (PAS) e diastólica (PAD), concentrações plasmáticas de glicose em jejum, hemoglobina glicada A1c (HbA1c), insulina, HDL-colesterol, triacilglicerol (TG) e proteína C reativa (PCR). De acordo com o número de passos realizados durante as 12 horas diárias de trabalho, os PMs foram divididos em três grupos: 600-2.000, 2.001-8.000 e > 8.000 passos. Em média, os participantes deram 5.169 ± 614 passos por turno de 12 horas. Os PMs do período noturno caminharam 25% mais do que no turno do dia (6188 ± 1069 vs. 4367 ± 664), essa diferença não foi estatisticamente significativa. Notavelmente, o IMC, MLG (13,4%), MME (14,5%), níveis plasmáticos de HDL-colesterol (32,2%) e PAD (19,1%) foram significativamente maiores no grupo 1 em comparação com os outros dois grupos. Além disso, a redução da atividade física, idade, IMC e tempo de permanência na PMESP foram associados com o aumento dos indicadores de SM. No geral, os PMs que executam menos de 2.000 passos por turno apresentaram alterações na composição corporal, plasmáticas e uma prevalência mais elevada de SM (64%) do que aqueles que se apresentaram fisicamente mais ativos.
Palavras-chave: Composição corporal; Medicina do trabalho; Doenças metabólicas; Doenças cardiovasculares; Nível de atividade física.

Resumen
Se evaluó el número de pasos (STEPS) en 25 policías militares (MPOs: diurno n = 14 y nocturno n= 11) del Estado de São Paulo (PMESP) durante el patrullaje en el centro de São Paulo y su asociación con indicadores de síndrome metabólico (MetS). Adicionalmente, fue medida la composición corporal y los parámetros antropométricos de los participantes: Índice de Masa CorporaSel (IMC), masa libre de grasa (FFM), masa de músculo esquelético (SMM); así como los datos clínicos y de laboratorio: presión arterial sistólica (PAS) y diastólica (PAD), niveles plasmáticos en glucosa en ayunas, hemoglobina glicosilada A1c (HbA1c), insulina, colesterol HDL, triacilglicerol (TG) y proteína C reactiva (PCR). De acuerdo con el número de pasos realizados durante las 12 horas diarias de trabajo, las MPO se dividieron en tres grupos: 600-2.000, 2.001-8.000 y > 8.000 pasos. En promedio, los participantes realizaron 5169 ±

614 pasos por turno de 12 h. Mientras que los MPO del periodo nocturno caminaron un 25% más que los del periodo diurno (6188 ± 1069 vs. 4367 ± 664), esta diferencia no fue estadísticamente significativa. En cuanto al IMC, FFM (13,4%), SMM (14,5%), niveles plasmáticos de colesterol HDL (32,2%) y PAD (19,1%), el grupo que caminó entre 600-2000 pasos mostró valores significativamente más altos en comparación con los demás grupos. Adicionalmente, la edad, disminución de la actividad física, IMC y la permanencia en el PMESP fueron asociadas con un aumento en los indicadores de MetS. En general, las MPO que realizaron menos de 2000 pasos por turno, presentaron alteraciones de composición corporal y plasma, así como una mayor prevalencia de MetS (64%) comparado con los policías que fueron categorizados como físicamente activos.

Palabras clave: Composición corporal; Medicina del trabajo; Enfermedades metabólicas; Enfermedades cardiovasculares; Nivel de actividad física.

1. Introduction

The World Health Organization (WHO, 2020) defines physical activity as any bodily movement produced by skeletal muscle that requires energy (Bull, et al., 2020). It has been demonstrated that regular physical activity is associated with reduced plasma triacylglycerol (TG) levels, visceral adipose tissue size, and lipid accumulation in the body, preventing obesity and several obesity-related diseases, including metabolic syndrome (MetS), type 2 diabetes mellitus, and cardiovascular disease (CVD) (Friedenreich, et al., 2015; Green, et al., 2014; McPhee, et al., 2016; Vissers, et al., 2013). Additionally, regular physical activity attenuates primary and secondary mortality due to CVD, hypertension, obesity, diabetes, cancer, depression, and osteoporosis (Ekblom-Bak, et al., 2021; Warburton, et al., 2006). Notably, physical activity is considered comparable to pharmacological therapies for treating stroke patients (Hoffmann, et al., 2016; Thornton, et al., 2016).

In 2004, the American College of Sports Medicine (ACSM) established five physical activity classification levels depending on the number of steps taken per day: 1) <5,000 steps/day (sedentary); 2) 5,001-7,499 steps/day (little active); 3) 7,500-9,999 steps/day (slightly active); 4) 10,000-12,499 steps/day (active); and 5) ≥12,500 steps/day (highly active). Five years later, Tudor-Loke et al., (2009) introduced two additional graduations to the "sedentary" level: <2,500 steps/day (basal activity) and 2,501-4,999 steps/day (limited activity) (Tudor-Locke, et al., 2009). It has been recommended that adults (26-65 years) perform at least 7,000 steps per day (Tudor-Locke, et al., 2011). More recently, the ACSM established that each increment from 2,000 daily steps to 10,000 steps is associated with a 10% reduction in adverse cardiovascular events (Kraus, et al, 2019). In addition, walking 30 min a day, five days a week, reduces the risk of cardiovascular incidents by 19% (Murtagh, et al., 2010). Indeed, there is an inverse relationship between physical activity and chronic diseases, and a 20-30% reduction in premature death in physically active individuals (Paterson & Warburton, 2010; Warburton & Bredin, 2016)

In recent years, chronic non-communicable diseases associated with morbidity and mortality have markedly increased, and physical inactivity is one of the critical factors (Lavie, et al., 2019; Myers, et al., 2019). Despite the widespread acceptance of physical exercise's beneficial effects (Penedo & Dahn, 2005), a third of the world's population is considered sedentary (JI, 2019). Merino (2010) investigated cardiovascular and metabolic changes and the leading causes of death in the Military Police of São Paulo State (PMESP) compared to the São Paulo city civilian population between 2002 and 2006. This author reported that military police officers (MPOs) aged between 20 and 54 had mortality rates that were 2.5 and 4 times higher due to CVD and liver disease, respectively, compared to the civil population in the same age range. Additionally, Merino found that during the first ten years of service (i.e., 20-29 years of age), MPOs have a lower CVD-related mortality rate than the civilian population with the same age range. On the other hand, in the last ten years of service, deaths due to CVD were 3.5 and 2.9 times higher for MPOs between 45-49 and 50-54 years old, respectively, compared to the civilian São Paulo city population (Merino, 2010).

In a recent study, Souza (2021) reported that São Paulo city MPOs are overweight or obese and that 43% exhibit MetS. A high MetS incidence was also detected among MPOs from Bahia, Brazil, reaching 38.5% of the total force (Filho & D'Oliveira Jr, 2014) and in police officers from other countries, including India (Tharkar, et al., 2008), the USA (Baughman et

al., 2016; Violanti, et al., 2009), Taiwan (Chang, et al., 2015), Italy (Garbarino & Magnavita, 2015), and Iran (Payab, et al., 2017). According to the studies cited, increased caloric ingestion, sleep restriction, stress, and a sedentary lifestyle were associated with elevated CVD and metabolic disease risks. In addition to insulin resistance, type-2 diabetes, and CVD (Bazotte et al., 2014; Grundy et al., 2004), MetS patients exhibit a spectrum of disease-related clinical conditions, including obesity, dyslipidemia, and hyperglycemia (Esposito, et al., 2012; Neeland, et al., 2019; Neeland, et al., 2018).

The present study investigated the number of steps performed during a 12 h day or night shift patrolling São Paulo city center and MetS indicators. We also evaluated the association of age, PMESP service time, and BMI with MetS indicators in the same volunteers.

2. Methodology

Recruitment of the participants

The present study was carried out at the Institute of Sport Sciences and Physical Activity (ICAFE) at Cruzeiro do Sul University (UNICSUL) in São Paulo, SP, Brazil, as previously described by Souza et al. (2021). The MPOs from Metropolitan Police Command Area 1 work in the radio patrol program in the São Paulo city center and participated in a previous study (Souza et al., 2021). Initially, 51 MPOs were recruited to monitor physical activity levels using a pedometer (YamaxDigi-Walker SW 700, Tokyo, Japan) during their patrols. The volunteers were separated according to day (n=29) or night (n=22) shift. In the São Paulo city radio patrol, officers work 12 h shifts [i.e., 6:00 am to 6:00 pm (day shift), or 6:00 pm to 6:00 am (night shift)] followed by 36 h of rest. Twenty-one volunteers did not correctly fill out the daily registration form (DRF) and were excluded. Thus, 25 participants completed the study (n=14 for the day shift and n=11 for the night shift). The Ethics Committee at Cruzeiro do Sul University (Protocol number 08905019.4.0000.8084) approved the study.

Experimental procedure

Questionnaire application, blood collection, and plasma measurements were performed at the ICAFE at UNICSUL. All participants were instructed to fast for at least 8 h before all assessments.

Body composition and anthropometric measurements (Table 1)

The height, measured using a stadiometer, and body mass (BM) of each volunteer were used to calculate the body mass index (BMI). Skeletal muscle mass (SMM; Kg), fat-free mass (FFM; Kg), absolute fat mass (AFM; Kg), and visceral adipose tissue (VAT; L) were determined using eight-point bioelectrical impedance analysis, with a SECA 515 medical Body Composition Analyzer (mBCA) (Hamburg, Germany), according to a previous study (Bosy-Westphal, et al., 2013). Hip circumference (HC; cm) and waist circumference (WC; cm) was measured following the method of Onis et al., (1996). The waist-to-hip ratio (WHR) was calculated using WC and HC data. The same protocol was used in our previous study (de Souza, et al., 2018).

Characteristics of the participants (Table 1)

The average age (years) of the 25 volunteers was 33.5±1.36. The age (years) of MPOs working the day shift ranged from 27 to 44 (35.5±1.57). The age of MPOs working the night shift ranged from 24 to 47 (30.7 ± 2.17). Participant percentage distribution by age was 21.4% and 54.5% (≤30), 50% and 36.4% (31 to 40), and 28.6% and 9.1% (≥41) for the day and night shifts, respectively. PMESP service time ranged from 3 to 23 years (10.4 ± 2.15) for the MPOs working the day shift and from 2 to 16 years (6.00 ± 1.51) for those working the night shift; the average for both shifts was 8.20±1.40 years. Service time

percentage distribution was 50% and 82% (≤5 years), 28.5% and 18% (10-20), and 21.5% and 0% (≥21) for the day and night shift groups, respectively. It should be pointed out that newcomer MPOs predominate the night shift. The individual and average values ± standard error of the means (SEM) are presented in Table 1.

The BM ranged from 73.2 to 127 Kg (88.6±3.75) and 60.3 to 111 Kg (85.7±4.31) for the MPOs working the day and night shifts, respectively. The average BM was 87.1 ± 2.68 Kg for both groups. Height varied from 1.62 to 1.89 meters (1.76±0.01). The BMI (Kg/m2) of the 25 volunteers was 28.3 ± 0.93. Notably, the BMI varied markedly between the day and night groups. According to the WHO BMI classification (1998), of the 14 MPOs working the day shift, three were eutrophic (21.5%), eight were overweight (57%), and three were obese (21.5%). Of the 11 MPOs working the night shift, two were eutrophic (18.2%), five were overweight (45.4%), and four were obese (36.4%). The AFM of day shift MPOs ranged from 13.7 to 56.1 Kg (Δ=42.3) and 7.96 to 36.2 kg (Δ=28.2) in the night shift group. The FFM of day shift MPOs ranged from 57.5 to 74.1 Kg (Δ=16.7) and 49.8 to 75.0 kg (Δ=25.1) in the night shift group. The SMM of day shift MPOs ranged from 27.6 to 37.5 kg (Δ=9.87) and 24.0 to 38.2 kg (Δ=14.2) in the night shift group. The average VAT value of the 25 volunteers was 3.3±0.35 L, ranging from 2.00 to 9.78 L (Δ=7.78) in the day shift MPOs and 1.46 to 3.35 L (Δ=1.89) in the night shift group.

The HC was 103.5±1.71 cm, and the WC was 96.8 ± 2.4 cm for the 25 volunteers. The HC values ranged from 93.5 to 128 cm (Δ=34.5 cm; 104±2.44) in the MPOs working the day shift and 90 to 116 cm (Δ=26 cm; 103±2.47) for those working the night shift. The WC ranged from 79 to 126 cm (Δ=47 cm; 96.3±3.52) in the MPOs working the day shift and 84 to 116 cm (Δ=32 cm; 97.4±3.44) in the night shift group. Nine MPOs working the day shift (64.4%) and eight from the night shift (72.7%) had a WC greater than 90 cm.

According to the WHO WHR classification (1998), six volunteers working the day shift were at moderate risk for developing CVD, three were at high risk, and six were at very high risk. Of the MPOs working the night shift, one was at low risk of developing CVD, six were at high risk, and four were at very high risk. When considering all 25 participants, 28% were at moderate risk for developing CVD, 32% were at high risk, and 40% were at very high risk.

Physical activity during the working period

Physical activity (i.e., number of steps) was monitored during the day and night patrol shifts. Briefly, participants were initially instructed to use the pedometer and complete the daily record form (DRF), indicating when the device was placed on and removed from the body. The MPOs used a pedometer for three 12 h working periods. The first period was dedicated to training the MPOs on using the pedometer. Each device was set up considering each police officers' body mass and step length (Schneider, et al., 2003). At the end of the patrol shift, the volunteers registered the number of steps performed in the DRF. Every day volunteers were reminded by text message via the WhatsApp application about using the device and recording data in the DRF at the beginning and end of the workday. The average number of steps was calculated using the data from two patrol shifts.

Table 1. Age, years of service at the PMESP, and body composition in military police officers working the day (n=14) and night (n=11) shifts and total sample (n=25). [São Paulo City, São Paulo State, Brazil, 2018].

	Age	Years*	BM (Kg)	Height (m)	BMI (Kg/m²)	AFM (Kg)	FFM (Kg)	SMM (Kg)	VAT (L)	WC (cm)	HC (cm)	WHR (m)
DAY SHIFT (n=14)												
1	34	11	84.3	1.79	26.3	20.7	63.6	31.5	2.73	93.5	102.0	0.92
2	31	3	91.9	1.84	27.1	17.8	74.1	37.5	2.00	87.0	103.0	0.84
3	43	23	98.8	1.78	31.2	41.2	57.6	28.5	3.38	111.0	115.0	0.97
4	29	4	78.5	1.77	25.1	16.0	62.5	31	1.98	84.0	97.0	0.87
5	43	23	91.0	1.79	28.4	30.2	60.7	30.5	3.27	104.0	104.0	1.00
6	43	22	127	1.79	39.6	56.1	71.3	35.8	9.78	126.0	128.0	0.98
7	35	4	86.3	1.75	28.2	27.6	58.7	28.6	3.85	97.0	101.0	0.96
8	30	3	81.5	1.89	22.8	19.8	63.3	31.1	3.39	79.0	94.5	0.84
9	39	13	82.7	1.76	26.7	22.7	60.1	29.2	4.10	96.0	99.0	0.97
10	27	3	73.2	1.76	23.6	13.7	59.5	29.2	2.66	85.0	93.5	0.91
11	32	3	80.6	1.69	28.2	22.4	58.2	27.6	3.64	92.5	103.0	0.90
12	37	16	105	1.78	33.1	36.1	68.8	32.4	6.61	114.0	111.0	1.03
13	44	13	82.1	1.81	25.1	20.9	61.2	29.1	3.28	91.5	102.0	0.90
14	32	4	76.8	1.87	22.0	19.4	57.5	28.3	4.73	88.0	97.0	0.91
Mean	**35.6**	**10.4**	**88.6**	**1.79**	**27.7**	**26.0**	**62.7**	**30.7**	**4.00**	**96.3**	**103.6**	**0.93**
SEM.	**1.57**	**2.15**	**3.75**	**0.01**	**1.23**	**3.09**	**1.40**	**0.77**	**0.55**	**3.52**	**2.44**	**0.02**
NIGHT SHIFT (n=11)												
15	47	16	104.0	1.69	36.5	33.2	71.0	35.3	2.31	116.0	113.0	1.03
16	26	3	83.1	1.77	26.5	18.9	64.2	31.2	3.05	91.0	98.0	0.93
17	25	5	78.0	1.70	27.0	8.0	73.5	36.3	1.46	84.0	98.0	0.86
18	28	4	97.9	1.67	35.1	10.5	49.8	24.0	2.26	112.0	112.0	1.00
19	35	4	60.3	1.65	22.1	12.8	65.3	32.0	1.66	87.5	90.0	0.97
20	25	5	82.2	1.87	23.5	19.9	63.3	30.4	2.86	84.0	96.5	0.87
21	32	3	86.8	1.75	28.3	24.1	62.7	30.9	3.10	99.0	108.0	0.92
22	24	2	82.0	1.74	27.1	20.7	66.1	31.7	1.69	91.5	102.0	0.90
23	25	4	84.8	1.68	30.0	24.7	60.2	29.3	2.43	103.0	106.0	0.97
24	38	16	72.4	1.62	27.6	18.2	54.3	25.0	2.19	93.0	98.0	0.95
25	33	4	111.0	1.77	35.5	36.2	75.0	38.2	3.35	110.0	116.0	0.95
Mean	**30.7**	**6.0**	**85.7**	**1.7**	**29.0**	**20.7**	**64.1**	**31.3**	**2.40**	**97.4**	**103.4**	**0.94**
SEM.	**2.17**	**1.51**	**4.31**	**0.02**	**1.45**	**2.63**	**2.29**	**1.30**	**0.19**	**3.44**	**2.47**	**0.02**
TOTAL SAMPLE (n=25)												
Mean	**33.5**	**8.4**	**87.3**	**1.76**	**28.3**	**23.7**	**63.3**	**31.0**	**3.3**	**96.8**	**103.5**	**0.93**
SEM.	**1.36**	**1.42**	**2.78**	**0.01**	**0.93**	**2.11**	**1.26**	**0.70**	**0.35**	**2.44**	**1.71**	**0.01**

Abbreviations: *Years: service length (years) at the PMESP. BM: body mass; BMI: body mass index; AFM: absolute fat mass; FFM: fat-free mass: SMM: skeletal muscle mass; VAT: visceral adipose tissue; WC: waist circumference; HC: hip circumference; WHR: waist-hip ratio. Source authors (2021).

Working length at PMESP

The participants were also divided by the time they worked at the PMESP. Of the 25 participants, sixteen worked at

the PMESP for 1 to 10 years, six worked for 11 to 19 years, and three for >19 years.

Clinical and laboratory data

Participants fasted for eight hours before blood samples were collected for determining plasma glucose, insulin, TG, HDL-cholesterol, CRP, and HbA1c concentrations. The estimated insulin resistance index (HOMA) was determined using the blood glucose and insulin levels (Matthews, et al., 1985). Resting blood pressure was measured with a Premium brand analog sphygmomanometer, following the procedures recommended by the 7th Brazilian Guideline of Arterial Hypertension (Malachias, et al., 2016). The Diagnosis and Analysis Center (CDA, São Paulo, SP, Brazil) conducted the laboratory measurements. Our group used the exact measurements in a previous study (Souza et al., 2021).

Metabolic syndrome indicators

Five criteria, based on Alberti et al., (2009) and the International Diabetes Federation (IDF), were used for diagnosing patients with MetS: 1) systolic blood pressure (SBP) >130 mmHg and diastolic blood pressure (DBP) >85 mmHg; 2) male abdominal circumference >90 cm; 3) glycemia >100 mg/dL; 4) serum triacylglycerol TG concentration >150 mg/dL; and 5) plasma HDL-cholesterol levels <40 mg/dL (Garbarino & Magnavita, 2015). Patients with at least three of the five indicators were considered to have MetS. The same protocol was used in our previous study (Souza et al., 2021).

Calculations performed using the results of the measurements mentioned above

The number of steps each study participant took during the day or night shifts was evaluated according to service time, age, BMI and the clinical and laboratory measurements.

Statistical analysis

The data were analyzed using the PRISM software, version 9.0 (Graph Pad, San Diego USA). The level of significance adopted was 95% ($p<0.05$). The Kolmogorov-Smirnov test was used for normal data distribution analysis. The Student's t-test (data with normal distribution) was used to compare two groups in the quantitative variables or the Mann-Whitney test (data without normality). One-way ANOVA with Tukey post-test was used to compare groups according to PMESP service time. For non-parametric data, the Kruskal-Wallis test was utilized. The Pearson's correlation test (data with normal distribution) or Spearman's test (data without normality) was used to check the relationship among measurements. The data are presented as percentages, and delta (Δ) values were calculated using the Excel program.

3. Results

The individual and average±SEM number of steps during the patrol shift, SBP and DBP (mmHg), fasting plasma levels of glucose (mg/dL), high glycated hemoglobin HbA1c (%), TG (mg/dL), HDL (mg/dL), and CRP (mg/dL), and HOMA are presented in Table 2. The average number of steps for all volunteers (n=25) was 5169±614 during each 12 h shift. On average, the MPOs working the day shift took 4368±664 steps, and those working the night shift took 6189 ± 1069 steps. While the MPOs patrolling at night performed 29.4% more steps than those of the day shift, this result failed to reach a level of statistical significance.

Table 2. Average number of steps during work and plasma and clinical measurements in military police officers of the day (n=14) and night (n=11) shifts and total sample (n=25). [São Paulo City, São Paulo State, Brazil,2018].

	STEPS (number)	SBP (mmHg)	DBP (mmHg)	Glucose (mg/dL)	HbA1c %	Insulin (µU/mL)	HOMA index	TG (mg/dL)	HDL (mg/dL)	CRP (mg/dL)
DAY SHIFT (n=14)										
1	4031	129	77	86	5.71	11.0	2.33	468	41	0.07
2	5251	140	80	78	5.82	4.4	0.85	52	37	0.39
3	4310	143	83	99	6.01	27.1	6.62	229	34	0.27
4	4220	138	83	99	5.60	6.0	1.47	62	62	0.05
5	3316	150	80	95	5.22	15.0	3.52	149	31	0.08
6	605	160	90	103	5.70	21.5	5.46	188	49	0.30
7	8225	128	71	86	5.62	36.5	7.74	198	33	0.18
8	10847	130	70	96	5.31	32.7	7.74	138	44	0.01
9	3466	134	81	91	5.42	11.3	2.54	115	34	0.19
10	2890	126	72	84	5.58	35.4	7.33	127	46	0.09
11	2731	128	66	107	5.66	56.2	14.80	129	42	0.19
12	3722	148	82	105	5.70	58.1	15.10	184	47	0.31
13	3275	112	68	91	5.36	8.0	1.80	69	47	0.18
14	4257	121	82	100	5.67	12.5	3.08	48	59	0.16
Mean	**4367.6**	**134.8**	**77.5**	**94.3**	**5.60**	**24.0**	**5.7**	**154.0**	**43.3**	**0.2**
SEM.	**664.41**	**3.38**	**1.87**	**2.30**	**0.06**	**4.74**	**1.22**	**28.58**	**2.50**	**0.03**
NIGHT SHIFT (n=11)										
15	7075	140	80	87	6.09	51	1.09	179	25	0.46
16	5335	140	70	91	5.37	3.7	0.83	78	42	0.01
17	12811	140	80	93	5.66	2.5	0.57	36	82	0.1
18	1883	120	90	101	6.12	17	4.24	94	46	0.36
19	4534	126	80	83	5.39	5.7	1.17	73	53	0.2
20	3172	120	70	86	5.53	7.6	1.61	145	34	0.01
21	2888	133	80	101	5.81	9.3	2.32	96	49	0.06
22	9594	110	73	97	5.53	35.5	8.49	355	31	0.27
23	5793	110	60	83	5.75	10.1	2.07	76	44	0.41
24	4043	100	60	86	5.18	7.6	1.61	95	41	0.29
25	10947	110	70	87	6.21	92	19.7	353	38	0.27
Mean	**6188.6**	**122.6**	**73.9**	**90.5**	**5.7**	**22.0**	**4.0**	**143.6**	**44.1**	**0.22**
SEM	**1068.7**	**4.29**	**2.76**	**2.0**	**0.1**	**8.3**	**1.7**	**33.3**	**4.5**	**0.04**
TOTAL SAMPLE (n=25)										
Mean	**5169**	**129.4**	**75.9**	**92.6**	**5.64**	**23.1**	**4.96**	**149.4**	**43.6**	**0.19**
SEM	**614**	**2.89**	**1.61**	**1.58**	**0.05**	**4.43**	**1.01**	**21.3**	**2.37**	**0.02**

Abbreviations: STEPS: Number of steps during work; SBP: systolic blood pressure. DBP: diastolic blood pressure; Hb A1c = high glycated hemoglobin A1c; HOMA (homeostatic model assessment) - insulin resistance indicator; TG = triacylgriserol; HDL = high-density lipoprotein; CRP: C-reactive protein. Source authors (2021).

For all MPOs, the SBP and DBP were 129.4±2.89 and 75.9±1.61 mmHg, respectively. When considered separately, the day shift group presented average SBP and DBP of 134.8±3.38 and 77.5±1.87 mmHg, and the night shift group had values

of 122.6±4.29 and 73.9±2.76 mmHg. Moreover, the SBP of the day shift MPOs ranged from 112 to 160 mmHg and 100 to 140 mmHg for the night shift. The DBP ranged from 66 to 90 mmHg and 60 to 90 mmHg for the MPOs working the day and night shift, respectively. Considering individual values, we found that seven day shift MPOs presented an SBP above 130 mmHg, and one had a DBP above 85 mmHg. In the night shift group, four MPOs had an SBP above 130 mmHg, and one had a DBP above 85 mmHg. Overall, 13 of the 25 MPOs were hypertensive (52%), with two only having elevated DBP, ten only having elevated SBP and one having both SBP and DBP elevated.

The fasting glycemia of all volunteers was 92.6±1.58 mg/dL, a value within the normal levels (≤99 mg/dL) (Xavier, et al., 2013). Four day and two night shift MPOs exhibited fasting hyperglycemia (≥100 mg/dL). Concerning HbA1c, 56% of the participants (n=8 from the day shift and n=6 from the night shift) had values above normal (i.e., ≤5.6%) (American Diabetes Association, 2018). The insulinemia of all participants was 23.1±4.43 µU/mL, with values ranging from 4.4 to 58.1 µU/mL (Δ=53.7) for the day shift group and 2.5 to 92 µU/mL (Δ=89.5) in the night shift group. The HOMA-IR of all participants was 4.96±1.01. Notably, the mean HOMA-IR values of the day shift group were significantly greater than the night shift group [5.74±1.22 vs. 3.68±1.60, respectively ($p<0.04$)]. Additionally, 11 of the day shift and four of the night shift MPOs were insulin resistant, representing 60% of the total sample.

Plasma TG levels of all participants were 149±21.3 mg/dL, slightly below the normal value of <150 mg/dL (SPOSITO, et al., 2007). A total of eight MPOs (32% of the total sample), five from the day and three from the night shift, presented elevated values. The average plasma HDL value of all participants was 43.6±2.37 mg/dL. While the average plasma HDL value was >40 mg/dL, which is considered normal for adults (Xavier, et al., 2013), five of the day and four of the night shift MPOs had low values (i.e., 36% of the total). Finally, the plasma CRP levels of all participants ranged from 0.07 to 0.46, values within the normal range (<0.60 mg/dL) (Roberts et al., 2001).

Correlations of the number of steps during the work, service time (years) at the PMESP, age and BMI with BM, AFM, FFM, SMM, VAT, WC, HC, WHR, SBP, DBP, glucose, HbA1c, insulin, HOMA-IR, TG, HDL and CRP of all volunteers are presented in Figure 1.

The number of steps was positively correlated with FFM ($r=0.40$; $p<0.05$) and SMM ($r=0.44$; $p<0.05$). The number of years of work at the PMESP correlated positively with WC ($r=0.52$; $p<0.01$), WHR ($r=0.57$; $p<0.01$), and AFM ($r=0.46$; $p<0.05$). There was a positive trend with BM ($r=0.35$; $p=0.08$) and SBP ($r=0.35$; $p=0.08$). The age of the volunteers was positively correlated with WC ($r=0.57$; $p<0.01$), WHR ($r=0.55$; $p<0.01$), AFM ($r=0.57$; $p<0.01$) and VAT ($r=0.45$; $p<0.05$). There was a positive trend of age with BM ($r=0.36$; $p=0.08$) and SBP ($r=0.34$; $p=0.09$). BMI was associated with a trend towards years of work at the PMESP ($r=0.36$; $p=0.08$) and age ($r=0.34$; $p=0.08$), and a significant correlation with CRP ($r=0.65$; $p<0.001$), TG ($r=0.44$; $p<0.05$), insulin ($r=0.48$; $p<0.05$), HbA1c ($r=0.59$; $p<0.05$) and as expected, with body composition: AFM ($r=0.65$; $p<0.001$), WC ($r=0.88$; $p<0.001$), and WHR ($r=0.65$; $p<0.001$).

Based on the collected data and analyses, it was determined that nine day (64.2%) and seven night (63.6%) shift MPOs exhibited MetS, which corresponds to 64% of the total sample.

Figure 1. Correlation matrix heat map. Body composition, plasma and work variables of 25 military police officers in the radio patrol. Data analyzed by Spearman correlation. Significance level *p<0.05. &Trend significance.
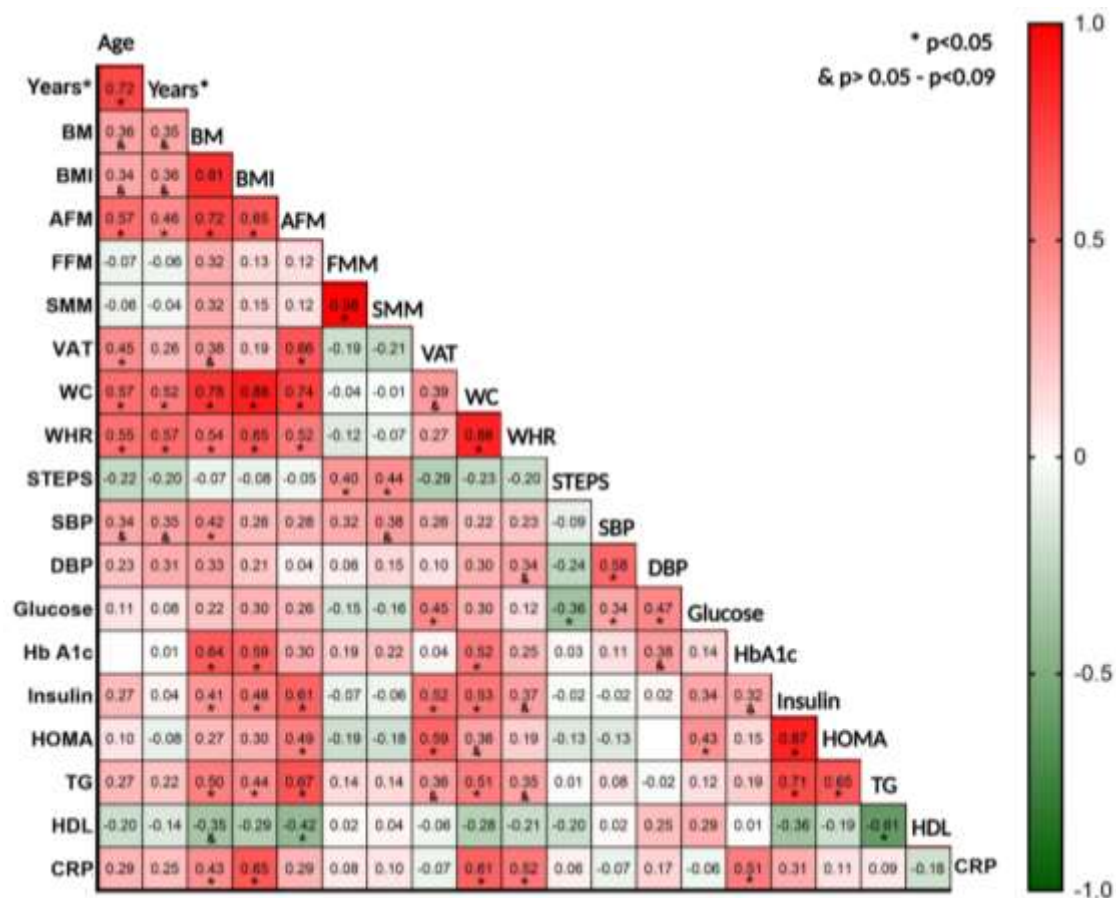
Abbreviations: *Years: working length (years) in the Corporation.; BM: body mass; BMI: body mass index; AFM: absolute fat mass; FFM: fat-free mass: SMM: skeletal muscle mass; VAT: visceral adipose tissue; WC: waist circumference; HC: hip circumference; WHR: waist-hip ratio; STEPS: Number of steps during work shift; SBP: systolic blood pressure. DBP: diastolic blood pressure; Hb A1c = high glycated hemoglobin A1c; HOMA (homeostatic model assessment) - insulin resistance indicator; TG = triacylglycerol; HDL = high-density lipoprotein; CRP: C-reactive protein. Source authors (2021).

4. Discussion

In the present study, we evaluated the number of steps taken by MPOs during their 12 h patrols. Twelve hours comprise most of the day, considering the hours of sleep and the commute to work. The study of Tudor-Locke (2011) was used to interpret the results.

The average number of steps performed by the 25 MPOs over 12 h was 5169. The MPOs working the day shift took 4368 steps, and those working the night shift took 6189. The number of steps during the MPOs patrol, regardless of the shift, was less than 7000 steps, which is relatively low and corresponds to little daily activity. Even though it is only during the working period, this data represents about 75% of daytime MPOs' daily activity and 92% of those patrolling at night (data not shown). Although not significant, the MPOs working the night shift walked 29.4% more (1820 steps). This result is likely because there are fewer police reports at night.

There was no statistical difference in BMI between group 1 (600-2,000 steps) and group 2 (2,001-8,000 steps). We also did not detect significant differences in FFM and SMM between these two groups. Krumm et al., (2006) examined the relationship between daily steps measured using a pedometer and body composition parameters in 93 menopausal women and reported a linear relationship between steps performed and BMI. Moreover, women who took 5,000 to 7,500 steps per day had

lower BMI values than those who took less than 5,000 steps per day. Interestingly, there was no significant difference in BMI between women who took 7,500-9,999 steps per day and those who performed more than 10,000. Our data indicate that other factors, probably specific to radio patrol policing rather than physical activity, are involved in our findings.

We found higher BMI values in the group with >19 years of service than those with 1-10 years; however, the values were not significant (p<0.08). Additionally, BM (tendency, p <0.07) and AFM (p<0.01) were increased in the >19 years of service compared to the group with 1-10 years. These findings suggest that the MPOs who worked at the PMESP for a longer period display abnormal body composition, possibly contributing to the onset and progression of MetS.

Although we did not detect a statistical difference in the VAT, MPOs who performed a greater working number of steps (WNS) exhibited improved health parameters. On the other hand, the VAT increases with age and service length at the PMESP. The metabolic benefits that physical activity promotes are well known, and the consequences of low physical activity are associated with high VAT. Thus, the reduced number of steps taken by all MPOs probably contributed to the elevated VAT values. Notably, this condition is associated with peripheral insulin resistance and MetS prevalence (Lee & Kim, 2013), and frequent and intense physical activity significantly reduces VAT (Ismail, et al., 2012; Vissers, et al., 2013).

Additionally, WHR is one of the predictive risk markers for MetS development (Bener, et al., 2013), and the MPOs who performed the fewest WNS had the highest WHR values. It should be pointed out that 31% of the volunteers were classified as at very high risk, 42% at high risk, and 27% at moderate risk of developing cardiometabolic diseases.

The American Diabetes Association (2020) established desirable values for fasting glycemia, between 70 and 99 mg/dL. Herein, 16 of the 25 volunteers had abnormally high blood fasting glucose levels. Moreover, according to the American Diabetes Association (2020) reference values, 14 of the 25 participants (56%) presented elevated HbA1c values above the recommended value of 5.6%, indicative of chronic hyperglycemia. Of the 14 participants with elevated HbA1c levels, one-third walked more than 5,000 steps during their patrol shift. Interestingly, the MPOs with the highest plasma insulin levels also had the highest HbA1c values. These results indicate a simultaneous occurrence of low physical activity levels and chronic hyperglycemia. Indeed, it is well established that insufficient physical activity contributes to hyperglycemia and type-2 diabetes development (Gill & Cooper, 2008).

It is known that hypertriglyceridemia is a risk factor for acute myocardial infarction and stroke (Bays et al., 2013) and that there is a close association between hypertriglyceridemia and a sedentary lifestyle (Edwardson, et al., 2012). In the present study, eight (36%) of the 25 volunteers presented hypertriglyceridemia; however, we could not detect a relationship between the number of steps and high plasma TG levels. Thus, it is plausible that other factors, such as age, family history, gender, smoking, drinking, arterial hypertension, abdominal overweight, obesity, a diet rich in animal fats, and stress, contribute to this observation (Faludi, et al., 2017). The group with the longest service time in the PMESP had TG values above normal, suggesting that this factor contributed to the observed hypertriglyceridemia.

It has been reported that plasma HDL-cholesterol levels below 40 mg/dL are associated with physical inactivity and MetS risk (Celis-Morales et al., 2012). Herein, 38% of the MPOs had low HDL levels. Moreover, MPOs with ≥19 years of service at the PMESP presented HDL levels below 40 mg/dL. The participants with more years of service walked less during their patrol shift (2743.17±1107.16 steps/day) and presented low HDL values.

Our analysis of SBP and DBP indicates that 52% of the policemen had hypertension. The group that performed up to 2,000 steps daily presented significantly increased DBP. Moreover, the MPOs with the longer service time in the PMESP presented considerably elevated SBP. Finally, low WNS and more years at the PMESP were associated with aggravated hypertension.

Madjd et al., (2019) studied 65 sedentary, overweight or obese women who underwent two types of physical activity programs with a controlled diet to generate a daily caloric deficit of 500-600 calories for 24 weeks. One group had a long and

continuous walking protocol, with at least 100 steps per min for 50 min, six times a week and the other group walked twice a day for 25 min, six times a week. Under these conditions, the physical activity volumes were equalized. Before starting the protocol, the first group performed 3,925±701 steps per day, while the second group took 3,990±651. After 24 weeks, both groups significantly increased the number of steps, with the first group exhibiting an increase of +2196 ± 789 steps per day and the second group increased the number of daily steps by +2965±795. While both groups presented increased plasma HDL levels and reduced BM, BMI, WC, and total cholesterol, HbA1c, glucose, and insulin blood levels, the second group displayed more expressive results that could contribute to cardiometabolic disease prevention.

Vancini et al., (2018) described the relationship between symptoms of anxiety and depression and the level of habitual physical activity in male MPOs from the State of Espirito Santo, Brazil (who routinely deal with extraordinarily complex and hostile situations), according to the BMI. They observed that the overweight group had increased anxiety and depression associated with low physical activity levels. Additionally, the MPOs with the highest BMI had the most marked symptoms. These changes may be related to the number of military service years.

There are some limitations to take into consideration in analyzing our results. For example, we only studied male MPOs. A paired control group would be desirable, but it is difficult to define appropriate professional work for comparison. Moreover, we did not record the physical activity for 24 h. Lastly, despite providing proper teaching and support for the participants' to use and handle the pedometers and recording the number of steps during their patrol shift, the number of participants excluded from the study due to improper pedometer use was high.

5. Final Considerations

In conclusion, the occurrence of MetS increases in MPOs with more years of service at the PMESP. The number of daily steps taken by MPOs during their patrol indicates that the majority are not physically active. Additionally, these individuals presented unhealthy body compositions and plasma measurements associated with a high MetS prevalence (64%). Notably, all MPOs working at the PMESP for more than 19 years performed the fewest number of steps during work (up to 2,000 steps) and presented MetS. Intervention strategies are needed to increase physical activity practice during work and to prevent and treat the occurrence of metabolic changes in MPOs.

Acknowledgments

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