Prevalence of the Metabolic Syndrome Among U.S. Workers

Evelyn P. Davila, phd, mph[1]
Hermes Florez, md, phd, mph[2]
Lora E. Fleming, md, phd[1]
David J. Lee, phd[1]
Elizabeth Goodman, md[3]
William G. LeBlanc, phd[1]
Alberto J. Caban-Martinez, mph[1]
Kristopher L. Arheart, edd[1]
Kathryn E. McCollister, phd[1]
Sharon L. Christ, phd, ms, ma[4]
John C. Clark III, phd[1]
Tainya Clarke, ms, mph[1]

OBJECTIVE — Differences in the prevalence of cardiovascular disease (CVD) and its risk factors among occupational groups have been found in several studies. Certain types of workers (such as shift workers) may have a greater risk for metabolic syndrome, a precursor of CVD. The objective of this study was to assess the differences in prevalence and risk of metabolic syndrome among occupational groups using nationally representative data of U.S. workers.

RESEARCH DESIGN AND METHODS — Data from 8,457 employed participants (representing 131 million U.S. adults) of the 1999–2004 National Health and Nutrition Examination Survey were used. Unadjusted and age-adjusted prevalence and simple and multiple logistic regression analyses were conducted, adjusting for several potential confounders (BMI, alcohol drinking, smoking, physical activity, and sociodemographic characteristics) and survey design.

RESULTS — Of the workers, 20% met the criteria for the metabolic syndrome, with "miscellaneous food preparation and food service workers" and "farm operators, managers, and supervisors" having the greatest age-adjusted prevalence (29.6–31.1%) and "writers, artists, entertainers, and athletes," and "engineers, architects, scientists" the lowest (8.5–9.2%). In logistic regression analyses "transportation/material moving" workers had significantly greater odds of meeting the criteria for metabolic syndrome relative to "executive, administrative, managerial" professionals (odds ratio 1.70 [95% CI 1.49–2.52]).

CONCLUSIONS — There is variability in the prevalence of metabolic syndrome by occupational status, with "transportation/material moving" workers at greatest risk for metabolic syndrome. Workplace health promotion programs addressing risk factors for metabolic syndrome that target workers in occupations with the greatest odds may be an efficient way to reach at-risk populations.

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According to the Centers for Disease Control and Prevention, approximately one-third of Americans met the criteria for metabolic syndrome from 2003 to 2006 (1). Metabolic syndrome is a condition defined by the clustering of risk factors associated with obesity that raise the risk of cardiovascular disease and type 2 diabetes (2). Specifically, these risk factors are a large waist circumference (i.e., central adiposity), high level of triglycerides, low level of HDL cholesterol, high blood pressure, and high fasting blood glucose levels (2).

Research suggests that there may be differences in the prevalence of metabolic syndrome by occupation type. For example, studies have shown a high prevalence of metabolic risk factors among shift workers (3). Differences in the prevalence of metabolic syndrome among occupational groups have also been observed among workers in Spain (4). We have found a high prevalence of obesity among certain occupations such as "farming, forestry, fishing" and "transportation/material moving" occupations in the U.S. (5). However, the prevalence of the metabolic syndrome by occupation in the U.S. population is unknown. To address this gap, in the current study we examined the prevalence of the metabolic syndrome in 40 major U.S. occupational groups using nationally representative data.

RESEARCH DESIGN AND METHODS

— Data from the 1999–2004 National Health and Nutrition Examination Survey (NHANES), a multistage stratified complex design survey of a representative sample of the entire U.S. civilian population conducted by the National Center for Health Statistics (NCHS), was analyzed. In brief, trained interviewers and laboratory technicians conducted in-person interviews, performed physical examinations, and collected urine and blood samples either at mobile examination centers or at home (6). The response rates for participants interviewed in the NHANES surveys ranged from 79 to 84%, whereas the response rates for the participants examined ranged from 76 to 80% (6). Individuals who reported being employed and who had occupational group data, were ≥20 years, and were not pregnant were included in the analyses (n = 8,498).

Main variables

The presence of the metabolic syndrome was based on the modified version of the definition recommended in 2001 by the Third Report of the National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (7,8). Metabolic syndrome was a dichotomous variable defined to be present or not based on having at least three of the following five criteria: *1*) blood pressure ≥130/85 mmHg or receiving treatment for hypertension, *2*) HDL cholesterol <50 mg/dl if a woman and <40 mg/dl if a man, *3*) triglyceride level of ≥150 mg/

From the [1]Department of Epidemiology and Public Health, University of Miami, Miller School of Medicine, Miami, Florida; the [2]Geriatric Research Education and Clinical Centers, Miami Veterans Affairs Healthcare System, Miami, Florida; the [3]Center for Child and Adolescent Health Policy Mass General Hospital for Children, Boston, Massachusetts; and the [4]Center for Developmental Science, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina.
Corresponding author: Evelyn P. Davila, edavila1@med.miami.edu.
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dl, 4) waist circumference of >102 cm if a man or >88 cm if a woman, and 5) self-reported diabetes (9).

Employment status was based on the question "Did you work last week?" Occupational classifications were based on the 40 NCHS occupational codes (10) that appear in the NHANES data file. These variables were collapsed into 13 NCHS occupational groups. The collapsing of the 40 occupational groups into 13 occupational groups is the method used in all NCHS surveys, including the National Health Interview Survey with the occupational groups originally based on the more detailed U.S. Census Standard Occupation Classification System occupational groups (10,11). Table 2 shows where each of the 40 occupational groups falls within the 13 broader occupational groups.

Statistical analyses

Analyses were completed using SUDAAN (version 8.0) to take into account sample weights and design effects (12). The unadjusted and age-adjusted prevalence estimates for meeting the criteria for the metabolic syndrome were determined among workers aged ≥20 years. For unadjusted and age-adjusted prevalence estimates, all 40 occupational groups available in the NHANES data file were used. However, given the small sample size of workers in certain occupational groups, only 13 occupational groups were used for the logistic regression analyses. Occupation-specific prevalence estimates of metabolic syndrome were considered significantly "higher" than the "overall" sample prevalence rate if the occupation-specific prevalence was above the upper bound of the 95% CI for the overall sample. This is a variation on the method of testing a one-sample difference in proportions considering the overall sample as the population proportion (13).

Simple and multiple logistic regression analyses were then conducted with meeting criteria for the metabolic syndrome as the dependent variable (yes vs. no). Multiple logistic regression analyses adjusted for sex (male vs. female), age (in years), race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and other), education (less than high school, high school education or equivalent, and greater than high school), health insurance (none vs. insured), BMI (underweight/normal, overweight, and obese), smoking status (nonsmoker, former smoker, and current smoker), alcohol drinking status (abstainer vs. drinker), and physical activity (none, moderate, and vigorous). An α level of 0.05 was used to determine statistical significance. This study was approved by the University of Miami Human Subjects Committee.

Table 1—*Sample characteristics of U.S. workers by presence of the metabolic syndrome, NHANES, 1999–2004*

Demographics	Sample*	Total estimated U.S. workers	Metabolic syndrome prevalence (95% CI)
Sex			
Male	4,523 (53.5)	71,430,841	20.2 (18.1–22.3)
Female	3,934 (46.5)	60,275,573	21.4 (19.5–23.5)
Age-group			
20–44 years	5,485 (64.9)	82,268,270	14.0 (12.7–15.5)
45–64 years	2,507 (29.6)	44,652,675	25.5 (23.3–27.8)
≥65 years	465 (5.5)	4,536,988	32.1 (26.2–38.6)
Race/ethnicity			
Non-Hispanic white	3,990 (47.2)	94,142,211	21.0 (19.0–23.1)
Non-Hispanic black	1,728 (20.5)	13,875,980	17.7 (15.0–20.7)
Hispanic	2,476 (29.2)	18,066,872	21.9 (17.9–26.6)
Other	263 (3.1)	5,373,350	12.9 (9.3–17.7)
Education			
<High school	2,179 (25.8)	20,451,484	23.0 (19.8–26.5)
High school	2,123 (25.1)	33,287,060	23.8 (20.7–27.1)
>High school	4,150 (49.1)	77,659,837	18.4 (16.4–20.6)
Health insurance			
None	2,004 (25.3)	23,937,496	17.8 (15.3–20.5)
Insured	6,322 (74.7)	105,707,056	20.2 (18.4–22.2)
Alcohol consumer			
Abstainer	1,818 (26.1)	27,122,688	24.1 (21.7–26.7)
Drinker	5,137 (73.9)	91,101,707	19.4 (17.5–21.5)
Smoking status			
Nonsmoker	2,191 (27.3)	38,109,927	20.6 (17.7–23.8)
Former smoker	4,163 (51.8)	62,277,607	20.9 (18.9–23.0)
Current smoker	1,686 (20.9)	25,929,516	18.2 (15.8–20.9)
Physical activity level			
None	3,087 (36.5)	40,822,293	24.4 (22.0–27.1)
Moderate	2,156 (25.5)	36,429,138	23.3 (21.0–25.8)
Vigorous	3,214 (38.0)	54,166,982	13.8 (11.7–16.4)
BMI category			
Underweight	157 (1.9)	2,379,708	2.2 (0.3–13.5)
Normal	2,717 (33.0)	42,612,147	4.6 (3.3–6.5)
Overweight	2,884 (35.0)	45,068,224	15.8 (13.8–18.0)
Obese	2,481 (30.1)	38,248,387	42.5 (39.5–45.6)

Data are *n* (%) or *n* unless otherwise indicated. $n = 8{,}498$. *Sample varies due to item non-response.

RESULTS — The prevalence of metabolic syndrome stratified by worker sample characteristics is shown in Table 1 ($n = 8{,}457$); the subgroup with the highest prevalence of metabolic syndrome was obese workers (42.5%), followed by workers aged ≥65 years (32.1%). Unadjusted and age-adjusted prevalence estimates for each of the 40 occupational groups are presented in Table 2.

The overall unadjusted prevalence estimate for all workers was 18.7% (95% CI [17.4–20.0%]), whereas the age-adjusted estimate was 20.6% [18.9–22.3%]. Occupations with the highest unadjusted prevalence for meeting criteria for the metabolic syndrome (all significantly higher than the prevalence for the overall sample) were "other transportation and material occupations" (33.1% [23.1–45.0%]), followed by "farm operators, managers, and supervisors" (27.4% [15.7–43.3%]), and "motor vehicle operators" (26.4% [21.2–32.2%]). The lowest unadjusted prevalence for meeting criteria for the metabolic syndrome was found among "writers, artists, entertainers, and athletes" (6.9% [3.6–12.8%]), followed

Table 2—*Unadjusted and age-adjusted prevalence of metabolic syndrome by 40 occupational groups: NHANES, 1999–2004*

Detailed 40 of 13 occupational groups	Sample *n*	Total estimated U.S. workers	Prevalence (95% CI)	
			Unadjusted metabolic syndrome	Age-adjusted metabolic syndrome
Overall	8,498	132,126,344	18.7 (17.4–20.0)	20.6 (18.9–22.3)
Executive, administrative, managerial				
Executive, administrators and managers	624	12,452,093	19.0 (15.5–23.0)	20.2 (15.8–25.4)
Management-related occupations	236	4,545,506	16.4 (10.8–24.1)	18.9 (12.6–27.4)
Professional specialty				
Engineers, architects, scientists	239	5,099,103	11.6 (7.6–17.1)	9.2 (6.2–13.6)
Health diagnosing, assessing, and treating	200	4,245,052	13.1 (9.0–18.6)	11.8 (7.2–18.7)
Teachers	322	5,499,319	17.6 (13.0–23.4)	16.2 (11.7–22.1)
Writers, artists, entertainers, and athletes	147	2,756,259	6.9 (3.6–12.8)	8.5 (4.5–15.4)
Other professional specialty occupations	226	4,230,656	19.9 (13.6–27.6)	19.0 (13.5–26.0)
Technicians/relative support				
Technicians and related support occupations	235	4,328,669	17.3 (12.0–24.3)	21.9 (15.1–30.6)
Sales				
Supervisors and proprietors, sales occupations	183	3,475,855	19.0 (13.0–27.0)	21.2 (14.2–30.3)
Sales representatives, finance, business, commodities	213	4,417,352	19.0 (14.1–25.0)	20.2 (14.4–27.5)
Sales workers, retail and personal services	515	6,254,494	19.1(14.9–24.1)	21.4 (16.5–27.2)
Administrative support, including clerical				
Secretaries, stenographers, and typists	123	2,077,302	**24.7 (16.6–35.1)**	**25.2 (17.0–35.7)**
Information clerks	141	2,260,229	**20.8 (13.2–31.3)**	**25.5 (15.8–38.5)**
Records processing occupations	229	3,877,767	19.2 (14.3–25.1)	**22.6 (15.5–31.7)**
Material recoding, scheduling, and distribution clerks	149	2,172,409	**22.0 (14.2–32.3)**	17.9 (11.5–26.9)
Miscellaneous occupations administrative support	538	8,437,284	**20.8 (16.3–26.2)**	21.8 (16.4–28.4)
Private household				
Private service occupations	95	1,173,516	16.3 (9.3–26.9)	18.0 (9.1–32.5)
Protective service				
Protective service occupations	146	2,174,960	**23.6 (16.3–33.1)**	**26.1 (17.8–36.5)**
Service except protective and household				
Waiters and waitresses	145	2,118,954	7.6 (3.3–16.5)	13.1 (6.1–26.0)
Cooks	218	2,343,133	**22.5 (13.8–34.4)**	**26.0 (17.2–37.2)**
Miscellaneous food preparation and service occupations	191	2,199,576	**25.2 (16.4–36.5)**	**31.1 (19.6–45.4)**
Health service occupations	263	3,139,282	19.6 (13.9–26.9)	**26.6 (19.4–35.3)**
Cleaning and building service occupations	300	3,407,610	**21.7 (16.1–28.5)**	**25.3 (18.7–33.2)**
Personal service occupations	195	2,654,868	15.7 (9.8–24.3)	17.6 (11.0–27.0)
Farming, forestry, fishing				
Farm operators, managers, and supervisors	44	751,233	**27.4 (15.7–43.3)**	**29.8 (13.8–52.9)**
Farm and nursery workers	113	972,004	18.7 (11.4–29.1)	**22.4 (13.2–35.3)**
Related agricultural, forestry, and fishing occupations	164	173,386	16.0 (9.9–24.9)	19.4 (11.5–30.8)
Precision, production, craft, repair				
Vehicle and equipment mechanics and mobile repairers	110	1,693,265	**20.5 (11.1–34.8)**	17.7 (11.0–27.3)
Other mechanics and repairers	166	2,978,631	**23.0 (16.3–31.1)**	21.3 (14.8–29.7)
Construction trades	470	7,303,001	11.9 (8.4–16.6)	14.8 (8.22–25.2)
Extractive and precision production occupations	232	3,705,680	**21.3 (15.2–29.0)**	**23.7 (17.1–32.0)**
Textile, apparel, and furnishings machine operators	79	879,662	**23.0 (13.3–36.7)**	**24.2 (14.5–37.4)**
Machine operators, assemblers				
Machine operators, assorted materials	212	2,858,367	**22.7 (16.4–30.7)**	19.2 (13.6–26.3)
Fabricators, assemblers, inspectors, and samplers	191	2,864,668	**20.3 (14.7–27.4)**	21.3 (14.5–31.9)
Transportation/material moving				
Motor vehicle operators	310	4,548,701	**26.4 (21.2–32.2)**	**25.6 (20.4–31.6)**
Other transportation and material occupations	96	1,569,250	**33.1 (23.1–45.0)**	**25.6 (18.4–34.6)**
Handlers, equipment, cleaners, helpers, laborers				
Construction laborers	112	1,172,573	**20.0 (13.4–28.5)**	**24.2 (17.0–33.1)**
Laborers, except construction	43	584,216	14.5 (4.6–37.5)	16.4 (5.6–39.1)
Freight, stock, and material movers	154	1,886,241	16.7 (9.5–27.9)	17.4 (9.7–29.1)
Other helpers, equipment cleaners, hand packagers, and laborers	129	1,284,122	12.7 (7.4–21.1)	14.9 (8.1–26.0)

Data are *n* unless otherwise indicated. Prevalence estimates were considered significantly "higher" than the total sample prevalence estimate if the prevalence for that occupation was above the upper bound of the 95% CI for the total sample; these appear in bold (13).

by "waiters and waitresses" (7.6% [3.3–16.5%]) and "construction trades" workers (11.9% [8.4–16.6%]).

There was not much difference in the prevalence of meeting criteria for the metabolic syndrome after adjustment for age. However, the order or ranking of occupations with the highest prevalence did differ to some degree. For example, "other transportation and material occupations" and "motor vehicle operators," the two occupations falling within the group of "transportation/material moving" were no longer the occupational groups with the highest prevalence for meeting criteria for the metabolic syndrome. After adjustment for age, occupations with the highest prevalence of the metabolic syndrome (all significantly higher than the prevalence for the overall sample) now included "miscellaneous food preparation and service occupations" (31.1% [95% CI 19.6–45.4%]), followed by "farm operators, managers, and supervisors" (29.8% [13.8–52.9%]), and "health service occupations" (26.6% [19.4–35.3%]). The lowest age-adjusted prevalence of the metabolic syndrome was documented in "writers, artists, entertainers, and athletes" (8.5% [4.5–15.4%]), "engineers, architects, scientists" (9.2% [6.2–13.6%]), and "health diagnosing, assessing, and treating" workers (11.8% [7.2–18.7%]).

The logistic regression analyses adjusting for demographics and potential confounders showed that "transportation/material moving" workers relative to "executive, administrative, managerial" professionals were significantly more likely to meet the criteria for the metabolic syndrome (odds ratio 1.70 [95% CI 1.15–2.52]) (Table 3). Among all U.S. workers, other participant characteristics with significantly greater odds of meeting criteria for the metabolic syndrome included older age (1.03 [1.03–1.04]) and being overweight (5.63 [3.80–8.35]) or obese (25.94 [18.08–37.23]) relative to underweight or normal weight. Lower odds for metabolic syndrome included being non-Hispanic black (0.48 [0.36–0.65]) relative to non-Hispanic white, alcohol consumer relative to non–alcohol consumer (0.78 [0.64–0.97]), being a former smoker relative to a never smoker (0.81 [0.67–0.97], and doing vigorous physical activity relative to no physical activity (0.63 [0.53–0.75]).

Table 3—*Multiple logistic regression to assess the relationship between occupation and criteria for the metabolic syndrome among adults aged ≥20 years: NHANES 1999–2004*

	Odds ratio (95% CI)*
Age (years)	**1.03 (1.03–1.04)**
Sex	
Female	1.00
Male	1.10 (0.88–1.37)
Race/ethnicity	
Non-Hispanic white	1.00
Non-Hispanic black	**0.49 (0.37–0.65)**
Hispanic	0.95 (0.71–1.25)
Other	0.94 (0.57–1.55)
Education	
<High school	1.00
High school	0.99 (0.68–1.44)
>High school	0.93 (0.68–1.28)
Health insurance	
None	1.00
Insured	0.78 (0.63–1.02)
Alcohol consumer	
Abstainer	1.00
Drinker	**0.79 (0.63–0.97)**
BMI category	1.07 (1.05–1.09)
Underweight/normal	1.00
Overweight	**5.63 (3.80–8.35)**
Obese	**25.94 (18.08–37.23)**
Smoking status	
Nonsmoker	1.00
Former smoker	**0.81 (0.67–0.97)**
Current smoker	0.78 (0.58–1.04)
Physical activity level	
None	1.00
Moderate	0.93 (0.77–1.13)
Vigorous	**0.63 (0.53–0.75)**
Occupational group (13 groups)	
Executive, administrative managerial	1.00
Professional specialty	0.89 (0.66–1.23)
Technicians/relative support	0.96 (0.52–1.79)
Sales	1.08 (0.69–1.67)
Administrative support, including clerical	1.26 (0.90–1.78)
Private household	0.63 (0.27–1.44)
Protective service	1.23 (0.67–2.28)
Service except protective and household	1.08 (0.71–1.65)
Farming, forestry, fishing	0.95 (0.63–1.44)
Precision, production, craft, repair	0.97 (0.66–1.41)
Machine operators, assemblers	1.15 (0.73–1.81)
Transportation/material moving	**1.70 (1.15–2.52)**
Handlers, equipment, cleaners, helpers, laborers	1.07 (0.63–1.83)

*Statistically significant estimates at the 0.05 α level appear in bold.

CONCLUSIONS — This is the first nationally representative study of U.S. workers to estimate the prevalence of metabolic syndrome in various occupational groups. In both unadjusted and age-adjusted analyses, we found a threefold difference in the prevalence of metabolic syndrome across occupational groups, with the greatest unadjusted prevalence among "other transportation and material occupations" and age-adjusted prevalence among "food preparation and food service workers."

Differences in the prevalence of metabolic syndrome by occupation are likely to be strongly influenced by differences in the prevalence of obesity (14). Interestingly, even after adjustment for potential confounders including obesity, older age, sex, race/ethnicity, education, physical activity, alcohol consumption, and smoking, "transportation and material moving workers" showed statistically significant

greater odds for meeting the criteria for metabolic syndrome compared with other workers. This finding is consistent with several studies that have found transportation workers (such as truck drivers) to have a higher prevalence and incidence of cardiovascular disease, including heart disease and stroke (15,16). A potential explanation for the relationship between transportation work and meeting the criteria for the metabolic syndrome could be more irregular work schedules and shift work, sleep problems, and job stress, as these factors have been associated with metabolic syndrome (3–5,17,18); of note, each of these occupational factors is more prevalent among transportation workers relative to other occupational groups (16,19,20). Additional research is needed to understand the relative role that these occupational risk factors play in influencing metabolic syndrome prevalence rates across occupational groups, as well as occupation exposures, which may be unique among "transportation/material moving" workers.

The present study had several limitations, such as its cross-sectional design, which did not allow for causal inferences. Another limitation was the lack of fasting glucose values for determination of metabolic syndrome status among all NHANES study participants, which could have led to an underestimate of the prevalence of metabolic syndrome in this study. However, sensitivity analyses were performed in the subsample (one-third of the total NHANES sample) that did have the fasting blood glucose data needed for defining metabolic syndrome (i.e., with having a metabolic risk factor of having self-reported diabetes or a fasting blood glucose measurement of ≥100 mg/dl). Although not statistically significant, the results were similar in terms of direction of the estimates with use of the previous definition (i.e., self-report of diabetes only). Details about working conditions or work characteristics were not available in NHANES. Thus, we were unable to examine correlates of work schedule, sleep patterns and problems, and occupational stress on metabolic syndrome prevalence rates. Furthermore, data on type of occupation was only available in the continuous NHANES from 1999 to 2004, thereby limiting the sample size that would have been beneficial in looking at more specific occupational groups (i.e., 40 categories). Finally, given differences in survey design, it is not appropriate to merge NHANES III (1988–1994) data with data from the continuous NHANES (i.e., 1999 and forward).

In conclusion, our findings have implications for policy makers and employers. Given that studies have shown greater reports of missed work (21,22) and presenteeism (23) among U.S. individuals with the metabolic syndrome compared with individuals without metabolic syndrome independent of obesity, it would seem beneficial for occupational health advocates and employers to be aware of the prevalence of metabolic syndrome among their employees and the associated consequences. To offset such work implications, employers and occupational health advocates should introduce metabolic syndrome awareness, management, and preventive programs at the workplace, particularly in occupational groups in which the overall prevalence of metabolic syndrome is high. Thus, according to our findings, metabolic syndrome-related interventions appear to be most needed for "transportation and material moving" workers as well as for "farm operators, managers, and supervisors" and "miscellaneous food preparation and service occupations." Given the greater odds of metabolic syndrome among "transportation/material moving" workers even after adjustment for potential confounders, future occupational health research should examine factors that may explain the higher likelihood of metabolic syndrome in this occupational group. Finally, the high prevalence of the metabolic syndrome among older workers (24), combined with the growing numbers of older adults in the U.S. workforce (25), may lead to an increasing number of workers with metabolic syndrome and co-occurring cardiovascular consequences unless effective prevention programs, particularly those implemented in worksites for higher prevalence occupations, are rapidly developed and implemented.

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