Report of Empirical Study

HEALTH PSYCHOLOGY OPEN

Health Psychology Open
Volume 11: 1–10

DOI: 10.1177/20551029241244723
journals.sagepub.com/home/hpo
Sage

Cardiovascular risk, social vigilance, and stress profiles of male law enforcement officers versus civilians

Shannon C White[1], John M Ruiz[2], Matthew Allison[3], Bert N Uchino[4], Timothy W Smith[4], Daniel J Taylor[2], Dusti R Jones[5], Michael A Russell[1], Emily B Ansell[1] and Joshua M Smyth[1]

Abstract

This study examined the cardiovascular disease (CVD) risk profiles of male law enforcement officers (LEOs) and civilians. CVD risk profiles were based on data collected using traditional objective (e.g., resting BP, cholesterol), novel objective (e.g., ambulatory BP) and self-report measures (e.g., EMA social vigilance). A subset of male LEOs (n = 30, M age = 41.47, SD = 8.03) and male civilians (n = 120, M age = 40.73, SD = 13.52) from a larger study were included in analyses. Results indicated LEOs had significantly higher body mass index [BMI], 31.17 kg/m^2 versus 28.87 kg/m^2, and exhibited significantly higher trait and state social vigilance across multiple measures, whereas perceived stress was higher among civilians. Findings highlight the need for future research examining CVD risk associated with occupational health disparities, including attributes of individuals entering certain professions as well as experiential and environmental demands of the work.

Keywords

law enforcement officers, cardiovascular disease, psychosocial factors, occupational stress, health disparities

Introduction

In the United States [US], cardiovascular disease (CVD) was responsible for approximately 928,741 deaths in 2020 (Tsao et al., 2023), making it the leading cause of death among men and women. Although CVD mortality rates have declined somewhat since peaking in 1968, the prevalence of key CVD risk factors such as obesity (CDC, 2021), hypertension (Dorans et al., 2018), and type II diabetes (Bhupathiraju and Hu, 2016) have continued to rise. Recently, additional risk factors have been identified including elevated levels of inflammation (Held et al., 2017; Ridker, 2016).

Law enforcement officers (LEOs) as an occupational group in the US, compared with the general population, experience higher rates of CVD morbidity and mortality (Franke et al., 1998; Hartley et al., 2011; Violanti et al., 2017, 2021; Zimmerman, 2014). Some work has suggested that the increased mortality among LEOs is as a result of high prevalence in CVD risk factors such as obesity, metabolic syndrome, shorter sleep (<6 h), hypercholesterolemia, and tobacco use (Franke et al., 2002; Hartley et al., 2011; Violanti et al., 2021; Zimmerman, 2012). Yet, these risk factors for CVD are observed at high levels in the general population, consequently making it unclear to what

[1]Department of Biobehavioral Health, Pennsylvania State University, USA
[2]Department of Psychology, University of Arizona, USA
[3]Department of Family and Preventative Medicine, University of California San Diego, USA
[4]Department of Psychology, University of Utah, USA
[5]Center for Health Outcomes and Population Equity (HOPE), University of Utah, USA

Corresponding author:
Shannon C White, Department of Biobehavioral Health, Pennsylvania State University, 219 Biobehavioral Health Building, University Park, PA 16802, USA.
Email: scw5463@psu.edu

degree, or on what risk factors, LEOs may be distinct from the general population of the US.

Psychosocial factors contributors to cardiovascular disease

LEOs belong to a distinct occupational population in which their sworn duties may expose them to potentially traumatic and life-threatening situations. Occupational exposure to violent events, in combination with organizational factors (e.g., high demand/low control, shift work, increasing societal and cultural pressure), has the potential to result in increased exposure to psychosocial stressors. If police work leads to frequent and/or persistent exposure to stressors, this in turn may result in prolonged activation of physiological systems that respond to such events, and result in homeostatic disturbances (e.g., Smyth et al., 2013). Additionally, prospective work has found that the severity in which an individual perceives or experiences social stress is associated with accelerated progression of atherosclerosis and adverse cardiac events (Mathur et al., 2016; Yao et al., 2019).

Many factors that exacerbate perceived stress have been identified, including shift work, the possibility of witnessing and/or experiencing violent events, increasing cultural and societal pressure, and organizational pressure (e.g., lack of supervisor and coworker support, insufficient manpower, job insecurity, insufficient pay and excessive paperwork; Hartley et al., 2011; Poirier et al., 2023). Additionally, factors influencing how one interacts with the environment may also be present. Vigilance for social threats may be particularly common especially for caregivers, military, and LEOs who are charged with the safety of others. Prior research has shown that vigilance for non-social (dot-probe tasks, mirror tracing, Stroop tasks) and social stimuli (watching potential debate partners, social observation) evokes heightened cardiovascular reactivity including sustained increases in blood pressure that are hypothesized to increase CVD risk (Smith et al., 2000). Given their occupational demands, levels of vigilance would presumably be high among LEOs; therefore, this may result in more frequent and/or higher levels of stress. Health consequences significantly associated with persistently elevated levels of stress symptoms include anxiety, depression, burnout, chronic back pain, alcohol abuse, and hypertension (Gershon et al., 2002; Sara et al., 2018).

Seeking to expand upon previous work, the aim of this paper was to evaluate the cardiovascular risk profiles of male LEOs and civilians, comparing traditional and novel objective and self-reported CVD risk factors. For comparison, risk profiles are established using demographic, cardiometabolic, psychosocial stress, ecological momentary assessment (EMA), and ambulatory measures.

Methods

Participants

This paper presents a secondary analysis of data from the North Texas Heart study (see Ruiz et al., 2017), which was an investigation of atherosclerotic risk among a community sample. The Institutional Review Board at the study coordinating institute approved this study. The complete North Texas Heart sample was made up of 300 adults ages 21 to 70 years. Participants were eligible if they were (1) 21+ years of age, (2) residing within Denton County, Texas, and (3) had written and verbal fluency in English. Community members were excluded if they possessed any of the following: (1) cognitive impairment (i.e., dementia), (2) previous history of myocardial infarction or tertiary cardiac interventions (e.g., coronary artery bypass surgery, implanted cardiac defibrillator), (3) pregnancy within last year or anticipating pregnancy during study period, or (4) night shift worker. Ineligibility based on shift work at night may bias the LEO sample by excluding officers who work within the departmental patrol division (uniformed officers working in designated areas). These divisions are staffed 24-h a day and are responsible for most departmental police services.

For this report, the term ‘law enforcement officer’ was operationalized using the definition provided by U.S. Code, Title five in which a law enforcement officer is

> “An employee, the duties of whose position— (i) are primarily— (I) the investigation, apprehension, or detention of individuals suspected or convicted of offenses against the criminal laws of the United States, or (II) the protection of officials of the United States against threats to personal safety” (2001).

Participants were grouped based on occupation, creating a ‘LEO’ group and a ‘Civilian’ group. To ensure accuracy of groupings, data from the demographic’s questionnaire was used. Participants were asked to define their employment, based on a provided list. In addition, participants were asked to qualitatively describe their “specific occupation in life” in an open-ended item. Using responses from both questions, participants were categorized into either the ‘LEO’ or ‘Civilian’ group. Although most occupations were unambiguous, a handful of participant occupation classifications were more nuanced; these cases, along with justification, can be found in Table 1. Examination of demographics revealed that the sample of LEOs were all male. To avoid confounding sex differences with the group comparisons (as females would only be present in the civilian group), data

Table 1. Occupational justification for categorization.

Participant occupation	Justification	Group
Evidence Technician	Solely responsible for preserving the chain of custody for evidence and thereby not responsible for the investigation of a crime or the apprehension, or detention of individuals thought to be involved	Civilian
UNT Safety Officer (University Police)	Although responsible for the investigation of a crime, scope of job includes responsibilities as campus ambassador and safety officer. Further, jurisdiction remains solely within the confines of the university. In addition, certain crimes (i.e., all shootings, death investigations and homicides) will be handled by city or state law enforcement officials	Civilian
Public Safety Dispatcher	Responsible for the allocation and dispatch of resources to assist community personnel, dispatchers are not involved in the investigation, apprehension, or detention of individuals suspected or convicted of offenses	Civilian

analysis for this manuscript included only males (i.e., male LEOs and male Civilians were compared). All participating LEOs identified as being 'employed – full time'.

Data collection procedures

Participants screened and found eligible to participate were scheduled for an in-person clinic visit. At their scheduled appointment time, participants met with the study coordinator at the clinic to provide written, informed consent.

Demographic measures. Self-reported demographic information was collected from participants. Information included gender, race, ethnicity, marital status, household income, and educational attainment.

Cardiometabolic measures. Cardiometabolic risk factors within the current study included: body mass index (BMI), systolic blood pressure (SBP), diastolic blood pressure (DBP), high density lipoprotein (HDL), low density lipoprotein (LDL), fasting glucose, triglycerides, high-sensitivity c-reactive protein (CRP), and interleukin 6 (IL 6).

Following consent procedures, participants underwent a brief physical exam and interview with a study nurse. During the interview, participants' current medications and health conditions, health behaviors, and a detailed cardiac disease history were collected. A phlebotomist performed a fasting (8 h) blood draw to assess inflammatory markers and a complete lipid profile. While at the laboratory session, participants underwent a physical exam that included anthropomorphic measures and three measures of resting BP, which were averaged to determine a baseline clinical measure of blood pressure (Ruiz et al., 2017).

Psychosocial stress measures. A self-report questionnaire package was completed by participants to collect data within four interrelated domains of psychosocial risk. Information used in this analysis focused on data collected within the psychosocial stress domain. This analysis used the following measures.

Social vigilance questionnaire (SVQ). The SVQ measure is designed to measure the frequency of vigilant behaviors within social contexts using a range of 1 (almost never) to 5 (almost always). The scale includes 16-items, 10 of which are used for scoring purposes. Confirmatory factor analysis (CFA; Ruiz et al., 2017) validated a 3-factor solution: (1) Vigilance for social threats (4-items), (2) vigilance of others' reactions to self (3-items), and (3) vigilance of self (3-items). A total score (average of 10-items) was also derived. Within the full NTHS sample, the full-scale measure and independent subscales demonstrated good internal consistency; vigilance for social threats (Cronbach's alpha = .81), vigilance of others' reactions to self (Cronbach's alpha = .81), and vigilance of self (Cronbach's alpha = .81), and overall (Cronbach's alpha = .84).

Perceived stress (PSS). The 10-item PSS (Cohen et al., 1983) scale evaluates an individual's perceptions of the frequency of stressful events within the previous 30 days, using a frequency range of 0 (never) to 4 (very often). Specific items are reverse coded. All items are averaged to generate a total perceived stress score. The measure had good internal consistency (Cronbach's alpha = .88) within the complete NTHS sample.

Job content (JCQ). The Job Content Questionnaire (Karasek et al., 1998) is an instrument used to evaluate psychological dimensions of job environments. The measure includes assessments of both job demand and control characteristics. For the NTHS, methods presented by Schwartz et al. (1988) were used to measure job strain; a construct reflective of a combination of demand and content. For a complete explanation of methods utilized to measure job content see Ruiz et al. (2017). The measure includes 11 items from the JCQ including items like "my job requires a high level of skill" and employed a four-point

Likert scale from 1 (strongly disagree) to 4 (strongly agree). The measure scales had good internal consistency (Job Control (averaged) Cronbach's alpha = .65; Job Demand (averaged) Cronbach's alpha = .69) within the complete NTHS sample.

Ecological momentary assessment (EMA) and ambulatory data

While attending the laboratory visit, participants were provided with an ambulatory blood pressure monitor (ABPM: Oscar II; Suntech, Inc.) and a cellular phone for the 2-days and 1-night ambulatory/ecological momentary assessment (EMA) study. Blood pressure was measured at semi-random times at approximately 45-min intervals throughout the waking day. This sampling was done to prevent participants from anticipating a measurement and altering their activity as a result (see Ruiz et al., 2017). Participants were instructed to complete the EMA survey immediately following each blood pressure assessment throughout the day. This approach allowed for synchronizing the EMA record to the BP record throughout the ambulatory data capture period. Administration of the Social Vigilance Questionnaire was contingent on the participant reporting having spent time in a social context within the measurement window.

Data analysis plan

Statistical analysis was conducted using the SAS software, version 9.4 (SAS Institute, Cary, NC). Upon confirmation of occupational groupings, descriptive statistics including means (standard deviation) and frequency were calculated for demographics to characterize the study population, both in its entirety and based on occupation. When analyzing group differences, the cardiometabolic, psychosocial, and ambulatory daily experience variable models were run separately. The homogeneity of variance was assessed in each model using Levene's test for equality of variances. Models found to violate the assumption were evaluated using the Welsh's adjusted F ratio. Covariates included in each model can be found in respective tables. A p-value of <0.05 was considered statistically significant.

Results

Group differences

Demographic variables. The sample included 150 adult males, 30 LEOs (M age = 41.47, SD = 8.03) and 120 civilians (M age = 40.73, SD = 13.52). Officers were mostly White (90%), married (86%), had at least some college education (89%), and a household income > $75,001 (90%). Civilians were mostly White (66%), married (62%), had some college education (89%), and a household income <$75,000 (50.87%). Complete sample data is presented in Table 2.

Cardiometabolic variables. Mean BMI was significantly higher among LEOs (31.17 kg/m2) compared to civilians (28.87 kg/m2) ($F(1, 148) = 6.37$, $p = .00$, $r^2 = 0.04$). Among LEOs, ~33% met criteria for overweight (BMI = 25-29.9 kg/m^2) and ~56% for obese (BMI = > 30 kg/m^2). In contrast, among civilians, 35.59% similarly qualified as overweight but fewer, 33.05 %, qualified as obese. Given the strong association between BMI and other cardiometabolic risk variables, subsequent analyses controlled for participant BMI (Table 3). Once doing so, the only significant difference between occupational groups in cardiometabolic risk variables was for levels of IL-6 ($F(2, 122) = 7.54$, $p = .007$, $r^2 = 0.15$); triglycerides, HDL, LDL, SBP, DBP, glucose, and CRP did not differ significantly between groups. For all cardiometabolic variables, the assumption of variance heterogeneity was met ($p > 0.05$).

Psychosocial stress variables. Social vigilance, the reflection of an attentional and appraisal process in which an environment is continuously monitored for threat, was significantly higher in three of the four domains among the LEO group relative to civilians. LEOs exhibited higher levels of social vigilance for social threats ($F(1, 149) = 48.18$, $p = <0.0001$, $r^2 = 0.25$), social vigilance for self ($F(1, 149) = 4.96$, $p = .03$, $r^2 = 0.03$), and total social vigilance ($F(1, 149) = 17.21$, $p = <0.0001$, $r^2 = 0.10$). LEOs had a higher mean score than civilians for social vigilance for others' reactions to self (2.52 vs 2.40), but the difference was not significant. (See Table 4.) For all social vigilance variables, the assumption of variance heterogeneity was met ($p > 0.05$).

Groups also differed significantly in perceived stress. Unexpectedly, perceived stress was significantly higher among the civilian group ($F(1, 149) = 7.62$, $p = .01$, $r^2 = 0.05$). Based on scale range, scores among both groups indicated moderate mean levels of stress (LEOs = 2.12 vs civilians = 2.47). The assumption of variance homogeneity between groups was met for perceived stress ($p > 0.05$). Job strain, an assessment of psychological dimensions of a job environment related to increased CVD risk, did not differ significantly between groups.

EMA and ambulatory assessment variables. There were modest differences between occupational groups in ambulatory blood pressure, but these differences did not persist when controlling for BMI (see Table 5). Social vigilance data collected using ecological momentary assessment (EMA) was only provided when participants reported time spent in a social context during the measurement window. On average, LEOs completed the social vigilance

Table 2. Demographic characteristics.

	Total (*N* = 150) *N* (%)	LEOs (*N* = 30) *N* (%)	Civilians (*N* = 120) *N* (%)
Age [Mean ± SD]	40.88 ± 12.59	41.47 ± 8.03	40.73 ± 13.52
Marital Status			
Single	35 (23.49)	2 (6.67)	33 (27.73)
Married	100 (67.11)	26 (86.67)	74 (62.18)
Living with Partner	4 (2.68)	-	4 (3.36)
Divorced	9 (6.04)	2 (6.67)	7 (5.88)
Widowed	1 (0.67)	-	1 (0.84)
Race			
Asian	3 (2.00)	-	3 (2.50)
Black/African American	30 (20.00)	3 (10.00)	27 (22.50)
White	107 (71.33)	27 (90.00)	80 (66.67)
More than one race	5 (3.33)	-	5 (4.17)
Unknown	5 (3.33)	-	5 (4.17)
Ethnicity			
Non-Hispanic	130 (86.67)	25 (83.33)	105 (87.50)
Hispanic	20 (13.33)	5 (16.67)	15 (12.50)
Education			
High school/GED	13 (8.72)	3 (10.00)	10 (8.40)
College, <4 years	53 (35.57)	14 (46.67)	39 (32.77)
College, ≥ 4 years	81 (54.36)	13 (43.33)	68 (57.14)
Other	2 (1.34)	-	2 (1.68)
Household Income			
≤$75,000	59 (40.69)	2 (6.90)	57 (49.14)
≥ $75,001	86 (59.31)	27 (90.00)	59 (50.87)

Table 3. Cardiometabolic variables.

	LEOs (*N* = 30)		Civilians (*N* = 120)				
	M	SE	*M*	SE	Mean square	F value	Pr > F
Triglycerides (mg/dL)	111.12	12.26	118.33	6.11	1218.77	0.28	0.60[a]
High Density Lipoprotein (mg/dL)	45.65	1.62	46.94	0.81	39.02	0.50	0.48[a]
Low Density Lipoprotein (mg/dL)	110.65	5.88	111.66	2.88	23.26	0.02	0.88[a]
Systolic Blood Pressure (mm Hg)	144.76	3.92	144.07	1.90	10.20	0.02	0.87[a]
Diastolic Blood Pressure (mm Hg)	85.68	2.36	85.44	1.14	1.14	0.01	0.93[a]
Fasting Glucose (mg/dL)	91.75	1.96	90.96	0.98	14.52	0.13	0.72[a]
C-Reactive Protein (mg/L)	0.46	0.17	0.30	0.09	0.63	0.71	0.40[a]
Interleukin 6 (pg/mL)	−0.18	0.18	0.38	0.08	5.15	7.54	**0.007**[a]

Note. M = mean, SE = standard error of the mean; models control for body mass index [BMI].
[a]Indicates assumption of variance homogeneity was met.

assessment 7.43 and 7.2 times on days 1 and 2, compared to civilians who provided vigilance data 5.5 times and 6.3 times on days 1 and 2, respectively (a reflection of LEOs reporting being in social contexts more frequently). Significant differences were found for multiple subscales, with LEOs reporting higher ambulatory social vigilance than civilians. The assumption of variance homogeneity was met for social vigilance for self (F (1, 144) = 10.97, $p = .001$, $r^2 = 0.07$. The assumption of variance homogeneity was violated for social threats (F (1, 144) = 42.70, $p = <0.0001$, $r^2 = 0.34$) and total vigilance (F (1, 144) = 22.51, $p = <0.0001$, $r^2 = 0.20$). However, significant difference remained between groups when using the Welch's adjusted F ratio. Conversely, the assumption of variance homogeneity was violated for

Table 4. Baseline psychosocial characteristics.

	Total (*N* = 150) Mean ± SD	LEOs (*N* = 30) Mean ± SD	Civilians (*N* = 120) Mean ± SD	F value	Pr > F
Social Vigilance					
Others Reactions to Self	2.42 ± 0.90	2.52 ± 0.99	2.40 ± 0.88	1.06	0.30[a]
Social Threats	3.40 ± 0.97	4.35 ± 0.64	3.16 ± 0.89	53.99	**<.0001**[a]
For Self	3.20 ± 0.90	3.53 ± 0.79	3.12 ± 0.92	6.47	**0.01**[a]
Total Vigilance	3.01 ± 0.71	3.47 ± 0.66	2.89 ± 0.68	21.29	**<.0001**[a]
Perceived Stress	2.40 ± 0.63	2.12 ± 0.52	2.47 ± 0.64	7.62	**0.01**[a]
Job Content					
Skill Discretion	22.74 ± 5.38	23.66 ± 2.68	22.47 ± 4.78	2.93	0.09[b]
Decision Authority	22.92 ± 5.38	23.60 ± 5.39	22.72 ± 5.39	0.61	0.42[a]
Decision Latitude	45.67 ± 8.02	47.24 ± 6.58	45.20 ± 8.37	1.57	0.21[a]
Psychological Job Demands	31.31 ± 6.54	32.33 ± 5.55	31.00 ± 6.81	0.98	0.33[a]
Job Strain	2.91 ± 0.65	2.83 ± 0.68	2.94 ± 0.65	1.15	0.28[a]
Job Control	2.85 ± 0.48	2.96 ± 0.34	2.82 ± 0.52	2.64	0.11[b]
Job Demand	2.57 ± 0.53	2.66 ± 0.46	2.54 ± 0.55	1.12	0.29[a]

[a]Indicates assumption of variance homogeneity was met.
[b]Indicates Welch's adjusted F ratio.

Table 5. Ambulatory and daily experience variables.

	LEOs (*N* = 30)		Civilians (*N* = 120)		Mean Square	F value	Pr > F
Blood pressure	*M*	SE	*M*	SE			
Systolic Blood Pressure (mm Hg)[a]	151.01	3.74	150.79	1.88	1.21	0.00	0.96[b]
Diastolic Blood Pressure (mm Hg)[a]	86.60	2.42	86.13	1.22	5.13	0.03	0.86[b]
End of Day Stress	*M*	SD	*M*	SD			
Day 1	2.44 ± 1.58		2.34 ± 1.26			0.13	0.71[a]
Day 2	2.46 ± 1.17		2.44 ± 1.55			0.01	0.92[c]
Social Vigilance (mean of both days)	*M*	SD	*M*	SD			
Others Reactions to Self	1.72 ± 0.94		1.39 ± 0.63			3.17	0.08[c]
Social Threats	3.29 ± 1.35		1.60 ± 0.83			42.70	**<.0001**[c]
For Self	2.48 ± 1.09		1.83 ± 0.93			10.97	**0.001**[b]
Total Vigilance	2.50 ± 0.97		1.61 ± 0.65			22.51	**<.0001**[c]

Note. M = mean, SD = standard deviation, SE = standard error of the mean; Blood pressure models control for body mass index [BMI].
[a]Represents adjusted values after controlling for body mass index [BMI].
[b]Indicates assumption of variance homogeneity was met.
[c]Indicates Welch's adjusted F ratio.

groups others' reactions to self (F (1, 143) = 3.17, $p = .08$, $r^2 = 0.03$) and significant group differences did not remain when using Welch's adjusted F ratio (See Table 5).

Discussion

Previous research generally documents higher prevalence of CVD and higher rates of CVD mortality in LEOs relative to civilians at a broad level, although factors contributing to this divergence are less clear. In this study, potential contributors to these disparities were explored, encompassing measures based on baseline demographics and traditional self-report scales. More importantly, the present study is novel in the incorporation of inflammatory biomarkers, ambulatory monitoring of blood pressure and daily experiences, and the implementation of a social vigilance measure, gathered both at baseline and during ambulatory assessments.

When comparing groups, demographic information identified several differences. Racial diversity was more limited within the LEO group when compared to the civilian group. Only 10% of officers identified as non-White, whereas 25% of individuals in the civilian group identified as Asian or Black and 4% identified as more than one race. The difference in racial diversity is consistent with existing literature indicating that White non-Hispanics make up 69% of US LEOs (Goodison, 2022), however this sample of

LEOs remains less racially diverse than US law enforcement population. To ensure the recruitment of a representative sample in future research, recommendations made by Cunningham-Erves and colleagues (2022) emphasize the development of tailored research recruitment materials for African American and Latino populations. Recommendations include establishing relationships within communities and being physically present, placing recruitment materials in accessible areas (e.g., community social media pages, bulletin boards in parks, libraries, barber shops, churches, stores in Latino communities), and personalizing recruitment to address the beliefs and values of a specific group are achievable and cost-effective. Further, a significant difference was observed in household income between LEOs and civilians; the vast majority (90%) of LEOs reported a household income >$75,001, relative to civilians, of whom 50% reported a household income <$75,000. Given the association between lower household income and adverse health behaviors, outcomes, and health care (Dubay and Lebrun, 2012), it seems unlikely that household income is a prominent contributor to the divergence in CVD risk between groups in the current sample (i.e., the higher income of LEOs should be associated with better outcomes). Previous research suggests the prevalence of disease among adults with a lower income to poverty ratio is significantly greater than adults a higher ratio (Minhas et al., 2023). For example, the percentage of adults with coronary heart disease (CHD) among those with annual family incomes ranging from <$35,000 - $74,999 is 20.9%, whereas 10.2% of adults with family incomes >$75,000 have CHD (Schiller et al., 2012).

When comparing risk profiles based on cardiometabolic factors, the prevalence of overweight and obesity was significantly higher among LEOs; 88% of LEOs met the criteria for being classified as overweight or obese, compared to 68% of civilians. Moreover, this difference was particularly evident among those classified as obese. Previous work indicates that high rates of sedentary time and physical inactivity, in addition to poor dietary habits, are significant contributors to the prevalence of obesity among LEOs (Hartley et al., 2011; Lockie et al., 2022; Violanti et al., 2017). Although there are tests available for evaluating officer fitness or occupational readiness, there is no universally accepted standard (for testing or requirements), leaving individual departments to determine their own standards (Dicks et al., 2023).

During medical history reviews, groups had a similar percentage of participants who reported being informed they had high blood pressure, and groups had relatively equal numbers of participants who met criteria for hypertension (LEOs = 56.66% and civilians = 55.04%). Mean values of systolic and diastolic blood pressure, after controlling for body mass index, were only slightly higher among LEOs, a difference found not to be statistically significant. Similar levels of HDL and LDL were found between groups, and these levels were within the normal value range (Arnett et al., 2019; Unger et al., 2020). Biomarkers examined in this study included IL-6 and CRP. IL-6 is an upstream inflammatory cytokine known to contribute to the initiation, and progression, of atherosclerosis (Hartman and Frishman, 2014). CRP, a protein produced by the liver, is induced by the IL-6 action during the acute phase of an inflammatory process (Nehring et al., 2023). Groups were found to differ significantly in mean values of IL-6; however, these levels were well within the normal value range (Said et al., 2021). Although groups did not differ significantly, the mean value of CRP among LEOs (M = 0.46) can be classified as 'minorly elevated'; an elevation often seen in obesity, whereas the mean value within the civilian group (M = 0.30) is classified as 'normal' (Nehring et al., 2023). These results thus did not provide evidence that proinflammatory biomarkers reflect a substantial contributor to greater adverse cardiovascular risk often observed among LEOs, including increased rates of metabolic syndrome, obesity, and hypertension (Franke et al., 2002; Hartley et al., 2011; Ramey et al., 2014; Violanti et al., 2013, 2021; Wright et al., 2011). Thus, this finding from the current study is inconsistent with prior work; rather, we find that there are broadly similar CVD risk profiles when comparing cardiometabolic risk variables (other than BMI).

When comparing psychosocial factors within the current sample, traditional measures of stress (e.g., perceived stress, job control, job demand) seem to be unlikely contributors to CVD risk among LEOs. Instead, findings suggest LEOs have lower perceived stress and higher occupational control (Garbarino and Magnavita, 2015; Kivimäki et al., 2002), which should be associated with better cardiovascular health outcomes. In this particular study, perceived stress was measured using the PSS; a scale that broadly assesses the degree to which situations in one's life are appraised as subjectively stressful (notably, the PSS does not specifically assess occupational stress). That LEOs report experiencing lower perceived stress may be indicative of the balance between exposure to potential stressors and individual's perceptions of their capacity to adapt (Lazarus and Folkman, 1984). In particular, LEOs are subjected to occupational training that may be beneficial in the secondary appraisal of stressful situations (e.g., lethal force scenario response training; Baldwin et al., 2022). More specifically, the evaluation of one's coping resources and options to deal with the stressor (e.g., perceived control) identified in the appraisal process (Lazarus and Folkman, 1984). Work with LEOs to further develop coping resources (e.g., strengthen resilience) is on-going and has been suggested as a promising approach to addressing the underlying physiological mechanisms (Anderson et al., 2023).

The clearest divergence in psychosocial risk profiles was in social vigilance. Scores for all vigilance subscales (except 'others' reactions to self') were significantly higher among LEOs for both baseline and EMA data. The lack of significant difference between groups on the 'others' reactions to self' domain may be reflective of interpersonal power dynamics experienced by LEOs. To our knowledge this is the first use of the social vigilance questionnaire among LEOs and this interpretation is therefore speculative and requires future research to better understand the role of different types of social vigilance in LEOs.

The act of being vigilant involves continuously monitoring an environment for threat; it is possible that occupational training and responsibilities experienced by LEOs may entrain and/or elicit higher rates of vigilance. Although the behavior may be automatic, continuous exposure can lead to heightened cardiovascular reactivity and prolonged activation of physiological systems resulting in homeostatic disturbances (O'Neill, 2022). In addition to health conditions associated with homeostatic disturbance (e.g., diabetes), previous research suggests vascular resistance is a potential byproduct of vigilant behaviors that may manifest as increases in blood pressure, and total peripheral resistance, representing a CVD risk (Panaite et al., 2015; Smith et al., 2000).

Results from the current study also extend those of previous research by incorporating measures of ambulatory blood pressure. Contrary to expectations, ambulatory blood pressure did not significantly differ between groups when controlling for BMI. Nonetheless, the approach provides further evidence for the potential of wearable sensors to assess key health indicators among tactical and first response populations. As wearable sensors (e.g., heart rate monitors) and location tracking technology (e.g., GPS) become more accessible and affordable, researchers are better equipped to capture real time data regarding individual responses to stressors by measuring variables such as stress reactivity and changes in on-shift heart rate. Information collected through these methods could help inform workplace interventions that target key behaviors to improve health outcomes and reduce occupational health disparities within LEOs and other first response groups. For example, work conducted by Andersen et al. (2018) found that a physiologically informed intervention, teaching officers to modulate SNS and PNS activation during scenario-based training, significantly reduced objective errors in lethal force decision-making, and results were maintained over the 18-months study period.

Limitations

The current analysis has several limitations. Foremost, the small sample size of the LEO group reduces statistical power, therefore reducing the ability to detect smaller differences between groups. In addition, the small sample size precluded stratifying the LEO group according to specific work-related exposure that may impact health outcomes (e.g., years of service, departmental rank, shift worked, patrol status, etc.) The current study also utilized a convenience sample that was not representative of the U.S. law enforcement population. As there were no females in the LEO group, we were not able to compare CVD risk profiles between female LEO officers and civilians; this may be important given the association between sex and cardiovascular disease risk indicators (Humphries et al., 2017). Furthermore, the lack of racial diversity among the LEO group (90% White, relative to national average estimated to be 67%; Goodison, 2022) limits the generalizability of our findings. This study excluded participants (in both LEO and civilian groups) with a history of prior cardiovascular disease (e.g., heart attacks); this also limits generalizability. Finally, this was a secondary analysis of a community sample. As such, information on other key demographic, lifestyle, and psychosocial variables that were not collected would be beneficial in providing a more robust comparison of CVD risk profiles between male LEOs and civilians.

Conclusion and recommendations for future research

In the current study, we found that male LEOs had significantly higher levels of both trait and state social vigilance. High levels of social vigilance have been found to evoke heightened cardiovascular reactivity, resulting in sustained increases in blood pressure, thereby promoting greater possible CVD risk. Our findings highlight the need for momentary assessment of cardiovascular reactivity among LEOs as it relates to the onset and development of CVD. Future research should seek to continue this work with larger sample sizes across different states and departments. Furthermore, samples sufficient to stratify LEO populations by factors aside from just occupation (e.g., departmental rank, years of service, sex, etc.) would be highly informative. In addition, research should include measurement tools designed specifically for this population (e.g., scale for measuring vigilance among LEO). Finally, although research has identified the need for health and wellness programs specifically for law enforcement, data is needed to address the barriers to organizing and facilitating these programs (e.g., financial, policy, bureaucratic) within departments.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the the National Institutes of Health, National Heart, Lung, and Blood Institute (NHLBI), R01HL109340.

Ethical statements

Informed consent

Participants provided written, informed consent prior to beginning the protocol.

Ethical requirements

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and was approved by an Institutional Review Board/Ethics committee. See details under Methods. The study received an exemption from an Institutional Review Board/Ethics committee; See details under Methods.

ORCID iDs

Shannon C White https://orcid.org/0000-0003-0465-5832
Joshua M Smyth https://orcid.org/0000-0002-0904-5390

References

Andersen JP, Di Nota PM, Beston B, et al. (2018) Reducing lethal force errors by modulating police physiology. *Journal of Occupational and Environmental Medicine* 60(10): 867–874.

Andersen JP, Di Nota PM, Alavi N, et al. (2023) A biological approach to building resilience and wellness capacity among police exposed to posttraumatic stress injuries: protocol for a randomized controlled trial. *JMIR Res Protoc* 12: e33492. DOI: 10.2196/33492

Arnett DK, Blumenthal RS, Albert MA, et al. (2019) ACC/AHA guideline on the primary prevention of cardiovascular disease: a report of the American college of cardiology/American heart association task force on clinical practice guidelines. *Journal of the American College of Cardiology* 74(10): e177–e232.

Baldwin S, Bennell C, Blaskovits B, et al. (2022) A reasonable officer: examining the relationships among stress, training, and performance in a highly realistic lethal force scenario [original research]. *Frontiers in Psychology* 12. DOI: 10.3389/fpsyg.2021.759132

Bhupathiraju SN and Hu FB (2016) Epidemiology of obesity and diabetes and their cardiovascular complications. *Circulation Research* 118(11): 1723–1735.

CDC (2021) Adult obesity facts. Available at: https://www.cdc.gov/obesity/data/adult.html (accessed August 25).

Cohen S, Kamarck T and Mermelstein R (1983) A global measure of perceived stress. *Journal of Health and Social Behavior* 24(4): 385–396. DOI: 10.2307/2136404

Cunningham-Erves J, Kusnoor SV, Villalta-Gil V, et al. (2022) Development and pilot implementation of guidelines for culturally tailored research recruitment materials for African Americans and Latinos. *BMC Medical Research Methodology* 22(1): 248.

Dicks ND, Shoemaker ME, DeShaw KJ, et al. (2023) Contributions from incumbent police officer's physical activity and body composition to occupational assessment performance [Original Research]. *Frontiers in Public Health* 11. DOI: 10.3389/fpubh.2023.1217187

Dorans KS, Mills KT, Liu Y, et al. (2018) Trends in prevalence and control of hypertension according to the 2017 American college of cardiology/American heart association (ACC/AHA) guideline. *Journal of the American Heart Association* 7(11): e008888.

Dubay LC and Lebrun LA (2012) Health, behavior, and health care disparities: disentangling the effects of income and race in the United States. *Int J Health Serv* 42(4): 607–625.

Franke WD, Collins SA and Hinz PN (1998) Cardiovascular disease morbidity in an Iowa law enforcement cohort, compared with the general Iowa population. *J Occup Environ Med* 40(5): 441–444.

Franke WD, Ramey SL and Shelley MCI (2002) Relationship between cardiovascular disease morbidity, risk factors, and stress in a law enforcement cohort. *Journal of Occupational and Environmental Medicine* 44(12): 1182–1189.

Garbarino S and Magnavita N (2015) Work stress and metabolic syndrome in police officers. A prospective study. *PLoS One* 10(12): e0144318.

Gershon RR, Lin S and Li X (2002) Work stress in aging police officers. *J Occup Environ Med* 44(2): 160–167.

Goodison Sean E (2022) Local Police Departments Personnel, 2020. *Local Police Departments*. Available at: https://bjs.ojp.gov/library/publications/local-police-departments-personnel-2020#0-0

Hartley TA, Burchfiel CM, Fekedulegn D, et al. (2011) Health disparities in police officers: comparisons to the U.S. general population. *International Journal of Emergency Mental Health* 13(4): 211–220.

Hartman J and Frishman WH (2014) Inflammation and atherosclerosis: a review of the role of interleukin-6 in the development of atherosclerosis and the potential for targeted drug therapy. *Cardiology in Review* 22(3): 147–151.

Held C, White HD, Stewart RAH, et al. (2017) Inflammatory biomarkers interleukin-6 and C-reactive protein and outcomes in stable coronary heart disease: experiences from the STABILITY (stabilization of atherosclerotic plaque by initiation of Darapladib therapy) trial. *Journal of the American Heart Association* 6(10).

Humphries KH, Izadnegahdar M, Sedlak T, et al. (2017) Sex differences in cardiovascular disease - impact on care and outcomes. *Frontiers in Neuroendocrinology* 46: 46–70.

Karasek R, Brisson C, Kawakami N, et al. (1998) The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. *Journal of Occupational Health Psychology* 3(4): 322.

Kivimäki M, Leino-Arjas P, Luukkonen R, et al. (2002) Work stress and risk of cardiovascular mortality: prospective cohort study of industrial employees. *BMJ* 325(7369): 857.

Lazarus RS and Folkman S (1984) *Stress, Appraisal, and Coping*. New York, NY: Springer publishing company.

Lockie RG, Dawes JJ and Orr RM (2022) Health and fitness data for police officers within a health and wellness program: implications for occupational performance and career longevity. *Work* 73(3): 1059–1074. DOI: 10.3233/wor-211089

Mathur R, Pérez-Pinar M, Foguet-Boreu Q, et al. (2016) Risk of incident cardiovascular events amongst individuals with anxiety and depression: a prospective cohort study in the east London primary care database. *Journal of Affective Disorders* 206: 41–47.

Minhas AMK, Jain V, Li M, et al. (2023) Family income and cardiovascular disease risk in American adults. *Scientific Reports* 13(1): 279. DOI: 10.1038/s41598-023-27474-x

Nehring SM, Goyal A and Patel BC (2023) C reactive protein. In: *StatPearls*. StatPearls Publishing LLC.

O'Neill RM (2022) *Examining Social Vigilance and Associated Physiological Effects across Types of Situational Stress (Publication Number 29206771)*. University Libraries, University of Arizona: The University of Arizona]. ProQuest Dissertations & Theses A&I; ProQuest Dissertations & Theses Global. United States – Arizona. Available at: https://proxy.lib.ohio-state.edu/login?url=https://www.proquest.com/dissertations-theses/examining-social-vigilance

Panaite V, Salomon K, Jin A, et al. (2015) Cardiovascular recovery from psychological and physiological challenge and risk for adverse cardiovascular outcomes and all-cause mortality. *Psychosomatic Medicine* 77(3): 215–226.

Poirier S, Allard-Gaudreau N, Gendron P, et al. (2023) Health, safety, and wellness concerns among law enforcement officers: an inductive approach. *Workplace Health Saf* 71(1): 34–42.

Ramey SL, Perkhounkova Y, Moon M, et al. (2014) Physical activity in police beyond self-report. *Journal of Occupational and Environmental Medicine* 56(3): 338–343.

Ridker PM (2016) Residual inflammatory risk: addressing the obverse side of the atherosclerosis prevention coin. *European Heart Journal* 37(22): 1720–1722.

Ruiz JM, Taylor DJ, Uchino BN, et al. (2017) Evaluating the longitudinal risk of social vigilance on atherosclerosis: study protocol for the North Texas Heart Study. *BMJ Open* 7(8): e017345.

Said EA, Al-Reesi I, Al-Shizawi N, et al. (2021) Defining IL-6 levels in healthy individuals: a meta-analysis. *Journal of Medical Virology* 93(6): 3915–3924.

Sara JD, Prasad M, Eleid MF, et al. (2018) Association between work-related stress and coronary heart disease: a review of prospective studies through the job strain, effort-reward balance, and organizational justice models. *Journal of the American Heart Association* 7(9): e008073.

Schiller JS, Lucas JW and Peregoy JA (2012) Summary health statistics for u.s. Adults: national health interview survey, 2011. *Vital Health Stat* 10(256): 1–218, Epub ahead of print 2012/12/01.

Schwartz JE, Pieper CF and Karasek RA (1988) A procedure for linking psychosocial job characteristics data to health surveys. *American Journal of Public Health* 78(8): 904–909.

Smith TW, Ruiz JM and Uchino BN (2000) Vigilance, active coping, and cardiovascular reactivity during social interaction in young men. *Health Psychology* 19(4): 382–392.

Smyth J, Zawadzki M and Gerin W (2013) Stress and disease: a structural and functional analysis. *Social and Personality Psychology Compass* 7(4): 217–227.

Tsao CW, Aday AW, Almarzooq ZI, et al. (2023) Heart disease and stroke statistics—2023 update: a report from the American heart association. *Circulation* 147(8): e93–e621. DOI: 10.1161/CIR.0000000000001123

Unger T, Borghi C, Charchar F, et al. (2020) International society of hypertension global hypertension practice guidelines. *Hypertension* 75(6): 1334–1357.

Violanti JM, Fekedulegn D, Hartley TA, et al. (2013) Life expectancy in police officers: a comparison with the U.S. general population. *International Journal of Emergency Mental Health* 15(4): 217–228.

Violanti JM, Fekedulegn D, Andrew ME, et al. (2017) The impact of perceived intensity and frequency of police work occupational stressors on the cortisol awakening response (CAR): findings from the BCOPS study. *Psychoneuroendocrinology* 75: 124–131.

Violanti JM, Gu JK, Charles LE, et al. (2021) Dying for the job: police mortality, 1950-2018. *Policing* 44(6): 1168–1187. DOI: 10.1108/pijpsm-06-2021-0087

Wright BR, Barbosa-Leiker C and Hoekstra T (2011) Law enforcement officer versus non-law enforcement officer status as a longitudinal predictor of traditional and emerging cardiovascular risk factors. *Journal of Occupational and Environmental Medicine* 53(7): 730–734.

Yao BC, Meng LB, Hao ML, et al. (2019) Chronic stress: a critical risk factor for atherosclerosis. *Journal of International Medical Research* 47(4): 1429–1440. DOI: 10.1177/0300060519826820

Zimmerman FH (2012) Cardiovascular disease and risk factors in law enforcement personnel: a comprehensive review. *Cardiology in Review* 20(4): 159–166.

Zimmerman FH (2014) Cardiovascular risk in law enforcement. In: Violanti JM (ed) *Dying for the Job : Police Work Exposure and Health*. Charles C. Thomas Publisher.