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Newly Reported Hypertension After Military Combat Deployment in a Large Population-Based Study

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Abstract—High-stress situations, such as combat deployments, are a potential risk factor for hypertension. Although stress is postulated to increase blood pressure, the underlying role of stress on hypertension is not well established. We sought to determine the relations between combat deployment-induced stress and hypertension. The Millennium Cohort baseline questionnaire (2001–2003) was completed by 77 047 US active-duty and Reserve/National Guard members. Follow-up was completed by 55 021 responders \approx 3 years later (2004–2006). Multivariable logistic regression was used to estimate the 3-year risk of newly reported hypertension, adjusting for general and mental health, demographics, and occupational and behavioral characteristics. After applying exclusion criteria, our analyses included 36 061 service members. Subanalyses of deployers included 8829 participants. Newly reported hypertension was identified in 6.9% of the cohort between baseline and follow-up, many of whom had deployed on military operations in support of the conflicts in Iraq and Afghanistan. After adjusting, deployers who experienced no combat exposures were less likely to report hypertension than nondeployers (odds ratio: 0.77; 95% CI: 0.67 to 0.89). Among deployers, those reporting multiple combat exposures were 1.33 times more likely to report hypertension compared with noncombat deployers (95% CI: 1.07 to 1.65). Although military deployers, in general, had a lower incidence of hypertension than nondeployers, deployment with multiple stressful combat exposures appeared to be a unique risk factor for newly reported hypertension. (*Hypertension*. 2009;54:00-00.)

Key Words: hypertension ■ incidence ■ stressful events ■ cohort studies ■ military personnel

Military deployment may present profound psychological and physical stressors to deployers, such as exposure to life-threatening situations, dead or maimed bodies, and suboptimal living conditions. Although stress related to high-pressure work, natural disasters, and missile attacks has been associated with increased myocardial infarction and other cardiovascular risk,¹ the underlying role of deployment-induced stress or combat-related violence on hypertension is not well established.

Stress is postulated to increase blood pressure through the release of corticoids and inhibition of prostaglandin synthesis, which regulates blood pressure; the sudden rise in dopamine that increases coronary blood flow; or perhaps by altering electrolytes and increasing sodium, thereby aggravating hy-

pertension.^{2–4} Violence is thought to sustain nighttime blood pressure through mechanisms related to elevated sympathetic nervous system response.⁵ Several studies have linked acute stress from life-threatening situations, such as earthquake shock and combat, with elevated blood pressure, although this effect was temporary, lasting only hours to weeks.^{6–8} However, acute stress responses reported after terrorist attacks were shown to increase physician-diagnosed hypertension by 115% at 1 year and 75% at 2 years.⁹ Individuals with sustained nighttime blood pressure (<10% decrease from awake to sleep) were 3.5 times as likely to have personally seen violence (attacks, abuse, or crime) than those with a drop in nighttime blood pressure.¹⁰ Previous findings have shown no association between stress, as assessed by military deploy-

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ment to the 1991 Gulf War or Vietnam War, and hypertension,^{11–14} yet these studies were cross-sectional in nature, and hypertension may have resolved before evaluation. The Millennium Cohort Study is well positioned to evaluate potential associations and address concerns over the long-term health consequences related to the current operations in Iraq and Afghanistan.^{15–17} This is the first study to prospectively investigate the relations between military deployments and newly reported hypertension in a large population-based cohort, many of whose members were deployed with reported combat exposures.

Methods

Original Cohort

The Millennium Cohort invited a population-based random sample of the 2.2 million US military members who were serving as of October 1, 2000,¹⁵ oversampling for previous deployers to Southwest Asia, Bosnia, or Kosovo (1998–2000); Reserve and National Guard members; and women to ensure adequate power in stratified analyses.¹⁵ The Millennium Cohort Study baseline questionnaire was completed by 77 047 consenting enrollees (July 2001 to June 2003), whereas 55 021 responded to the follow-up questionnaire \approx 3 years later (June 2004 to February 2006). More details on the original cohort are available elsewhere.¹⁵

Study Population

In the current analyses, participants were limited to consenting service members who completed both baseline and follow-up questionnaires. Excluded were individuals who reported ever having hypertension at baseline ($n=5753$), service members previously deployed and returned before baseline questionnaire submission ($n=1960$), and persons who completed either questionnaire while still deployed ($n=2924$). In an attempt to reduce confounding from pregnancy-related hypertension, women who reported having no menstrual period because of pregnancy or recent birth and women who reported giving birth in the previous 3 years ($n=3409$) were excluded. Additional exclusions were missing outcome and covariate data ($n=4874$) and individuals with the reported year of hypertension onset before deployment ($n=40$). The final study population included 36 061 participants. Subanalyses evaluated deployers only, which included 8829 participants. This study was conducted in accordance with ethical and institutional guidelines with informed consent and was approved by the institutional review boards of the University of Arizona and the Naval Health Research Center.

Hypertension Outcome

“Newly reported hypertension” included individuals who reported hypertension at follow-up but not at baseline, while ensuring that the year of hypertension onset, if available, was reported after deployment among those who deployed during this period. The Millennium Cohort Study baseline questionnaire asked, “Has your doctor or other health professional EVER told you that you have any of the following conditions? . . . Hypertension (high blood pressure).” At follow-up, participants were asked the same question, but in the context of the last 3 years. A field was available for, “If YES, in what year were you first diagnosed?”

Deployment Data

Deployment data were obtained electronically from the Defense Manpower Data Center on the basis of inbound and outbound theater dates. Recent deployment in support of the conflicts in Iraq and Afghanistan was assessed as occurring after the baseline questionnaire and before follow-up. Combat exposures were evaluated at follow-up through self-report of personally witnessing or being exposed in the past 3 years to a person’s death because of war or disaster, physical abuse, dead or decomposing bodies, maimed soldiers or civilians, or prisoners of war or refugees. Single and

multiple exposures were assessed for each of the combat exposures described.

General/Mental Health and Behavioral Characteristics

Self-reported general health was assessed at baseline and characterized as excellent, very good, good, or fair/poor. Responses to the fair and poor categories were collapsed because of small cell counts. Mental component summary scores were evaluated at baseline through the Medical Outcomes Study short-form 36-item questionnaire for veterans.¹⁸

Average self-reported alcohol consumption in the past year at baseline was based on the Departments of Health and Human Services and Agriculture Dietary Guidelines for Americans.¹⁹ “Moderate drinking” was defined as an average alcohol consumption of 1 drink a day for women or 2 drinks a day for men, with 1 drink specified as either one 12-oz beer, one 4-oz glass of wine, or one 1.5-oz shot of liquor. Heavy drinking was defined as higher than this level, whereas low drinking levels or no alcohol consumption were assessed through self-report of <12 drinks of any type of alcoholic beverage in their entire life and/or in the past year.

Reports of physical activity and strength training were collected from the follow-up questionnaires. The variables were classified on the basis of the American College of Sports Medicine and the American Heart Association.²⁰ Participants who self-reported ≥ 150 minutes per week of moderate/light exercise (on the basis of 30 minutes per day, 5 days a week) and/or ≥ 60 minutes of vigorous exercise (on the basis of 20 minutes per day, 3 days a week) were considered physically active. Conducting 8 to 10 strength-training exercises was estimated at 30 minutes; therefore, individuals who self-reported ≥ 60 minutes per week of strength training or work that strengthened their muscles were considered to be engaged in active strength training.

Cigarette smoking was assessed using the baseline questionnaire and was categorized as nonsmoker, past smoker, and current smoker. Smoking status was based on self-report of lifetime smoking of ≥ 100 cigarettes (5 packs), a successful attempt to quit smoking, and cigarette use in the past year.

Demographic and Occupational Data

Demographic and occupational data were obtained electronically from the Defense Manpower Data Center and categorized as shown in Table 1. Body mass index scores were calculated from self-reported height and weight data collected from baseline questionnaires on the basis of the guidelines from the National Heart, Lung, and Blood Institute.²¹ Electronic outpatient and inpatient International Classification of Diseases, Ninth Revision, Clinical Modification codes were obtained from Department of Defense databases and civilian claims billed to the Department of Defense. Newly diagnosed hypertension codes were identified as ≥ 2 outpatient and/or ≥ 1 inpatient International Classification of Diseases, Ninth Revision, Clinical Modification code(s) from baseline to follow-up survey submission dates among active-duty participants only, because of unequal benefits in accessing the Department of Defense healthcare system among Reserve/National Guard members. To ensure adequate time for entry of codes into the databases, we also investigated 90 days after follow-up submission.

Statistical Analysis

Cumulative incidence of newly reported hypertension was calculated, in addition to κ coefficients and corresponding 95% CIs, to evaluate the agreement between self-report and hypertension diagnosis codes. Univariate analyses, including χ^2 tests of association, were conducted for the full model ($N=36\,061$) and the deployers-only model ($N=8829$). Initial model analyses assessed multicollinearity among all of the variables, which was deemed likely if the variance inflation factor was >4 , indicating high correlation. Potential confounders were retained in the adjusted model, in addition to variables of interest from literature review. Potential interactions were tested and considered significant at $P \leq 0.05$. Multivariable

Table 1. Characteristics of Millennium Cohort Study Participants by Military Deployment

Characteristics (N=36 061)	n (%)			
	Nondeployed (n=27 232)	No Combat (n=4385)	Deployed	
			Single (n=586)	Multiple (n=3858)
Sex*				
Male	20 363 (74.8)	3663 (83.5)	472 (80.5)	3329 (86.3)
Female	6869 (25.2)	722 (16.5)	114 (19.5)	529 (13.7)
Birth year*				
1960 and earlier	7552 (27.7)	830 (18.9)	100 (17.1)	564 (14.6)
1960–1969	11 379 (41.8)	1967 (44.9)	260 (44.4)	1493 (38.7)
1970–1979	7402 (27.2)	1388 (31.6)	197 (33.6)	1549 (40.2)
1980 and forward	899 (3.3)	200 (4.6)	29 (4.9)	252 (6.5)
Education*				
No high school diploma	1458 (5.4)	128 (2.9)	35 (6.0)	267 (6.9)
High school diploma	10 134 (37.2)	1382 (31.5)	223 (38.0)	1782 (46.2)
Some college	6824 (25.1)	1657 (37.8)	171 (29.2)	700 (18.1)
College graduate	5347 (19.6)	854 (19.5)	118 (20.1)	787 (20.4)
Advanced degree	3469 (12.7)	364 (8.3)	39 (6.7)	322 (8.4)
Marital status*				
Married	18 140 (66.6)	2953 (67.3)	361 (61.6)	2425 (62.8)
Single	7032 (25.8)	1139 (26.0)	183 (31.2)	1214 (31.5)
Other	2060 (7.6)	293 (6.7)	42 (7.2)	219 (5.7)
Race/ethnicity*				
Non-Hispanic white	19 787 (72.7)	3306 (75.4)	414 (70.6)	2647 (68.6)
Non-Hispanic black	2979 (10.9)	433 (9.9)	87 (14.9)	338 (8.8)
Asian/Pacific Islander	2315 (8.5)	310 (7.1)	35 (6.0)	545 (14.1)
Hispanic	1585 (5.8)	251 (5.7)	36 (6.1)	223 (5.8)
Other	566 (2.1)	85 (1.9)	14 (2.4)	105 (2.7)
Service component†				
Reserve/National Guard	12 896 (47.4)	1767 (40.3)	235 (40.1)	1458 (37.8)
Active duty	14 336 (52.6)	2618 (59.7)	351 (59.9)	2400 (62.2)
Military pay grade*				
Enlisted	19 371 (71.1)	3268 (74.5)	429 (73.2)	2727 (70.7)
Officer	7861 (28.9)	1117 (25.5)	157 (26.8)	1131 (29.3)
Service branch*				
Army	13 051 (47.9)	1121 (25.6)	259 (44.2)	2637 (68.3)
Air Force	7461 (27.4)	2297 (52.4)	220 (37.5)	705 (18.3)
Navy/Coast Guard	5535 (20.3)	818 (18.6)	89 (15.2)	235 (6.1)
Marine Corps	1185 (4.4)	149 (3.4)	18 (3.1)	281 (7.3)
Occupational category*				
Other occupations	18 373 (67.5)	3274 (74.7)	419 (71.5)	2260 (58.6)
Combat specialists	5496 (20.2)	951 (21.7)	128 (21.8)	1174 (30.4)
Healthcare specialists	3363 (12.3)	160 (3.6)	39 (6.7)	424 (11.0)
Body mass index†				
Underweight/normal	10 078 (37.0)	1588 (36.2)	221 (37.7)	1376 (35.7)
Overweight	14 294 (52.5)	2417 (55.1)	313 (53.4)	2152 (55.8)
Obese	2860 (10.5)	380 (8.7)	52 (8.9)	330 (8.5)

(Continued)

Table 1. Continued

Characteristics (N=36 061)	n (%)			
	Nondeployed (n=27 232)	No Combat (n=4385)	Deployed	
			Single (n=586)	Multiple (n=3858)
Alcohol consumption*				
None to low drinking	7485 (27.5)	1029 (23.5)	139 (23.7)	755 (19.6)
Moderate drinking	9199 (33.8)	1481 (33.8)	201 (34.3)	1269 (32.9)
Heavy drinking	10 548 (38.7)	1875 (42.7)	246 (42.0)	1834 (47.5)
Physical activity*				
Inactive	9434 (34.6)	1367 (31.2)	199 (34.0)	987 (25.6)
Active	17 798 (65.4)	3018 (68.8)	387 (66.0)	2871 (74.4)
Strength training*				
Inactive	14 975 (55.0)	2267 (51.7)	294 (50.2)	1518 (39.3)
Active	12 257 (45.0)	2118 (48.3)	292 (49.8)	2340 (60.7)
Smoking status*				
Nonsmoker	16 284 (59.8)	2673 (61.0)	370 (63.1)	2202 (57.1)
Past smoker	6669 (24.5)	996 (22.7)	138 (23.6)	885 (22.9)
Current smoker	4279 (15.7)	716 (16.3)	78 (13.3)	771 (20.0)
General health*				
Excellent	6212 (22.8)	1022 (23.3)	129 (22.0)	983 (25.5)
Very good	11 429 (42.0)	1885 (43.0)	245 (41.8)	1666 (43.2)
Good	7802 (28.6)	1280 (29.2)	178 (30.4)	1016 (26.3)
Fair/poor	1789 (6.6)	198 (4.5)	34 (5.8)	193 (5.0)
Mental component summary*				
>75th percentile	6847 (25.1)	1106 (25.2)	152 (25.9)	907 (23.5)
>50th to 75th percentile	6801 (25.0)	1119 (25.5)	139 (23.7)	965 (25.0)
>25th to 50th percentile	6732 (24.7)	1144 (26.1)	161 (27.5)	966 (25.1)
0 to 25th percentile	6852 (25.2)	1016 (23.2)	134 (22.9)	1020 (26.4)

* $\chi^2 P \leq 0.05$ in the full model (N=36 061) and in the deployers-only model (N=8829).

† $\chi^2 P \leq 0.05$ in the full model and $P > 0.05$ in the deployers-only model.

logistic regression was used to investigate relations between newly reported hypertension and combat deployment. Statistical analyses were performed using SAS software, version 9.2 (SAS Institute, Inc).

Results

Within ≈ 3 years between baseline and the follow-up questionnaire (average: 2.7 years), 25% were deployed in support of the operations in Iraq and Afghanistan, with half of those reporting combat exposures during deployment (Table 1). In the full model, compared with nondeployers, deployers without combat were proportionately more likely to be men, younger, have some college education, married, non-Hispanic white, on active duty, enlisted, in the Air Force, in occupations other than combat or health care, overweight, reporting heavy drinking, physically active, engaging in strength training, nonsmokers or current smokers, and reporting better general or mental health. In the deployers-only model, compared with noncombat deployers, multiple combat-exposed deployers were proportionately more likely to be men,

younger, less than some college educated, single, Asian/Pacific Islanders, an officer, in the Army or Marine Corps, combat or healthcare specialists, reporting heavy drinking, physically active, engaging in strength training, current smokers, reporting other than good general health, and in worse overall mental health.

Within ≈ 3 years between baseline and follow-up surveys, 2485 responders (6.9%) reported hypertension (Table 2). When newly reported hypertension was evaluated against objective hypertension diagnosis codes, there was moderate agreement ($\kappa=0.46$; 95% CI: 0.44 to 0.49). Including 90 days after follow-up submission to allow for adequate time for entry of code(s) did not change the agreement ($\kappa=0.49$; 95% CI: 0.47 to 0.52). In both the full and the deployers-only models, there was no variable with a variance inflation level of >4 , indicating no multicollinearity. Furthermore, interaction terms between deployment and sex, as well as alcohol consumption, were tested but were not statistically signifi-

Table 2. Approximate 3-Year Incidence and Adjusted Odds of Newly Reported Hypertension and Military Deployment Between Baseline (2001–2003) and Follow-Up (2004–2006)

Covariates (N=36 061)	Cumulative Incidence, %	Adjusted OR*	95% CI
Newly reported hypertension	6.9		
Deployment status			
Nondeployed	7.3		
Deployed no combat	5.4	0.77	0.67 to 0.89
Deployed single combat	5.5	0.78	0.54 to 1.13
Deployed multiple combat	6.1	0.98	0.84 to 1.13
Sex			
Male	7.4		
Female	5.0	0.72	0.63 to 0.81
Birth year			
1960 and earlier	10.8		
1960–1969	6.9	0.53	0.48 to 0.59
1970–1979	4.0	0.33	0.29 to 0.38
1980 and forward	2.8	0.30	0.21 to 0.43
Marital status			
Married	7.9		
Single	4.4	0.86	0.76 to 0.98
Other	7.2	0.95	0.80 to 1.11
Race/ethnicity			
Non-Hispanic white	6.4		
Non-Hispanic black	11.0	1.84	1.62 to 2.08
Asian/Pacific Islander	6.1	1.16	0.97 to 1.38
Hispanic	6.8	1.10	0.91 to 1.32
Other	7.3	1.20	0.90 to 1.59
Service component			
Reserve/National Guard	7.1		
Active duty	6.7	1.19	1.08 to 1.31
Military pay grade			
Enlisted	7.3		
Officer	5.8	0.82	0.70 to 0.96
Body mass index			
Normal/underweight	3.6		
Overweight	7.7	1.77	1.58 to 1.98
Obese	14.6	3.09	2.69 to 3.55
Physical activity			
Inactive	8.3		
Active	6.2	0.90	0.82 to 0.99
Strength training			
Inactive	7.8		
Active	5.9	0.86	0.78 to 0.94

(Continued)

Table 2. Continued

Covariates (N=36 061)	Cumulative Incidence, %	Adjusted OR*	95% CI
General health			
Excellent	4.5		
Very good	6.4	1.27	1.12 to 1.44
Good	9.0	1.67	1.45 to 1.91
Fair/poor	9.8	1.68	1.38 to 2.04

*Data are adjusted for above characteristics plus education, service branch, occupation, alcohol consumption, smoking status, and mental component summary.

cant. All of the results were adjusted for general and mental health, demographics, and occupational and behavioral characteristics. Compared with nondeployers, noncombat deployers were 0.77 times as likely to report hypertension (95% CI: 0.67 to 0.89). In addition, being a woman, younger, single, an officer, physically active, or conducting strength training was inversely associated with newly reported hypertension, whereas risk factors included being non-Hispanic black, on active duty, overweight or obese, and reporting poorer general health.

In subanalyses among deployers only, deployers with multiple combat exposures were 1.33 times more likely to report hypertension than noncombat deployers (95% CI: 1.07 to 1.65; Table 3). In addition, being younger, an officer, or a current smoker was inversely associated with incident hypertension, whereas risk factors included being non-Hispanic black or Hispanic, overweight or obese, and reporting poorer general and mental health. When each type of combat exposure was analyzed separately, personally witnessing or being exposed to a person's death because of war or disaster was statistically significantly associated with newly reported hypertension both at single (odds ratio [OR]: 1.50; 95% CI: 1.10 to 2.05) and multiple exposures (OR: 1.43; 95% CI: 1.12 to 1.83). Exposure to physical abuse, dead or decomposing bodies, maimed soldiers or civilians, or prisoners of war or refugees was not statistically significantly associated with newly reported hypertension.

Discussion

Over the ≈3-year period, newly reported hypertension was observed in 6.1% of deployers with multiple combat exposures and 6.9% overall in this large population-based cohort of young adults (mean age: 35 years). Newly reported hypertension was found to be higher among nondeployers than deployers. Although deployment in general appeared to be inversely associated with newly reported hypertension, deployers presumably are healthier than nondeployers, because service members must be medically cleared for deployment. Deployment alone may not capture the effects of stress associated with actual combat. Compared with noncombat deployers, deployers with multiple combat exposures were statistically significantly at higher risk of newly reported hypertension.

National statistics from 2003 to 2004 reported a higher prevalence of hypertension among non-Hispanic blacks than non-Hispanic whites (OR: 1.61; 95% CI: 1.30 to 1.99) but no

Table 3. Among Deployers: Approximate 3-Year Incidence and Adjusted Odds of Newly Reported Hypertension and Combat Exposures

Covariates (N=8829)	Cumulative Incidence, %	Adjusted OR*	95% CI
Newly reported hypertension	5.7		
Deployment status			
Deployed no combat	5.4		
Deployed single combat	5.5	1.02	0.69 to 1.51
Deployed multiple combat	6.1	1.33	1.07 to 1.65
Birth year			
1960 and before	9.6		
1960–1969	6.3	0.56	0.44 to 0.72
1970–1979	3.5	0.33	0.24 to 0.46
1980 and forward	2.5	0.26	0.13 to 0.51
Race/ethnicity			
Non-Hispanic white	5.1		
Non-Hispanic black	10.3	1.97	1.49 to 2.60
Asian/Pacific Islander	4.2	1.03	0.69 to 1.56
Hispanic	7.3	1.50	1.04 to 2.16
Other	5.9	1.12	0.61 to 2.06
Military pay grade			
Enlisted	6.1		
Officer	4.4	0.62	0.43 to 0.90
Body mass index			
Normal/underweight	2.9		
Overweight	6.5	1.92	1.50 to 2.47
Obese	12.2	3.33	2.42 to 4.59
Smoking status			
Nonsmoker	5.9		
Past smoker	6.3	0.95	0.76 to 1.19
Current smoker	4.2	0.70	0.52 to 0.94
General health			
Excellent	3.7		
Very good	5.5	1.33	1.01 to 1.75
Good	7.4	1.45	0.91 to 2.33
Fair/poor	7.1	1.76	1.12 to 2.76
Mental component summary			
>75th percentile	5.5		
>50th to 75th percentile	4.9	1.03	0.78 to 1.35
>25th to 50th percentile	5.5	1.15	0.88 to 1.50
0 to 25th percentile	6.8	1.41	1.08 to 1.86

*Data are adjusted for above characteristics plus sex, education, marital status, service component, service branch, occupation, alcohol consumption, physical activity, and strength training.

association between Mexican Americans and non-Hispanic whites (OR: 0.68; 95% CI: 0.43 to 1.08).²² In this study, non-Hispanic blacks had an 84% higher risk for newly reported hypertension than non-Hispanic whites, with no association between Hispanics and non-Hispanic whites.

Among deployers, similar trends were observed with 97% higher risk among non-Hispanic blacks than non-Hispanic whites, yet higher risk was also observed among Hispanics than non-Hispanic whites (50%).

Obese persons are at increased risk for developing hypertension, cardiovascular disease, and stroke.^{23,24} In the current study, obese individuals had a 3-fold higher risk of reporting hypertension than normal or underweight persons. Similar trends showing increased body mass index as a risk factor for hypertension have been identified in other prospective cohort studies.^{25,26}

Physical activity is especially important in promoting cardiovascular benefits, along with a reduction in high blood pressure.^{24,27} Strength training has been shown to complement aerobic exercise,²⁸ help facilitate weight control,²⁹ and be potentially beneficial in the management of hypertension.³⁰ In this study, individuals who were physically active and actively strength trained were at a decreased risk of newly reported hypertension. However, this association was only significant when nondeployers were included in the model. Although physical activity and strength training were not captured at baseline, excluding these variables from the model did not change the relations between deployment and newly reported hypertension. In addition, light-intensity exercise could not be distinguished; thus, including this subgroup in the “inactive” category may have potentially biased the results toward the null, thereby minimizing the association found.

Several studies have found current smoking to increase blood pressure and to be a risk factor for hypertension, possibly because of sympathetic activation and arterial stiffness.^{31–35} Contrarily, in the total sample of deployers and nondeployers, there was no association between cigarette smoking and newly reported hypertension. In the sample of deployers only, current smoking was inversely associated with newly reported hypertension. These findings may be attributable to differences between groups at baseline, in which current smokers were statistically significantly younger and less overweight/obese than past and nonsmokers. Vascular stiffness, which reportedly increases with age,³⁶ may be less prominent in the younger, although currently smoking population. In addition, potential confounding because of weight gain or loss may not have been fully adjusted in our model using baseline body mass index alone as a measurement of adiposity and body composition.

Limitations and Strengths

Limitations of this study include potential biases related to loss to follow-up and misclassification of exposures and outcome because of self-report. In addition, risk factors such as family history and high dietary salt were not measured. Although we do not expect family history to differ between deployers and nondeployers, because family history of disease is not a screening requirement for deployment, change in diet among deployers may differ from nondeployers. Selection bias could have occurred from individuals who were unable to submit the questionnaires while deployed to remote locations. For this reason, individuals who completed their questionnaire while deployed were excluded. Subanalyses of

current deployers or participants who completed either survey while deployed resulted in similar findings, with noncombat current deployers being less likely to report hypertension than nondeployers (OR: 0.54; 95% CI: 0.40 to 0.75) and current deployers with multiple combat exposures at increased risk for newly reported hypertension than noncombat deployers (OR: 1.30; 95% CI: 1.05 to 1.61). Conversely, current deployers with multiple combat exposures were statistically significantly less likely to report hypertension than nondeployers (OR: 0.61; 95% CI: 0.45 to 0.84). Misclassification bias may have occurred for some who did not have adequate time to be examined and diagnosed with hypertension on return from deployment. However, a subanalysis, in which only deployments completed ≥ 3 months before the follow-up questionnaire were conducted to allow for adequate diagnosis time, resulted in no difference in findings.

Self-reported hypertension and combat-related exposures may be prone to recall bias and may not represent the true measure of hypertension or combat exposures in the population. Medical charts were not available for analyses; however, electronic medical encounters were available with moderate agreement observed between self-report and hypertension codes. Although awareness of blood pressure measurements was not assessed, >99.8% of participants had ≥ 1 encounter within the military healthcare system, during which blood pressure is routinely measured.

Despite the limitations, the strength of this study lies in the prospective design, which allows for calculation of cumulative incidence and estimated risk of newly reported hypertension. Previous studies have shown these cohort data to be reliable and survey response to be uninfluenced by poor health status.^{15,17,37-43} We believe that these results are generalizable to the entire US military because of the large sample size and population-based random sampling methods used. To some extent, results may also be generalizable to any population of healthy young adults. Furthermore, a large sample size allows for subgroup comparisons, adequate power to detect statistically important differences, and the ability to adjust for potential confounding.

Perspectives

In this large population-based cohort, an estimated 6.9% of military service members reported hypertension within an ≈ 3 -year period. A lower incidence of newly reported hypertension was found among military deployers, likely because of deployers being healthier than nondeployers because of the medical clearance requirement for deployment. Deployers reporting multiple combat exposures, especially those who personally witnessed a death because of war or disaster, were at statistically significantly increased risk for newly reported hypertension. This may indicate a stress-induced hypertensive effect in an otherwise healthy population. Future studies evaluating military deployment and hypertension diagnosis through blood pressure measurements are recommended. Additional follow-up of this cohort will allow for better understanding of relations between military combat deployment and other occupational and psychosocial stressors with newly reported hypertension and other chronic health conditions.

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Disclosures

None.

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14. ABSTRACT

Objective: We sought to determine if high-stress situations such as military deployments are a potential risk factor for new-onset hypertension.

Research Design: Using data from the Millennium Cohort Study, multivariable logistic regression was used to estimate the 3-year risk of new-onset hypertension among those who deployed and those not deployed.

Results: Newly reported hypertension was found in 5.7% of deployers and 7.3% of nondeployers. After adjusting for potential confounding, deployers with no reported combat exposures were less likely to develop incident hypertension than nondeployers (odds ratio, 0.77; 95% confidence interval, 0.67-0.89). There was no association between hypertension and deployers reporting combat exposures compared with nondeployers. Among deployers, those reporting combat exposures were 1.28 times more likely to report incident hypertension compared with deployers not reporting combat exposures (95% confidence interval, 1.04-1.57).

Conclusions: While deployers, in general, had a lower incidence of self-reported hypertension than nondeployers, deployers reporting stressful combat exposures were more likely to report new-onset hypertension than deployers who did not report combat exposures.

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