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Police Trauma and Cardiovascular Disease: Association Between PTSD Symptoms and Metabolic Syndrome

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Abstract: *Although prior evidence exists concerning the association between posttraumatic stress disorder (PTSD) and cardiovascular disease, few studies have examined associations of PTSD symptomatology and the metabolic syndrome in the high stress occupation of police work. The metabolic syndrome is a clustering of cardiovascular disease risk factors that have also been independently associated with psychological conditions. the aim of this study was to examine associations between the PTSD symptoms and metabolic syndrome in police officers. A stratified sample of 115 police officers was randomly selected from the Buffalo, NY Police Department. PTSD symptoms were measured with the Impact of Event scale (IES), divided into categories of subclinical, mild, moderate and severe symptom levels. The metabolic syndrome was considered present if three or more of its component parameters (obesity, elevated blood pressure, reduced high density lipoprotein (HDL) cholesterol, elevated triglycerides, and abnormal glucose levels) were present in each officer. Results indicated a significantly increased prevalence of the metabolic syndrome among those officers in the severe PTSD symptom category compared with the lowest PTSD severity category (prevalence ratio (PR) = 3.31, 95% C.I. = 1.19 - 9.22). Adjustment for age did not alter the association appreciably (PR = 3.12, 95% C.I. = 1.15 - 8.50). Adjustment for several demographic and lifestyle factors (age, education, smoking, alcohol intake) reduced the magnitude of the prevalence ratio slightly for the severe versus subclinical PTSD category (PR = 2.69, 95% C.I. = 0.79 - 9.13), with adjustment for age and education accounting for most of the attenuation (PR = 2.71, 95% C.I. = 0.99 - 7.37). Thus, officers with severe PTSD symptoms were approximately three times more likely to have the metabolic syndrome and education may account for some of this association. [International Journal of Emergency Mental Health, 2006, 8(4), pp. 227-238].*

Key words:*police, posttraumatic stress disorder, metabolic syndrome, cardiovascular disease*

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Introduction

Hans Selye (1984) recognized police work as one of the most stressful occupations in the world. There is increased risk that police officers will be exposed to traumatic events during the course of their careers and that they will experience posttraumatic stress disorder (PTSD) symptoms as a result of this exposure (Violanti & Paton, 1996). Such exposure may involve incidents defined by the *Diagnostic and Statistical Manual of Mental Disorders (DSM)* IV as traumatic - actual or threatened death, serious injury, threat to one's physical integrity; or witnessing such events occurring to other persons or significant others (American Psychiatric Association, 1994). Specific examples include police shootings, physical assault, witnessing violence and familial abuse, handling dead bodies, and disaster scenes, such as September 11. An essential feature of PTSD is the development of characteristic symptomatology, in-cluding re-experiencing the event, avoidance of stimuli associated with the trauma, numbing of general responsiveness, and symptoms of increased arousal (American Psychiatric Association, 1994). Despite such risk, there have been no previous empirical studies conducted examining associations between PTSD and the possible cardiovascular health effects in police work.

The Police, Trauma, and Cardiovascular Disease Risk

The allostatic load model provides an excellent heuristic framework in which to investigate the impact of PTSD on health. Allostatic overload can produce wear and tear on the body and precipitate disease (McEwen & Stellar, 1993; McEwen & Seeman, 1999; McEwen & Wingfield, 2003). Allostatic failure to engage or shut off stress mediators, such as the hormone cortisol, is one example of stress response dysregulation. Problems associated with allostatic overload in PTSD include stress response overreactivity, exaggerated startle response, sleep disruption, and nightmares. Persons with PTSD show a greater sympathetic nervous system response to situations that resemble the traumatic event, including cardiovascular, skin conductance, and electromyographic responses (Blanchard, Kolb, & Prins, 1998; Boscarino & Chang, 1999).

Individuals with a history of PTSD have demonstrated higher lifetime rates of endocrine disorders, major depression, medically explained and unexplained somatic complaints, and eating disorders. Evidence linking exposure to trauma with cardiovascular disease has been found across different populations and stressor events. Military veterans diagnosed with PTSD, for example, were significantly more likely to have had abnormal electrocardiographic results, including a higher prevalence of myocardial (Q-wave) infarctions and atrioventricular conduction defects (Boscarino & Chang, 1999; Boscarino, 2004).

Civilian populations exposed to traumatic events also have reported increased cardiovascular health problems. A recent meta-analysis of cardiovascular status in persons with PTSD indicates that they have a higher resting heart rate and elevated blood pressure compared to individuals without PTSD. A subset analysis revealed that the effect sizes for comparisons on basal heart rate were greatest in studies with the most chronic PTSD samples (Buckley et al., 2004).

Few studies have looked at cardiovascular health in police officers. In the 22-year follow-up of the Helsinki Policemen Study, Pyörälä and colleagues (2000) hypothesized that complex clustering of risk factors related to insulin resistance could be predictive of coronary heart disease and stroke risk. Factor analysis of 10 risk variables produced three underlying factors: an insulin resistance factor, which comprised BMI, subscapular skinfold, insulin, glucose, maximal oxygen uptake, mean blood pressure, and triglycerides; a lipid factor, which comprised cholesterol and triglycerides; and a lifestyle factor, which comprised physical activity and smoking. In this prospective study, the insulin resistance factor proved to be a statistically significant predictor of coronary heart disease. While metabolic syndrome was not specifically determined in this population, analysis of the 22-year risk of coronary heart disease by tertiles (three levels rated from low to high) of insulin resistance showed that excess risk was confined to the highest tertile. Humbarger and colleagues (2004) determined the cross-sectional prevalence of metabolic syndrome in a sample of 84 adult male police officers in Texas with a mean age of 36.2 years. Utilizing the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (ATP III) guidelines, 27.4% of participants were found to have metabolic syndrome. The authors concluded that metabolic syndrome in male police officers may be higher than the American male population, and thus law enforcement officers may be at increased risk for future cardiovascular disease morbidity and mortality.

Police mortality studies indicate an elevated risk of atherosclerotic heart disease in police officers. A substantial

number of officers were found to be at elevated risk for atherosclerotic heart disease; 76% had elevated cholesterol, 26% had elevated triglycerides, and 60% elevated body fat composition (Franke, Cox, Schultz, & Anderson, 1997). Previous evidence indicates that police officers are immediately and continuously exposed to considerable stress and traumatic events in their work, as well as shift work, poor diet, and inadequate exercise habits (Violanti, Vena, & Petralia, 1998). Public safety officers had a higher probability of developing coronary heart disease than did the Framingham study population (Franke et al., 1997).

The Metabolic Syndrome and Cardiovascular Disease

The use of a cluster of cardiovascular related health constituents has been suggested as an alternative approach to defining risk of cardiovascular disease (CVD). The metabolic syndrome is a clustering of cardiovascular disease risk factors that have also been independently associated with psychological conditions. Utilizing year 2000 U.S. Census data and NCEP ATP III guidelines, it is estimated that at least 47 million Americans have the metabolic syndrome (Panagiotakos et al., 2004). Reilly and Rader (2003) estimated that in the United States approximately 25% of adults over age 20 and up to 45% of the population over age 50 have the metabolic syndrome.

The NCEP ATP III (2002) put forth guidelines for the proposed clinical definitions of the metabolic syndrome in adults to aid in diagnosis and suggestion of preventive interventions for this syndrome. ATP III defined metabolic syndrome as abnormalities in any three or more of the following clinical measures: waist circumference (obesity), triglycerides, HDL cholesterol, blood pressure, and fasting glucose level (Grundy et al., 2005).

An 11-year follow-up of the Atherosclerosis Risk in Communities (ARIC) study examined the risk of incident cardiovascular disease and metabolic syndrome. McNeill and colleagues (2005) examined the magnitude of association between the NCEP ATP III definition of metabolic syndrome and CVD. The metabolic syndrome was found to be present in 23% of ARIC participants without diabetes or prevalent CVD at the baseline evaluation. Elevated blood pressure and low HDL cholesterol demonstrated the strongest associations with incident CVD over the 11-year follow-up period. Men and women with the metabolic syndrome were approximately 1.5 to 2 times more likely to develop CHD than those without the syndrome after adjustment for age, smoking, LDL cholesterol, and race (McNeill, et al., 2005).

Current Study

The present study utilized data obtained from the Buffalo Police Health Study. This baseline health study was conducted to establish a baseline for the first ever population-based stress study designed to identify patterns of stress, subclinical CVD biomarkers, body composition, and psychosocial factors in the high stress occupation of police work (Violanti et al., 2006). We examined associations between PTSD symptoms and cardiovascular disease risk in police officers, based on diagnostic criteria of the metabolic syndrome.

METHODS

Police Sample

The Buffalo, New York Police Department, an urban police force of 934 officers at the time of data collection, was the selected sample site (Violanti et al., 2006). The Center for Preventive Medicine, State University of New York at Buffalo, School of Public Health and Health Professions, Buffalo, NY, served as the data collection site. A random sample stratified on gender (n = 115) was generated from all police officers in the department using a computer-generated random number table. Women officers were over-sampled to help ensure adequate representation. No specific inclusion criteria were used for the study, other than the participant would be a sworn police officer and willing to participate in the study. Of the 115 randomly selected officers invited to participate, 100% completed the clinic examination. Thirteen participants were missing metabolic syndrome data and one was missing IES data, leaving a final sample of 101 officers with complete data (40 women and 61 men).

All participant officers in the study were informed of the purpose and benefits of the project; the research methods to be used; the potential risks or hazards of participation; and the right to ask for further information at any time during the research procedure. They were further informed that their choice to participate was a voluntary one, and that they were free to withdraw from the research project at any time. All phases, testing, and reports of the study were approved by the State University of New York at Buffalo Internal Review

Board and the National Institute for Occupational Safety and Health Human Subjects Review Board.

Measures

PTSD Symptoms

The Impact of Event Scale (IES) was used to measure psychological symptoms of PTSD (Horowitz, Wilner, & Alvarez, 1979). It should be noted that the IES measures PTSD symptomatology and is not a substitute for an actual clinical diagnosis of PTSD. However, the categorized IES measure is based on norms established from actual diagnosed cases of PTSD. It is widely acknowledged that IES captures intrusive and avoidance symptomatology, rendering its usefulness as a measure for posttraumatic stress (Beaton, Murphy, Johnson, Pike, & Corniel, 1999; Weiss, & Marmar, 1997).

The IES consists of 15 items that evaluate experiences of avoidance and intrusion related to the intensity of posttraumatic stress. The measure was employed to assess PTSD symptoms in general and not in reference to a specific incident. The introductory question for the IES is phrased "Below is a list of comments made by people after stressful events. Please check each item, indicating how frequently these comments were true for you during the past seven days. If they did not occur during that time, please 'mark not at all' (0)." Respondents were asked to rate items on a 4-point scale according to how often each had occurred in the past 7 days: 0 (not at all), 1 (rarely), 3 (sometimes), and 5 (often). Seven of the items measure intrusive symptoms (intrusive thoughts, nightmares, intrusive feelings and imagery), and the remaining eight items measure avoidance symptoms (numbing of responsiveness, avoidance of feelings, situations, ideas), and combined provide a total subjective score of traumatic stress symptomatology. Both the intrusion and avoidance scales of the IES have displayed acceptable reliability (Chronbach alpha of 0.79 and 0.82, respectively), and a split-half reliability for the whole scale of 0.86 in validation studies (Horowitz et al., 1979). The IES has also displayed the ability to discriminate a variety of traumatized groups from non-traumatized groups (Briere, 1997; Sundin & Horowitz, 2002; Sundin & Horowitz, 2003). The IES used in the present study had a Chronbach's coefficient of 0.90 for the avoidance subscale, and 0.91 for the intrusive subscale, indicating good reliability.

To more precisely appraise the variation of PTSD symptoms, the IES was categorized based on a previously established formulation (Corniel, 1999). Categorization was based on the mean IES score of a normative group of diagnosed PTSD patients admitted for treatment (M = 35.3; SD = 17.2; Horowitz et al., 1979). A 0.50 standard deviation from the mean defined trauma stress levels, since that degree of variation best distinguished between those with mild, moderate, and severe reported trauma stress symptoms. Based on the previous evidence, the following levels of PTSD symptomatology were employed: 0 – 8 (subclinical), 9 – 25 (mild), 26 – 43 (moderate), and > 44 (severe; Beaton, Murphy, Johnson, Pike & Corneil, 1998; Beaton et al., 1999; Corneil, 1995; Corneil, Beaton, Murphy, Johnson & Pike, 1999).

Metabolic Syndrome Criteria

The metabolic syndrome component measures were based on the NCEP ATP III guidelines (2002) with recent modifications from the American Heart Association and the National Heart, Lung and Blood Institute (Grundy et al., 2005) and were determined as follows:

- *Waist circumference* - Waist circumference was measured as abdominal girth at the highest point of the iliac crest and the lowest part of the costal margin in the mid-axillary line. It was considered elevated if the measurement was 102 centimeters or greater in male participants and 88 centimeters or greater in females.
- *Blood pressure* – The average of the second and third of three systolic and diastolic sitting readings were used. Blood pressure was considered to be elevated if the systolic blood pressure was 130 mmHg or greater, diastolic blood pressure was 85 mmHg or greater, or if high blood pressure and antihypertensive treatment were reported.
- *HDL cholesterol* - Fasting HDL-C was defined as reduced if the fasting level was 40 mg/dL or less in men and 50 mg/dL or less in women.
- *Triglycerides* – Fasting triglycerides were defined as elevated if the level was 150 mg/dL or higher for both men and women.
- *Glucose* – Glucose intolerance was considered present when the fasting level was 100 mg/dL or higher or when medication for diabetes treatment was reported.

Although Grundy and colleagues (2005) incorporated drug treatment for elevated triglycerides or reduced HDL cholesterol into their definition, we defined these two conditions based on blood levels only. In our study, participants were asked to list all medications taken in the past 30 days. Participants did not specify the condition for which a particular medication was prescribed. Although several participants listed cholesterol lowering medication, no one reported medication for specific treatment of either elevated triglycerides or reduced HDL cholesterol.

The metabolic syndrome was considered present if three or more of the component parameters were present. Participants were categorized according to the number of metabolic syndrome disorders they had (0, 1, 2, 3, 4 or 5).

Statistical Methods

Descriptive statistics were used to characterize the study population. Prevalence of metabolic syndrome was computed by levels of selected covariates as well as by levels of PTSD severity category. Tests for trend for ordinal covariates and chi-square tests of independence for nominal covariates were used to assess statistical significance. Poisson regression analyses, relating PTSD severity category to the metabolic syndrome, were performed and estimates of prevalence ratios and their 95% CI were computed. Unadjusted and age- and multivariable-adjusted prevalence ratios were estimated.

RESULTS

Demographic characteristics of the participants in the sample are provided in Table 1, categorized by gender. Over half of the sample was < 40 years of age, 20% were African-American, and 42% were women. Sixty-five percent of the sample was at the rank of patrol officer. Approximately 37% of officers in the sample had served more than fifteen years in the department, 53% were current or former smokers, and nearly 52% of the sample consumed alcohol one or more times a week.

Gender-specific mean levels and percentages for each of the individual components of the metabolic syndrome are provided in Table 2, along with gender-specific prevalence estimates using the specific cutpoints for the metabolic syndrome components. Elevated waist circumference and reduced HDL cholesterol were relatively common in both sexes, while elevated triglycerides and fasting glucose occurred frequently in men but less so in women. Elevated blood pressure and its treatment were somewhat more common in men than in women, yet overall these prevalence estimates were relatively infrequent.

Table 3 presents prevalence of the metabolic syndrome by demographic and lifestyle characteristics. Metabolic syndrome for each participant was defined as having three or more of the syndrome component parameters present. Differences in metabolic syndrome prevalence were significant for race ($p = 0.005$), with Hispanic officers having the highest prevalence (66.7%) and Caucasian and African American officers having notably lower prevalence estimates (13.3% and 10.0%, respectively). A significant difference was observed for education ($p = 0.014$), with lowest education having the highest metabolic syndrome prevalence. We also observed a nearly significant trend in metabolic syndrome prevalence with increasing years of police service ($p = 0.127$) and a slightly elevated prevalence among the highest police rank (e.g. Captain/Detective 21%). Although not statistically significant, some elevation in prevalence of metabolic syndrome was seen in both those who did not consume alcohol (24.0%) and those who consumed six or more alcoholic beverages per week (22.2%).

Table 4 displays prevalence and prevalence ratios for metabolic syndrome across PTSD symptom categories. Although a test for linear trend across PTSD categories was not significant ($p<0.606$), prevalence of metabolic syndrome was highest in the severe PTSD symptom category (50.0%). For unadjusted results, the prevalence ratio for metabolic syndrome was significantly elevated among officers in the severe PTSD compared with those in the subclinical symptom category (PR = 3.31, 95% C.I. = 1.19 - 9.22). Adjustment for age attenuated this association slightly, but the ratio remained significant (PR = 3.12, 95% C.I. = 1.15 - 8.50). Adjustment for several demographic and lifestyle factors (age, education, smoking, alcohol intake) reduced the prevalence ratio somewhat, comparing severe with subclinical PTSD (PR = 2.69, 95% C.I. = 0.79 - 9.13). Adjustment for age and education accounted for most of the attenuation (PR = 2.71, 95% C.I. = 0.99 - 7.37).

Table 1
Demographic and life style characteristics by gender.

Characteristics	Women N	Women %	Men N	Men %	Total N	Total %
Race						
White	30	75.0	45	73.8	75	74.3
Black	10	25.0	10	16.4	20	19.8
Hispanic	0	0.0	6	9.8	6	5.9
Age group (years)						
< 40	21	52.5	32	52.5	53	52.5
40-49	17	42.5	21	34.4	38	37.6
≥ 50	2	5.0	8	13.1	10	9.9
Education						
≤ High school/GED	6	15.0	13	21.3	19	18.8
College < 4 yrs	15	37.5	17	27.9	32	31.7
College 4+ yrs	19	47.5	31	50.8	50	49.5
Marital status						
Single	12	30.0	10	16.4	22	21.8
Married	18	45.0	47	77.1	65	64.4
Divorced	10	25.0	4	6.6	14	13.9
Years of service						
1 – 5	13	32.5	13	21.3	26	25.7
6 – 10	8	20.0	7	11.5	15	14.9
11 – 15	9	22.5	14	23.0	23	22.8
> 15	10	25.0	27	44.3	37	36.6
Smoking status						
Current	10	25.0	10	16.7	20	20.0
Former	16	40.0	17	28.3	33	33.0
Never	14	35.0	33	55.0	47	47.0
Rank						
Police officer	29	76.3	35	58.3	64	65.3
Sergeant/Lieutenant	6	15.8	9	15.0	15	15.3
Captain/Detective	3	7.9	16	26.7	19	19.4
Alcohol drinks/week						
0	12	30.0	13	21.3	25	24.8
< 1	13	32.5	10	16.4	23	22.8
1 – 5	8	20.0	27	44.3	35	34.7
≥ 6	7	17.5	11	18.0	18	17.8

Table 2
Mean levels or percentages and prevalence of metabolic syndrome components by gender.

Component	Gender	Overall mean (SD) or percentage*	Component cutpoint	N	Prevalence of Component %
Waist circumference, cm	Men	97.2 (10.4)	≥ 102	23	37.7
	Women	80.6 (10.4)	≥ 88	9	22.5
Triglycerides, mg/dL	Men	110.6 (63.3)	≥ 150	14	22.9
	Women	72.9 (34.9)	≥ 150	1	2.5
HDL cholesterol, mg/dL	Men	45.2 (12.2)	< 40	24	39.3
	Women	55.3 (12.8)	< 50	14	35.0
Fasting glucose, mg/dL	Men	95.7 (13.9)	≥ 100	20	32.8
	Women	87.8 (7.7)	≥ 100	2	5.0
Diabetic medication use, %	Men	3.3	Yes	2	3.3
	Women	0.0	Yes	0	0.0
Blood pressure					
Systolic, mmHg	Men	117.7 (11.9)	≥ 130	9	14.8
	Women	106.8 (10.4)	≥ 130	1	2.5
Diastolic, mmHg	Men	73.5 (9.9)	≥ 85	7	11.5
	Women	68.0 (8.1)	≥ 85	1	2.5
Antihypertensive medication use, %	Men	6.6	Yes	4	6.6
	Women	0.0	Yes	0	0.0

SD = standard deviation
* Based on 40 women and 61 men.

DISCUSSION

Police work, with its increased risk for trauma exposure and PTSD, may increase risk factors associated with cardiovascular disease. Our aim in the present paper was to examine results from the BCOPS baseline health study concerning the association of PTSD symptoms with the metabolic syndrome.

Approximately 16% of the police officers in our sample met the criteria for metabolic syndrome. This was somewhat lower than some national general population studies indicate. In the Third National Health and Nutrition Examination Survey (NHANES) 1988-1994, Ford, Giles, and Mokdad (2004) estimated the unadjusted prevalence rate of metabolic syndrome to be 21.8%, while the age-adjusted prevalence rate was 23.7%. Similar to our police sample, the prevalence rates obtained from the NHANES data increased with increasing age. NHANES reported metabolic syndrome prevalence among 30-39 year olds to be 13%, which was the same for this age group in our police sample. Hispanic police officers in the present study had a considerably higher prevalence of metabolic syndrome at 66.7% compared to 13.3% for Caucasian officers. Similarly, St. Onge, Janssen, and Heymsfield (2004) found that the overall prevalence reported for the selected participants ranged from 17.5% in non-Hispanic black men to 30.6% in Hispanic women. Nationwide, NHANES data demonstrated a higher age-adjusted prevalence (31.9%) in Mexican Americans. Although there were a small number of Hispanic officers in the present study, future work with

larger samples should help to verify an increased metabolic syndrome risk among this population of police officers.

Due to the lack of previous work involving police officers in this area, we were unable to compare the present results of PTSD and metabolic syndrome with other studies. Our findings in the present study indicated a slight linear trend in metabolic syndrome across increasing categories of PTSD symptoms; however, it was not significant. Results indicated that there was a significant three-fold greater prevalence of the metabolic syndrome in those officers with severe PTSD symptoms. Thus, the higher prevalence of metabolic syndrome appeared to be confined to those officers who have the most severe PTSD symptoms. These results provide evidence that an association between PTSD and metabolic syndrome may exist, and indicate that further research utilizing a larger sample size would be useful.

Table 3
Prevalence of metabolic syndrome by demographic and life style characteristics.

Characteristics	Number at risk	Number with metabolic syndrome	Prevalence of metabolic syndrome (%)	P-value*
Race				
White	75	10	13.3	0.005
Black	20	2	10.0	
Hispanic	6	4	66.7	
Age group (years)				
< 40	53	7	13.2	0.249
40-49	38	6	15.8	
≥ 50	10	3	30.0	
Education				
d" High school/GED	19	7	36.8	0.014
College < 4 yrs	32	4	12.5	
College 4+ yrs	50	5	10.0	
Marital status				
Single	22	2	9.1	0.626
Married	65	12	18.5	
Divorced	14	2	14.3	
Years of service				
1 – 5	26	3	11.5	0.127
6 – 10	15	1	6.7	
11 – 15	23	3	13.0	
> 15	37	9	24.3	
Smoking status				
Current	20	3	15.0	0.875
Former	33	6	18.2	
Never	47	6	12.8	
Rank				
Police officer	64	10	15.6	0.548
Sergeant/Lieutenant	15	1	6.7	
Captain/Detective	19	4	21.1	
Alcohol drinks/week				
0	25	6	24.0	0.941
< 1	23	1	4.4	
1 – 5	35	5	14.3	
≥ 6	18	4	22.2	

*Based on linear trend for ordinal characteristics and chi-square for nominal characteristics.

Table 4
Prevalence estimates and ratios for metabolic syndrome by PTSD severity category.

			Unadjusted		Age-adjusted		Multivariable-adjusted*	
PTSD category	N	Prevalence (%)	PR	95% CI	PR	95% CI	PR	95% CI
Sub-clinical	53	15.1	1.00	referent	1.00	referent	1.00	referent
Mild	19	21.1	1.39	0.47 - 4.11	1.48	0.50 - 4.42	1.82	0.59 - 5.62
Moderate	23	4.4	0.29	0.04 - 2.17	0.28	0.04 - 2.14	0.37	0.04 - 3.17
Severe	6	50.0	3.31	1.19 - 9.22	3.12	1.15 - 8.50	2.69	0.79 - 9.13

Abbreviations: PTSD = Posttraumatic stress disorder; PR = prevalence ratio; CI = confidence interval
**Adjusted for age, education, smoking and alcohol intake.*

Adjustment for demographic and lifestyle variables, which included age, education, smoking, and alcohol consumption, lowered the magnitude of the association with the metabolic syndrome in those officers in the severe PTSD category compared with those in the subclinical category (PR = 2.69). Adjustment for alcohol consumption and smoking did not alter the association appreciably, whereas adjustment for education accounted for most of the attenuation in the prevalence ratios (age-adjusted PR = 3.12 versus age and education-adjusted PR = 2.71). Although education was associated with the metabolic syndrome in this study, education was not significantly associated with PTSD ($p = 0.753$).

Limitations

The cross-sectional design of this study precludes causal inferences. Although the sample size was limited, the random selection of officers with 100% response provided a representative sample. We were unable to conduct specific comparisons by gender, race, or specific components of the metabolic syndrome across PTSD categories due to small numbers of participants.

Previous research suggests that other factors may also affect the level of PTSD symptoms. Stress reactions other than PTSD may mediate the relationship between trauma exposure and physical health. Examples are PTSD comorbidity with other disorders, life event stresses, or disease as a direct result of a traumatic experience such as military combat (Beckham et al., 1998; Sibai, Fletcher, & Armenian, 2001). Other research has suggested that PTSD may play more of an indirect rather than direct role in disease (Boscarino & Chang, 1999; Schnurr & Jankowski, 1999). Prior trauma and intensity of the response to a traumatic event may increase levels, while individual resiliency may act as a protective factor against the development of PTSD (Schnurr, Friedman, & Bernardy, 2002; Schnurr & Green, 2004). Physiological factors, such as abnormally low stress resistance hormones, also may be associated with the underlying pathology of PTSD (Yehuda & McFarlane, 1997). Sher (2004) has suggested that the risk of developing depression is determined by a complex interplay of genetic susceptibility, environmental exposures (that may be occupational or from home life), and aging. We did not have sufficient information available on those additional variables to evaluate their potential role in this association.

Strengths

This study included well-established measurements of the physiological components of the metabolic syndrome along with a standardized and reliable measure for PTSD symptoms. The study employed use of a standardized protocol, and had a high response rate and level of cooperation.

The police occupation offers an excellent opportunity to study a population exposed to traumatic events. In number, the police population represents approximately 708,000 sworn officers in the United States alone (Reaves, 2002). Although the cross-sectional design of this study precludes causal inferences, the assessment of PTSD-metabolic syndrome associations at a single point in time provides important descriptive health-related findings of a mid-sized city police department. Recently, where the potential for PTSD has in-

creased (Galea, Ahern, & Resnick, 2002) the need for examination of more objective health outcomes associated with PTSD has become even more important, particularly among those who work in first responder occupations.

In summary, officers with severe PTSD symptoms had a three-fold greater prevalence of the metabolic syndrome compared with officers having subclinical PTSD symptoms. Adjustment for factors including age, education, smoking and alcohol consumption, slightly lowered the magnitude of this association with adjustment for education accounting for most of the attenuation.

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