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Evaluation of high blood pressure and obesity among US coal miners participating in the Enhanced Coal Workers' Health Surveillance Program

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Abstract

Since 2005, the Enhanced Coal Workers' Health Surveillance Program (ECWHSP) has offered respiratory examinations to coal miners in a mobile examination unit. As little is known about the cardiovascular health of coal miners, we describe the prevalence of high blood pressure (BP) and obesity among ECWHSP participants. During 2015, 1402 ECWHSP health examinations were performed. The prevalence of BP consistent with hypertension (systolic BP \geq 140 mm Hg or diastolic BP \geq 90 mm Hg), prehypertension (systolic BP 120–139 mm Hg or diastolic BP 80–89 mm Hg), and hypertensive crisis (systolic BP \geq 180 mm Hg or diastolic BP \geq 110 mm Hg) were calculated and compared with the US adult population using standardized morbidity ratios (SMRs). Most participants were male ($N = 1317$, 94%), White ($N = 1303$, 93%) and non-Hispanic ($N = 1316$, 94%). Thirty-one percent ($N = 440$) of participants had BP in the hypertensive range and 87% ($N = 1215$) were overweight/obese. Twenty-four participants (2%) had a BP reading consistent with a hypertensive crisis. Prevalence of obesity (52%, SMR = 1.52, 95% confidence interval = 1.41–1.64) and BP consistent with hypertension (31%, SMR = 1.60, 95% confidence interval = 1.45–1.76) was higher than the US adult population. The prevalence of obesity and BP consistent with hypertension in this population of coal miners is substantial, indicating a need for cardiovascular health interventions in coal mining communities. *J Am Soc Hypertens* 2017;11(8): 541–545. Published by Elsevier Inc. on behalf of American Society of Hypertension.

Keywords

Coal; miners; occupational health; mobile health screening

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Introduction

Since 2005, the National Institute for Occupational Safety and Health has administered the Enhanced Coal Workers' Health Surveillance Program (ECWHSP) which offers medical examinations to coal miners at no cost to themselves in a mobile examination unit that travels to coal mining regions throughout the country. Outreach has been primarily directed to active coal miners, but former miners have been invited in the past. Examinations are focused on the detection of radiographic and lung function abnormalities. Spirometry testing is performed along with radiographic examinations and occupational history questionnaires. To assess for contraindications to spirometric testing, blood pressure (BP) screening and a health history questionnaire are offered. A limited assessment of cardiovascular health risk factors, including hypertension and obesity, can be made using information gathered during these evaluations.

Hypertension is an important risk factor for cardiovascular disease and affects almost one-third of the US adult population.¹ Cardiovascular disease is the leading cause of death in the United States with one of every three deaths caused by heart disease or stroke.^{2,3} As the leading cause of preventable death in people aged 40–65 years, or before retirement age, cardiovascular disease can be caused or exacerbated by occupational exposures.^{3,4} Mining-related risk factors for cardiovascular disease include particulate matter,⁵ carbon monoxide,⁶ noise,⁷ vibration,⁸ temperature extremes,⁹ and shift work.¹⁰ These occupational-related factors combined with personal risk factors can put miners at greater risk of poor cardiovascular health. One US-based study found that during 1997–2007, compared with other industrial sectors, workers in the mining sector had the highest rates of diagnosed hypertension.¹¹ However, this estimate might not reflect the burden of disease among coal workers specifically. Most studies evaluating hypertension in coal miners have occurred outside of the United States.^{12–14}

Using BP readings and body mass index (BMI) collected during ECWHSP encounters, we describe the prevalence of BP in the hypertensive range and obesity among coal miners participating in the ECWSHP. Early detection of these cardiovascular risk factors, with appropriate referral and follow-up, can lead to interventions to prevent stroke, heart attack, and other cardiovascular events.

Methods

In 2015, 1402 ECWHSP health examinations were performed in West Virginia, North Dakota, Montana, Wyoming, Colorado, Utah, Ohio, Virginia, and Kentucky. Health evaluations included occupational history and a selected health history to rule out contraindications for spirometry. Miners were asked if they have had any surgeries in the past 90 days, if they have ever had a stroke, if they have ever been told by a doctor that they had an aneurysm, if they are troubled by shortness of breath when hurrying on level ground or walking up a slight hill, and if they have to walk slower than people of their own age on level ground because of shortness of breath. BP was measured once for each miner using an automated sphygmomanometer (General Electric Carescape V100 Vital Signs Monitor). BP was taken with the participant seated and after they had rested, usually while completing

their occupational and health history. If BP readings appeared unusually high or low, the measurement was repeated to assure consistency and to rule out contraindications for spirometry. Only one BP measurement per participant was recorded. Height and weight were measured with footwear and any tools, safety gear, or other equipment removed. Automated sphygmomanometers and scales were maintained according to the manufacturer's instructions.

Definitions

BMI (kilogram per square meter) was classified using the current Centers for Disease Control and Prevention (CDC) standard definition: underweight was defined as a BMI <18.5 kg/m², normal weight 18.5–24.9, overweight 25.0–29.9, and obese ≥30.0 or higher.¹⁵ Categories of BP were defined using the American Heart Association's recommendations for healthy BP¹⁶:

- Normal blood pressure = systolic measure <120 mm Hg AND diastolic measure <80 mm Hg
- Prehypertension = systolic measure 120–139 mm Hg OR diastolic measure 80–89 mm Hg
- Hypertension = systolic measure ≥140 mm Hg OR diastolic measure ≥90 mm Hg
- Hypertensive crisis = systolic measure ≥180 mm Hg OR diastolic measure ≥110 mm Hg

Statistical Analysis

Data were analyzed using SAS V.9.3 and V.9.4 (SAS Institute, Cary, NC, USA). Statistically significant differences were assessed using chi-square tests or Fisher's exact test when cell sizes were <5. We considered two-sided $P < .05$ to be statistically significant.

We compared the observed prevalence of blood pressures consistent with prehypertension, hypertension, hypertensive crisis, and measures of overweight/obesity among participants to expected values for the US adult population obtained from the National Health and Nutrition Examination Survey (NHANES) from the 2007 to 2012 continuous datasets. NHANES is a set of surveys using interviews and physical examinations to assess the health and nutrition of the US population.¹⁷ To be consistent with how blood pressure was measured among most ECWHSP participants, hypertension for NHANES participants was determined from the first blood pressure measured during the NHANES medical examination. We calculated standardized morbidity ratios (SMRs) using indirect standardization for race/ethnicity (non-Hispanic White, non-Hispanic Black, or Hispanic), sex, age (20–39, 40–59, or ≥60 years), and cigarette smoking status (ever vs. never smoker).^{18,19}

Results

A majority of the 1402 participants were male (94%), White (93%), and non-Hispanic (94%; Table 1). The median age was 54 years with a range of 15–88 years. Forty-six percent of participants had a blood pressure reading consistent with prehypertension and 31% had a

reading consistent with hypertension. The prevalence of blood pressures consistent with prehypertension was higher among males compared with females (48% vs. 35%, $P = .0244$); there was not a significant statistical difference in the prevalence of blood pressures consistent with hypertension by sex. Blood pressures in the hypertensive range were more prevalent among non-Hispanic miners than Hispanic miners (33% vs. 22%, $P = .0478$). Among the 440 individuals with blood pressure in the hypertensive range, 24 (5%) had a blood pressure reading consistent with a hypertensive crisis. This represented 2% (24/1402) of all ECWHSP participants. Eighty-seven percent of ECWHSP coal miners were found to be either overweight or obese, with 52% (725/1402) being obese and 35% (490/1402) being overweight. A statistically significant difference was found as males were more likely to be overweight or obese than females (88% vs. 80%, $P = .0299$).

Twenty-nine percent of participants reported having shortness of breath when hurrying on level ground. When compared with miners who did not have shortness of breath when hurrying on level ground, these individuals had a higher prevalence of blood pressures consistent with hypertension (43% vs. 28%, $P < .0001$) and were more likely to be overweight or obese (91% vs. 86%, $P = .0042$).

The prevalence of blood pressures in the hypertensive range among ECWHSP coal miners was 60% higher than what would be expected for the US adult population (SMR = 1.60, 95% confidence interval [CI] = 1.45–1.76). Blood pressures consistent with prehypertension were higher than what would be expected for the US adult population, but not statistically significant (SMR = 1.06, 95% CI = 0.98–1.15). The combination of blood pressures in the prehypertensive and hypertensive ranges was 23% higher than what would be expected (SMR = 1.23, 95% CI = 1.16–1.31). The prevalence of blood pressures consistent with hypertensive crisis among ECWHSP coal miners was 60% higher than what would be expected for the US adult population (SMR = 1.60, 95% CI = 1.06–2.40). Obesity (SMR = 1.52, 95% CI = 1.41–1.64) and overweight/obesity (SMR = 1.17, 95% CI = 1.11–1.24) were also more prevalent than what would be expected for the US adult population.

Discussion

Studies of coal miners' health have traditionally focused on respiratory disease. We found that the prevalence of blood pressures in the hypertensive range and obesity among ECWHSP coal miners was higher than what would be expected for the US adult population. Nearly eight of every 10 coal miners evaluated by the ECWHSP had blood pressure readings indicating either prehypertension or hypertension and nearly nine of 10 were overweight or obese.

Few studies have focused specifically on cardiovascular risk factors in US coal miners. However, a review of 374 miners undergoing evaluation for CWP from 1989 to 1992 found that 17.4% had hypertension, and among these individuals, 38% had no previous history of this condition.²⁰ Routine evaluations for respiratory impairment among coal miners could be an opportunity to provide health education and intervention for cardiovascular risks. Public health workers and technicians performing respiratory evaluations can discuss cardiovascular risk factors, send a letter summarizing cardiovascular findings to the miner's

home, provide copies of findings to the miner's personal physician, and, in urgent cases, provide referrals for follow-up and evaluation.²⁰

This study has a number of limitations. The primary limitation is that the data were collected for the purposes of determining fitness for spirometry testing, not for cardiovascular assessment. For this reason, blood pressure was only assessed at one point in time for most miners, which may not be an accurate representation of their resting blood pressure. Although the measurement was repeated if it was abnormally high or low, these repeated measurements were not performed on all participants. In addition, a clinical diagnosis of hypertension requires measurement on more than one occasion. However, we used an epidemiologic definition similar to NHANES which assesses hypertension on one occasion.²¹ The procedures for assessing blood pressure, such as having the participant rest and be seated are similar in NHANES and ECWHSP. The use of one blood pressure measurement has been found to overestimate the prevalence of high blood pressure.²² To account for this, we compared the one blood pressure reading taken from ECWHSP to the first blood pressure reading taken from NHANES. Thus, the potential for overestimation exists for both the study and the comparison groups. Finally, answers to health questions were self-reported and may be subject to recall or reporting bias.

The prevalence of obesity and blood pressures consistent with hypertension in this population of coal miners is substantial, indicating a need for cardiovascular health interventions in coal mining communities. Existing mobile occupational health surveillance programs such as the ECWHSP could offer opportunities to identify coal miners at risk for poor cardiovascular health outcomes and refer them to intervention and treatment.

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Table 1
Demographic and health characteristics among coal miners evaluated by ECWHSP in 2015 (N = 1402)

Characteristic	All Participants		Participants With Pre-HTN		Participants With HTN		Overweight or Obese Participants	
	Frequency	Pre-HTN Prevalence*	Frequency	HTN Prevalence*	Frequency	HTN Prevalence*	Frequency	Overweight or Obese Prevalence*
Total	1402	46%	648	31%	440	31%	1215	87%
Age group (y)								
15-44	480	55%	259	15%	71	15%	388	82%
45-64	664	47%	306	36%	234	36%	596	90%
65+	258	33%	83	54%	135	54%	231	91%
Sex								
Male	1317	48%	619	32%	413	32%	1147	88%
Female	85	35%	29	33%	27	33%	68	80%
Race								
White	1303	47%	605	32%	407	32%	1127	87%
Black	17	41%	7	35%	6	35%	15	88%
American Indian/Alaska Native	55	45%	25	36%	20	36%	51	93%
Other [†]	16	47%	7	27%	4	27%	13	81%
Ethnicity								
Non-Hispanic	1316	47%	609	33%	422	33%	1141	88%
Hispanic	86	48%	39	22%	18	22%	74	87%
Surgeries in past 90 d								
Yes	41	39%	16	37%	15	37%	35	90%
No	1360	48%	632	32%	425	32%	1179	87%
Ever had a stroke								
Yes	31	39%	12	45%	14	45%	30	97%
No	1366	48%	633	32%	425	32%	1180	87%
Doctor diagnosis of aneurysm								
Yes	24	50%	12	25%	6	25%	20	87%
No	1378	47%	636	32%	434	32%	1195	88%
Shortness of breath when hurrying on level ground								

Characteristic	All Participants		Participants With Pre-HTN		Participants With HTN		Overweight or Obese Participants	
	Frequency	Prevalence*	Frequency	Pre-HTN Prevalence*	Frequency	HTN Prevalence*	Frequency	Overweight or Obese Prevalence*
Yes	413	45%	180	45%	172	43%	374	91%
No	985	49%	467	49%	267	28%	838	86%
Walk slower than people own age [‡]								
Yes	235	41%	94	41%	109	47%	213	92%
No	1158	49%	551	49%	329	29%	994	87%

ECWHSP, Enhanced Coal Workers' Health Surveillance Program; HTN, hypertension.

Numbers in bold represent significant differences ($P < .05$) by chi-square test.

* Prevalence is calculated among those who had a blood pressure measurement or height and weight assessment.

[‡] Other includes individuals who indicated more than one race category.

[‡] This question was only asked among miners with an affirmative answer to "Are you troubled by shortness of breath when hurrying on level ground or walking up a slight hill?" Individuals with a negative answer to "Are you troubled by shortness of breath when hurrying on level ground or walking up a slight hill?" were categorized as "No" to whether they walk slower than people their own age.