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Sex-based differences in cardiometabolic risk among spanish police officers and security guards: a cross-sectional analysis of 7,360 workers

Diferencias según el sexo en el riesgo cardiometabólico entre policías y vigilantes de seguridad españoles: un análisis transversal de 7.360 trabajadores

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Abstract

Background: Law enforcement and private security personnel are exposed to occupational stressors that increase their cardiometabolic risk. However, few large-scale studies have evaluated this risk using validated indices and sex-based analysis.

Objective: To assess the prevalence of cardiometabolic risk factors in Spanish police officers and security guards, stratified by sex, age, smoking, and job role.

Methods: A cross-sectional study was conducted in 7,360 workers (6,341 men, 1,019 women) from law enforcement and private security sectors. Anthropometric and biochemical data were collected using standardized protocols. Cardiometabolic risk was assessed via validated indices, including FLI, TyG, METS IR, VAI, and CMI. Multivariate logistic regression examined associations between demographic and occupational factors and adverse metabolic outcomes.

Results: Male sex, age ≥50 years, and being a police officer were independently associated with increased risk of obesity, hepatic steatosis, insulin resistance, metabolic syndrome, and atherogenic dyslipidemia (OR >2.0, $p < 0.001$). All indices showed worse cardiometabolic profiles in men. Smoking had a weaker association with some outcomes.

Conclusions: Spanish police officers and security guards exhibit a high prevalence of cardiometabolic risk, especially among older men and police officers. Targeted, sex-specific screening and prevention strategies are urgently needed in this population.

Palabras clave: Metabolic Syndrome. Occupational Health. Police. Cardiometabolic Risk. Sex Factors. Cross-Sectional Studies.

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Resumen

Antecedentes: El personal de los cuerpos de seguridad y de la seguridad privada está expuesto a estresores ocupacionales que incrementan su riesgo cardiometabólico. Sin embargo, pocos estudios a gran escala han evaluado este riesgo utilizando índices validados y un análisis estratificado por sexo.

Objetivo: Evaluar la prevalencia de factores de riesgo cardiometabólico en policías y vigilantes de seguridad en España, estratificados por sexo, edad, hábito tabáquico y rol laboral.

Métodos: Se llevó a cabo un estudio transversal en 7.360 trabajadores (6.341 hombres y 1.019 mujeres) de los sectores de seguridad pública y privada. Se recogieron datos antropométricos y bioquímicos mediante protocolos estandarizados. El riesgo cardiometabólico se evaluó mediante índices validados, incluyendo FLI, TyG, METS-IR, VAI y CMI. Se aplicó regresión logística multivariante para examinar las asociaciones entre factores demográficos y ocupacionales y desenlaces metabólicos adversos.

Resultados: El sexo masculino, la edad ≥50 años y ser policía se asociaron de manera independiente con un mayor riesgo de obesidad, esteatosis hepática, resistencia a la insulina, síndrome metabólico y dislipidemia aterogénica (OR >2,0; p < 0,001). Todos los índices mostraron perfiles cardiometabólicos más desfavorables en los hombres. El tabaquismo presentó una asociación más débil con algunos desenlaces.

Conclusiones: Los policías y vigilantes de seguridad en España presentan una elevada prevalencia de riesgo cardiometabólico, especialmente los hombres de mayor edad y los policías. Se necesitan con urgencia estrategias de cribado y prevención dirigidas y específicas por sexo en esta población.

Keywords: Síndrome metabólico. Salud laboral. Policía. Riesgo cardiometabólico. Variables sociodemográficas.

Introduction

Law enforcement professionals are exposed to unique occupational stressors, including irregular work shifts, sedentary periods punctuated by intense physical effort, psychosocial stress, and circadian disruption. These factors contribute significantly to elevated cardiometabolic risk profiles, including increased prevalence of obesity, dyslipidemia, hypertension, and insulin resistance[1–3]. Despite these well-recognized risks, comprehensive data on cardiometabolic health in police officers and private security guards remain scarce, particularly with sex-stratified analysis.

Maintaining optimal cardiometabolic health is critical not only for the personal well-being and professional readiness of these workers but also for broader public safety outcomes and institutional sustainability[4,5]. Recent investigations have shown alarming rates of cardiometabolic disorders among law enforcement officers, with elevated body fat, hepatic steatosis, and metabolic syndrome as key findings[6,7]. These risks are exacerbated by unhealthy behaviours such as smoking, low physical activity, poor sleep quality, and irregular eating patterns[8–10].

Importantly, sex differences in fat distribution, hormonal regulation, and cardiovascular responses may modify disease presentation and risk perception[11,12]. Biological and occupational differences between men and women, including role-specific exposures, highlight the necessity of conducting sex-specific analyses in this population.

In Spain, police officers and private security guards operate under different institutional frameworks and occupational demands. However, both professions share

exposure to metabolic risk factors such as shift work and lifestyle stressors[13]. While prior studies have explored cardiovascular risk in military and law enforcement personnel, few have employed a wide range of validated cardiometabolic indices— such as the Visceral Adiposity Index (VAI), Fatty Liver Index (FLI), and Metabolic Score for Insulin Resistance (METS-IR)—to capture the complexity of metabolic dysfunction[14–16].

The aim of this study is to analyse sex-based differences in cardiometabolic risk factors among 7,360 Spanish police officers and security guards, based on anthropometric, clinical, and biochemical markers. The study incorporates a wide set of validated indices to provide a comprehensive and multidimensional assessment. Understanding these differences will inform tailored strategies for prevention, early detection, and occupational health interventions in these critical public service populations.

Materials and methods

Study Design and Participants

This cross-sectional study analysed clinical, anthropometric, and biochemical data from 7,360 Spanish workers, including 6,341 men and 1,019 women, employed as police officers or private security guards (**Figure 1**). All participants were evaluated as part of an occupational health surveillance program between 2019 and 2023. All subjects provided written informed consent, and data collection complied with

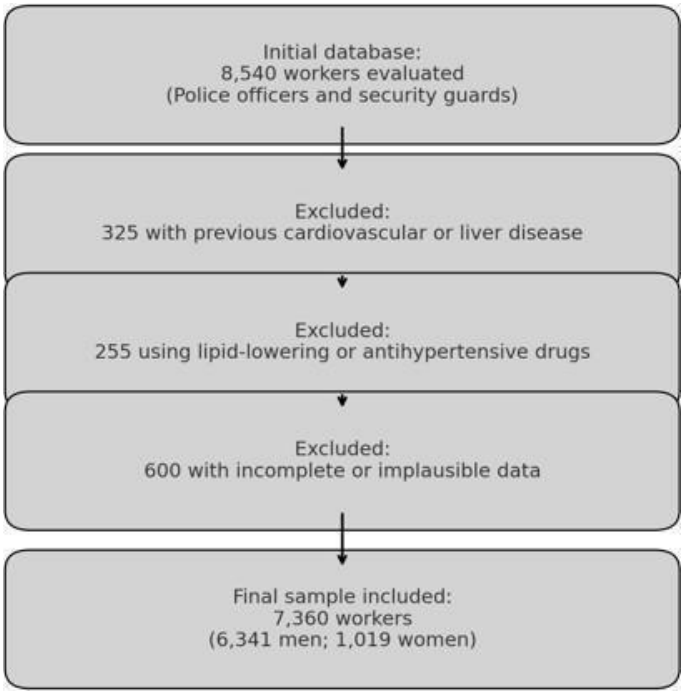

Figure 1. Flowchart of Participant Selection Process.

the Declaration of Helsinki and Spanish data protection regulations.

Inclusion and Exclusion Criteria

Inclusion criteria were:

1. Active professional status as a police officer or private security guard.
2. Age between 18 and 65 years.
3. Complete clinical, anthropometric, and biochemical data records.

Exclusion criteria included:

1. Self-reported history of cardiovascular disease, hepatic disease, or diabetes mellitus.
2. Use of lipid-lowering or antihypertensive medications.
3. Incomplete or biologically implausible data.

Variables and Measurements

Standardized procedures were followed for all measurements. Participants were evaluated fasting (≥8 h).

Anthropometric parameters included height, weight, body mass index (BMI), and waist circumference, measured following WHO protocols[17]. These metrics have been validated as predictive of cardiovascular and metabolic risk in occupational cohorts[18].

Blood pressure was measured using an automated sphygmomanometer (Omron M6®), in a seated position after 5 minutes of rest. Systolic and diastolic values were averaged from two measurements. Elevated blood pressure is a recognized independent predictor of cardiovascular events and metabolic syndrome[19,20].

Biochemical parameters were analyzed from venous blood samples using enzymatic assays: total cholesterol, HDL-c, LDL-c (Friedewald formula), triglycerides, fasting glucose, liver enzymes (ALT, AST, GGT), and creatinine. These parameters are essential markers of dyslipidemia, glycemic control, hepatic function, and renal status, all of which are key components of cardiometabolic health[21–24].

Cardiometabolic indices were calculated using validated formulas (**Table 1**):

Statistical Analysis

Descriptive statistics were computed for all variables, stratified by sex. Means and standard deviations (SD) were reported for continuous variables; categorical variables were presented as percentages. Group comparisons were assessed using Student's t- test for continuous variables and chi-square test for categorical variables. A p-value<0.05 was considered statistically significant. Analyses were performed using SPSS v29.0.

Results

Table 2 presents the basic anthropometric, biochemical, and sociodemographic characteristics of the 7,360 participants, stratified by sex. The mean age

Table 1. Cardiometabolic Risk Indices: Definitions, Formulas, and Clinical Applications.

Index	Formula / Components	Clinical Relevance
Body mass index	Weight (kg) / Height² (m²)	Classification of overweight and obesity[17,18]
Waist-to-Height Ratio (WtHR)	Waist circumference (cm) / Height (cm)	Visceral adiposity and cardiovascular mortality[25]
CUN-BAE	−44.988 + (0.503 × age) + (10.689 × sex) + (3.172 × BMI) − (0.026 × BMI²) + (0.181 × BMI × sex) − (0.02 × BMI × age) − (0.005 × BMI² × sex) + (0.00021 × BMI² × age)	Estimates body fat percentage[26]
METS-VF	4.466 + 0.011*(TG×WC) + 3.239*(sex) + 0.319*SBP + 0.594*Glucose + 0.013*age	Estimates visceral fat; validated in European populations[27]
Body roundness index	364.2 − 365.5 × √(1 − (WC/2π)² / (0.5 × height)²)	Surrogate marker of abdominal adiposity[28]
Body shape index	WC / [BMI^(2/3) × height^(1/2)]	Predictor of mortality and abdominal obesity[28]
Visceral adiposity index	Men: [(WC / 39.68 + (1.88 × BMI)) × (TG / 1.03) × (1.31 / HDL-c)]	Estimates visceral adipose tissue dysfunction[29]
	Women: [(WC / 36.58 + (1.89 × BMI)) × (TG / 0.81) × (1.52 / HDL-c)]	
Conicity Index	WC / [0.109 × √(weight / height)]	Estimates abdominal fat distribution[30]
PRISQ	Composite score: age, sex, BMI, SBP, DBP, TG, HDL-c, glucose	Screening for prediabetes[31]
Fatty liver index	[e(0.953 × ln(TG) + 0.139 × BMI + 0.718 × ln(GGT) + 0.053 × WC − 15.745)] / [1 + e((0.953 × ln(TG) + 0.139 × BMI + 0.718 × ln(GGT) + 0.053 × WC − 15.745)] × 100	Predictor of hepatic steatosis[32]
Lipid accumulation product	Men: (WC − 65) × TG	Central lipid accumulation and insulin resistance[33]
	Women: (WC − 58) × TG	
Atherogenic Indices	TC/HDL-c, TG/HDL-c, LDL-c/HDL-c	Associated with coronary risk[34]
TyG	Ln [TG (mg/dL) × Glucose (mg/dL)/2]	Insulin resistance surrogate[35]
METS-IR	Ln[2 × Glucose + TG] × BMI / Ln(HDL-c)	Non-insulin-based index of insulin resistance[36]
Cardiometabolic index	WtHR × (TG / HDL-c)	Composite index of global metabolic risk[37]
Metabolic Syndrome	NCEP-ATP III criteria: ≥3 of the following: WC↑, TG↑, HDL-c↓, BP↑, glucose↑	Multifactorial metabolic risk[38]

CUN BAE (Clinica Universitaria de Navarra, Body Adiposity Estimator). METS-VF Metabolic score for visceral fat. PRISQ Prediabetes Risk Score in Qatar. TyG Triglyceride glucosa index. METS-IR Metabolic score-insulin resistance. TG Triglycerides. HDL-c High density lipoprotein. LDL-c Low density lipoprotein. WC Waist circumference. GGT Gamma-Glutamyl Transferase.

Table 2. Descriptive Characteristics of the Study Population by Sex.

	Women n=1,019	Men n= 6,341	
	Mean (SD)	Mean (SD)	p-value
Age (years)	42.2 (9.1)	44.3 (9.4)	<0.0001
Height (cm)	163.8 (6.1)	176.2 (6.2)	<0.0001
Weight (kg)	66.5 (11.4)	85.1 (13.3)	<0.0001
Waist circumference (cm)	73.9 (8.9)	88.5 (9.9)	<0.0001
Systolic blood pressure (mmHg)	118.4 (15.4)	129.7 (15.4)	<0.0001
Diastolic blood pressure (mmHg)	72.7 (10.2)	78.9 (10.6)	<0.0001
Total cholesterol (mg/dl)	191.4 (35.5)	196.9 (36.6)	<0.0001
HDL-cholesterol (mg/dl)	59.5 (12.5)	50.4 (10.4)	<0.0001
LDL-cholesterol (mg/dl)	113.3 (33.8)	121.1 (34.7)	<0.0001
Triglycerides (mg/dl)	93.2 (52.4)	130.5 (80.4)	<0.0001
Glycaemia (mg/dl)	88.6 (13.1)	93.3 (21.3)	<0.0001
ALT (U/L)	21.0 (10.7)	33.9 (19.4)	<0.0001
AST (U/L)	18.6 (7.6)	25.8 (13.9)	<0.0001
GGT (U/L)	22.0 (20.5)	37.3 (35.5)	<0.0001
Creatinine (mg/dl)	0.78 (0.14)	0.98 (0.16)	<0.0001
	Percentage	Percentage	p-value
18-29 years	8.3	6.7	<0.0001
30-39 years	30.0	23.7	
40-49 years	39.4	38.3	
≥ 50 years	22.3	31.3	
Non smokers	65.0	68.9	<0.0001
Smokers	35.0	31.1	
Police officer	39.4	58.4	<0.0001
Security guard	60.6	41.6	

HDL-c High density lipoprotein. LDL-c Low density lipoprotein. AST Aspartate Aminotransferase. ALT Alanine Aminotransferase. GGT Gamma-Glutamyl Transferase.

was significantly higher in men (44.3 ± 9.4 years) than in women (42.2 ± 9.1 years) ($p < 0.0001$). Significant sex-based differences were also observed in all anthropometric measures, with men exhibiting greater height, weight, and waist circumference ($p < 0.0001$ for all). Cardiovascular parameters such as systolic and diastolic blood pressure were markedly higher in men (129.7 ± 15.4 mmHg and 78.9 ± 10.6 mmHg, respectively) compared to women (118.4 ± 15.4 mmHg and 72.7 ± 10.2 mmHg, $p < 0.0001$).

In lipid profile, men showed higher total cholesterol, LDL-c, and triglyceride levels, whereas HDL-c was significantly lower than in women ($p < 0.0001$). Liver enzymes (ALT, AST, GGT) and serum creatinine were also elevated in men ($p < 0.0001$), potentially indicating greater hepatic and renal metabolic stress.

From a sociodemographic perspective, a higher proportion of women were aged 30– 39 years, whereas men were more represented in the ≥50 age group. A greater proportion of men were police officers (58.4%) compared to women (39.4%), while the opposite was true for private security roles (60.6% women vs. 41.6% men). Smoking prevalence was higher in women (35.0%) than in men (31.1%), but men had a

higher prevalence of advanced age and central obesity, reinforcing the need for sex-stratified preventive strategies.

Taken together, these findings underline those women exhibited more favorable levels of blood pressure, lipid profile, and liver enzymes, whereas men consistently displayed a more adverse metabolic profile.

Table 3 displays the mean values of a broad panel of validated cardiometabolic risk indices by sex. Across nearly all markers, men had significantly worse cardiometabolic profiles ($p < 0.0001$), including higher values for BMI (27.4 vs. 24.8), WtHR (0.50 vs. 0.45), METS-VF (6.4 vs. 5.4), and VAI (8.2 vs. 2.7). These findings suggest more pronounced visceral adiposity and metabolic derangement in men.

Markers of insulin resistance, such as the triglyceride-glucose index (TyG: 8.6 vs. 8.2) and METS-IR (40.5 vs. 34.3), were also significantly higher in men ($p < 0.0001$). Similarly, men had elevated lipid-related

Table 3. Mean Values of Cardiometabolic Risk Indices by Sex.

	Women n=1,019	Men n= 6,341	
	Mean (SD)	Mean (SD)	p-value
Body mass index	24.8 (4.2)	27.4 (3.9)	<0.0001
Waist to height ratio	0.45 (0.05)	0.50 (0.05)	<0.0001
CUN BAE	35.0 (6.0)	27.0 (5.5)	<0.0001
METS-VF	5.4 (0.8)	6.4 (0.6)	<0.0001
Body roundness index	2.5 (1.0)	3.5 (1.0)	<0.0001
Body shape index	0.068 (0.006)	0.074 (0.006)	<0.0001
Visceral adiposity index	2.7 (1,8)	8.2 (7.0)	<0.0001
Conicity index	1.1 (0.1)	1.2 (0.1)	<0.0001
PRISQ	13.0 (8.6)	19.7 (9.3)	<0.0001
Fatty liver index	16.4 (18.6)	44.1 (26.5)	<0.0001
Lipid accumulation product	17.8 (18.0)	36.9 (33.5)	<0.0001
Bard scoring	1.4 (1.2)	1.4 (1.2)	0.982
Total cholesterol/HDL-c	3.3 (0.9)	4.1 (1.2)	<0.0001
Triglycerides/HDL-c	1.7 (1.1)	2.8 (2.2)	<0.0001
LDL-c/HDL-c	2.0 (0.8)	2.5 (1.0)	<0.0001
Triglyceride glucose index	8.2 (0.5)	8.6 (0.6)	<0.0001
METS-IR	34.3 (7.2)	40.5 (8.0)	<0.0001
Cardiometabolic index	0.8 (0.6)	1.5 (1.2)	<0.0001
nº factors of metabolic syndrome	0.8 (1.1)	1.4 (1.3)	<0.0001
Globorisk	2.1 (1.7)	5.8 (3.4)	<0.0001
REGICOR scale	3.0 (2.2)	3.3 (2.2)	<0.0001
SCORE scale	0.4 (0.9)	1.6 (2.2)	<0.0001
ALLY vascular age	0.2 (11.9)	6.8 (10.5)	<0.0001

HDL-c High density lipoprotein. LDL-c Low density lipoprotein CUN BAE (Clinica Universitaria de Navarra Body Adiposity Estimator). METS-VF Metabolic score for visceral fat. PRISQ Prediabetes Risk Score in Qatar. METS-IR Metabolic score-insulin resistance. REGICOR (Registre Gironi del Cor). SCORE Systematic COronary Risk Evaluation. ALLY Avoidable lost life years.

risk ratios (TC/HDL, TG/HDL, LDL/HDL) and higher cardiometabolic index (1.5 vs. 0.8).

Interestingly, the PRISQ score was notably higher in men (19.7 ± 9.3 vs. 13.0 ± 8.6), indicating greater prediabetes risk. Hepatic steatosis risk, measured through the Fatty Liver Index (FLI: 44.1 vs. 16.4) and LAP (36.9 vs. 17.8), was also considerably higher among male participants.

Notably, the Bard score for liver fibrosis showed no sex differences, suggesting early-stage steatosis without advanced fibrosis. However, men had a higher average vascular age (ALLY: 6.8 vs. 0.2 years) and greater estimated cardiovascular risk according to REGICOR, SCORE, and Globorisk scales ($p < 0.0001$), reinforcing the burden of cumulative risk in this group.

These results highlight those men not only present with higher obesity and visceral adiposity, but also a significantly greater risk of prediabetes and metabolic liver disease, indicating an overall more severe cardiometabolic risk patter

Table 4 summarizes the prevalence of elevated values for several risk indicators. A higher proportion of men exceeded threshold values for WtHR >0.50 (47.2% vs. 14.7%), BMI-defined obesity (21.7% vs. 11.1%),

Table 4. Prevalence of Elevated Cardiometabolic Risk Indicators by Sex.

	Women n=1.019 Percentage	Men n= 6.341 Percentage	p-value
Waist to height ratio >0.50	14.7	47.2	<0.0001
Obesity Body mass index	11.1	21.7	<0.0001
Obesity CUN BAE	46.7	63.0	<0.0001
METS-VF high	0.4	10.5	<0.0001
Diabesity	0.9	3.3	<0.0001
PRISQ high risk	5.4	19.4	<0.0001
Hypertension	12.8	32.7	<0.0001
Total cholesterol > 200 mg/dl	36.4	44.1	<0.0001
LDL-c > 130 mg/dl	28.3	37.8	<0.0001
Triglycerides > 150 mg/dl	9.3	27.7	<0.0001
Glycaemia 100-125 mg/dl	11.1	18.0	<0.0001
Glycaemia > 125 mg/dl	1.4	3.7	<0.0001
Metabolic syndrome	8.8	19.8	<0.0001
Lipid accumulation product high	24.4	44.8	<0.0001
Fatty liver index high risk	5.9	29.8	<0.0001
Total cholesterol/HDL-c moderate-high	10.3	19.5	<0.0001
Triglycerides/HDL-c high	8.3	3.2	<0.0001
LDL-c/HDL-c	10.6	27.6	<0.0001
Atherogenic dyslipidemia	5.2	12.0	<0.0001
METS-IR high	3.5	12.6	<0.0001
Triglyceride glucose index high	14.5	30.7	<0.0001
REGICOR moderate-high	18.5	22.0	<0.0001
SCORE moderate-high	4.3	26.9	<0.0001

HDL-c High density lipoprotein. LDL-c Low density lipoprotein. CUN BAE (Clinica Universitaria de Navarra, Body Adiposity Estimator). METS-VF Metabolic score for visceral fat. PRISQ Prediabetes Risk Score in Qatar. METS-IR Metabolic score-insulin resistance. REGICOR (Registre Gironi del Cor). SCORE Systematic COronary Risk Evaluation.

and CUN-BAE-defined adiposity (63.0% vs. 46.7%) (p < 0.0001). Visceral obesity, measured via METS-VF, was markedly more frequent in men (10.5% vs. 0.4%).

The prevalence of diabesity (concurrent diabetes and obesity) and PRISQ high-risk category were both significantly higher in men (3.3% and 19.4%) than in women (0.9% and 5.4%, respectively). Hypertension was also over twice as prevalent in men (32.7%) compared to women (12.8%).

Regarding lipid disorders, men exhibited a higher prevalence of hypertriglyceridemia (>150 mg/dL: 27.7% vs. 9.3%) and elevated LDL-c (>130 mg/dL: 37.8% vs. 28.3%). Similarly, glycaemia >125 mg/dL was observed in 3.7% of men vs. 1.4% of women, while metabolic syndrome was present in 19.8% of men and 8.8% of women (p < 0.0001).

Hepatic risk markers also showed sex-based disparities: FLI high-risk levels were observed in 29.8% of men vs. 5.9% of women, and elevated LAP in 44.8% vs. 24.4%, respectively. Atherogenic dyslipidemia and insulin resistance (METS-IR and TyG) were likewise more common among men.

Overall, these results indicate a significantly higher cardiometabolic burden among male

officers and guards across virtually all domains assessed, supporting the urgent need for sex-specific screening, prevention, and intervention strategies.

In particular, the high prevalence of hypertension, atherogenic dyslipidemia, and metabolic syndrome in men underscores the clinical relevance of these indicators as priority targets for occupational health interventions.

Table 5 presents the results of a multivariate logistic regression model examining the association between key demographic and occupational predictors—sex, age group, smoking status, and type of employment—and various cardiometabolic risk outcomes. Male sex emerged as a strong independent predictor for most adverse outcomes. Specifically, being male was significantly associated with increased odds of central obesity (OR 2.00; 95% CI: 1.52–2.39; p < 0.001), elevated waist-to-height ratio (OR 3.10; 95% CI: 2.92–3.27; p < 0.001), metabolic syndrome, and atherogenic dyslipidemia. These findings align with prior evidence indicating greater visceral adiposity and metabolic burden in male law enforcement professionals.

Older age (≥50 years) was also a consistent risk factor. Participants in this age group had more than double the odds of obesity (OR 2.54; 95% CI: 2.38–2.70; p < 0.001) and were more likely to present with hepatic steatosis, insulin resistance (TyG and METS- IR), and hypertension. This age-related risk gradient emphasizes the need for intensified surveillance in senior personnel, particularly in physically demanding occupations such as policing and private security.

Smoking showed a weaker yet statistically significant association with some outcomes, including obesity (OR 1.24; 95% CI: 0.79–1.58; p = 0.04). While not as strong as other predictors, its inclusion reflects the cumulative impact of lifestyle-related exposures in cardiometabolic deterioration.

Interestingly, being a police officer (as opposed to a private security guard) was associated with increased odds of several adverse outcomes, including obesity (OR 2.80; 95% CI: 2.69–3.29; p < 0.001). This may be attributable to more irregular shift work, higher levels of occupational stress, or differential access to health promotion services between the two professional groups.

Collectively, these findings underscore the multifactorial nature of cardiometabolic risk in this occupational cohort and highlight the importance of sex- and age-stratified risk assessment. Preventive strategies should particularly target male, older, and uniformed personnel to reduce long-term morbidity.

Discussion

This study provides a comprehensive overview of the cardiometabolic health profile of 7,360 Spanish police officers and private security guards, revealing significant sex- and occupation-based disparities in metabolic risk. The high prevalence of obesity, visceral adiposity, metabolic syndrome, insulin resistance, and hepatic steatosis among male officers underscores the urgency for targeted occupational health interventions.

The results corroborate previous evidence indicating that law enforcement professionals are disproportionately affected by cardiometabolic disorders due to cumulative exposures such as shift work, psychosocial stress, and reduced physical activity[42,43]. Men demonstrated significantly higher mean values and prevalence rates for almost all markers, including BMI, waist-to-height ratio, triglyceride/HDL-c ratio, and the Fatty Liver Index. These findings are consistent with recent studies showing that male sex is an independent predictor of visceral obesity, insulin resistance, and atherogenic dyslipidemia in uniformed populations[44–46].

The marked differences observed in metabolic syndrome prevalence (19.8% in men vs. 8.8% in women) align with prior occupational studies in military and paramilitary cohorts[47,48]. Notably, metabolic syndrome has been identified as a strong predictor of

Table 5. Multivariate Analysis of Cardiometabolic Risk Predictors.

Outcome Variable	Predictor	Odds Ratio (OR)	95% CI	p-value
Obesity (BMI ≥30)	Male Sex	2.0	1.52–2.39	<0.001
Obesity (BMI ≥30)	Age ≥50 years	2.54	2.38–2.7	<0.001
Obesity (BMI ≥30)	Current Smoker	1.24	0.79–1.58	0.04
Obesity (BMI ≥30)	Police Officer	2.8	2.69–3.29	<0.001
High Waist-to-Height Ratio	Male Sex	3.1	2.92–3.27	<0.001
High Waist-to-Height Ratio	Age ≥50 years	1.54	1.32–1.85	<0.001
High Waist-to-Height Ratio	Current Smoker	2.14	1.92–2.48	<0.001
High Waist-to-Height Ratio	Police Officer	1.43	1.21–1.68	<0.001
Metabolic Syndrome	Male Sex	2.19	1.78–2.37	<0.001
Metabolic Syndrome	Age ≥50 years	2.33	1.99–2.45	<0.001
Metabolic Syndrome	Current Smoker	2.56	2.39–2.69	<0.001
Metabolic Syndrome	Police Officer	3.38	2.89–3.8	<0.001
High Fatty Liver Index	Male Sex	1.83	1.69–2.2	<0.001
High Fatty Liver Index	Age ≥50 years	2.16	2.01–2.46	<0.001
High Fatty Liver Index	Current Smoker	1.18	0.72–1.38	0.04
High Fatty Liver Index	Police Officer	2.69	2.47–3.0	<0.001
High Triglyceride-Glucose Index	Male Sex	2.41	2.24–2.9	<0.001
High Triglyceride-Glucose Index	Age ≥50 years	2.96	2.48–3.42	<0.001
High Triglyceride-Glucose Index	Current Smoker	2.53	2.06–2.67	<0.001
High Triglyceride-Glucose Index	Police Officer	1.57	1.45–1.8	<0.001
Hypertension	Male Sex	2.03	1.82–2.46	<0.001
Hypertension	Age ≥50 years	1.96	1.75–2.28	<0.001
Hypertension	Current Smoker	1.44	1.02–1.57	<0.001
Hypertension	Police Officer	3.47	3.06–3.65	<0.001
Atherogenic Dyslipidemia	Male Sex	1.11	0.68–1.49	0.04
Atherogenic Dyslipidemia	Age ≥50 years	2.85	2.44–2.98	<0.001
Atherogenic Dyslipidemia	Current Smoker	1.96	1.81–2.41	<0.001
Atherogenic Dyslipidemia	Police Officer	2.6	2.37–2.73	<0.001
High METS-IR	Male Sex	1.85	1.62–2.24	<0.001
High METS-IR	Age ≥50 years	2.63	2.18–2.92	<0.001
High METS-IR	Current Smoker	1.39	1.0–1.79	0.04
High METS-IR	Police Officer	2.45	2.04–2.75	<0.001
Elevated VAI	Male Sex	2.35	2.08–2.46	<0.001
Elevated VAI	Age ≥50 years	1.36	1.25–1.71	0.04
Elevated VAI	Current Smoker	1.85	1.55–2.31	<0.001
Elevated VAI	Police Officer	1.7	1.44–2.1	<0.001

BMI Body mass index. METS-IR Metabolic score-insulin resistance. VAI Visceral adiposity index.

cardiovascular events and all-cause mortality, particularly when accompanied by hepatic steatosis and insulin resistance[49].

Regarding liver health, the Fatty Liver Index (FLI) and Lipid Accumulation Product (LAP) revealed substantial sex disparities, with high-risk FLI values present in nearly 30% of men. Non-alcoholic fatty liver disease (NAFLD) is increasingly recognized as a hepatic manifestation of metabolic syndrome and is strongly associated with visceral fat accumulation and cardiometabolic dysfunction[50,51]. Its early identification through non-invasive scores like FLI is particularly relevant in asymptomatic working populations.

A notable finding was the higher cardiometabolic burden observed in police officers compared to private security guards. Although both groups share exposure to physical and psychological stressors, police work often involves more intensive shift patterns, higher exposure to critical incidents, and longer service duration—factors known to

compound metabolic risk[52,53]. This was reflected in the multivariate models, where being a police officer significantly increased the odds of obesity, hypertension, and metabolic syndrome, even after adjusting for sex, age, and smoking.

Our findings on age as a risk modifier are also consistent with current literature. Participants aged ≥50 years had significantly higher odds of almost all metabolic abnormalities, consistent with physiological age-related changes in fat distribution, insulin sensitivity, and vascular function[54,55].

Interestingly, while smoking was associated with certain outcomes, such as obesity and dyslipidemia, its role as an independent predictor was relatively weaker. However, the synergistic effect of smoking with other occupational stressors should not be underestimated, as tobacco use remains a modifiable risk factor that exacerbates metabolic and cardiovascular pathology[56,57].

In addition, diet quality and sleep habits may substantially influence cardiometabolic risk in this occupational group. The Mediterranean diet has been consistently shown to exert a protective effect against obesity, metabolic syndrome, and cardiovascular disease, and adherence to this dietary pattern could mitigate part of the risk observed among police officers and security guards[58,59]. Likewise, sleep deprivation and poor sleep quality, which are common in shift-based professions, have been associated with insulin resistance, hypertension, and lipid alterations[60,61]. Although these variables were not evaluated in the present study, they should be incorporated into future research and preventive strategies.

Collectively, these findings advocate for the implementation of routine screening programs, health promotion strategies, and occupational health policies tailored to high-risk groups within law enforcement. The use of composite indices such as METS- IR, VAI, and PRISQ allows for early identification of subclinical metabolic dysfunction and can serve as practical tools in occupational health settings.

Strengths and Limitations

A major strength of this study is the large sample size and inclusion of both police and private security personnel, providing a representative snapshot of cardiometabolic health in this occupational sector. The use of a broad panel of validated risk indices—including hepatic and insulin resistance markers—adds diagnostic and prognostic depth beyond traditional risk factors.

Limitations include the cross-sectional design, which precludes causal inference. Additionally, lifestyle variables such as diet quality, physical activity, and sleep patterns were not included, potentially underestimating or confounding certain associations. Finally, the study focused exclusively on Spanish personnel, limiting generalizability to other countries or healthcare systems.

Key Contributions

This study makes several key contributions to the field of occupational health and cardiometabolic risk assessment. First, it is one of the largest analyses to date examining sex-based differences in metabolic risk among police officers and security personnel, a population underrepresented in current research. Second, the study integrates a broad panel of validated risk indices—including FLI, METS-IR, PRISQ, and VAI—offering a multidimensional approach that goes beyond traditional metrics such as BMI and lipid panels. Third, it identifies police officers and older male workers as particularly vulnerable subgroups, underscoring the need for tailored preventive strategies. Finally, by comparing public and private security sectors within the same national context, the study provides valuable insight into the occupational determinants of cardiometabolic health.

Conclusions

This large-scale cross-sectional study highlights a high burden of cardiometabolic risk among Spanish police officers and private security guards, with significant disparities according to sex, age, smoking status, and occupational category. Male sex, age ≥50 years, and employment as a police officer were independently associated with increased odds of

central obesity, hepatic steatosis, insulin resistance, metabolic syndrome, and elevated cardiovascular risk scores.

The application of comprehensive and validated indices—such as FLI, METS-IR, VAI, and CMI—enabled the detection of subclinical risk patterns that may go unnoticed with conventional clinical measures. These findings underscore the need for systematic, sex-sensitive screening and preventive interventions in law enforcement and related security professions.

Given the operational demands and public safety responsibilities inherent to these occupations, protecting the cardiometabolic health of uniformed personnel is not only a matter of individual well-being but also a critical public health and occupational priority. Longitudinal studies are warranted to explore causal pathways and the impact of targeted interventions on health outcomes and service performance.

From a practical perspective, our results can inform the development of workplace- based preventive programs tailored to high-risk groups within law enforcement and private security. Institutional strategies—such as regular cardiometabolic screening, health promotion campaigns, and structured interventions targeting diet, sleep, and physical activity—may substantially mitigate the observed burden of risk.

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Conflict of interest

The authors declare no conflicts of interest.

Authors contribution

Each author made an equal contribution to this research work.

Ethical considerations

The study adhered to all relevant national and international ethical standards for biomedical research, including the principles outlined in the Declaration of Helsinki.

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