Nutrient Intake and Adherence to Dietary Recommendations Among US Workers

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Objective: To assess nutrient intake according to dietary guidelines among US worker groups. **Methods:** Participants of 1999 to 2004 National Health and Nutrition Examination Survey completed two 24-hour recall dietary interviews to assess daily intake of protein, carbohydrate, fat, cholesterol, calcium, sodium, and fiber. Employed participants ($n = 8987$) were classified as (1) white collar, (2) service worker, (3) farmer, and (4) blue collar. **Results:** Nutrient intake varied by occupational group, particularly for fiber, sodium, calories, and percentage of calories from protein, saturated fat, and carbohydrate. Adherence to recommendations was noted for saturated fat and cholesterol, but workers were poorly adherent to recommendations for all other nutrients, particularly fiber. **Conclusions:** Workers display differences in nutrient intake across occupational groups with poor eating behaviors evident across all groups. Fiber is particularly poorly consumed, with less than 5% of all US workers meeting the recommendations.

Poor nutrition is a factor in the development of such major chronic conditions as obesity, type 2 diabetes, cardiovascular disease, hypertension, stroke, osteoporosis, some cancers, and many others.[1–4] Dietary guidelines have been developed by a number of organizations with an interest in promoting adequate nutrient intake. These include the Institute of Medicine,[5] the US Departments of Agriculture and Health and Human Services,[6] and jointly by the American College of Sports Medicine and the American Dietetic Association,[7] among others. Adherence to dietary guidelines in the US population remains low,[8,9] but it has been shown to be associated with a lower incidence of such chronic conditions as cancer and cardiovascular disease[10–12] as well as reduced all-cause mortality.[13]

The distribution of some chronic conditions varies across occupations. This variation has been clearly shown for cardiovascular disease, hypertension, and metabolic syndrome, for which higher rates were observed in blue-collar workers than in white-collar workers.[14–17] Several studies of the National Health and Nutrition Examination Survey (NHANES) from 1999 to 2004 have also shown that obesity rates differ across occupational groups.[18–20] Dietary differences across occupations could be an important factor contributing to current trends in chronic disease. The compliance to dietary guidelines varies across occupations among Australian and French adults with inferior occupations having lower rates of compliance[21–23]; however, no similar studies have been conducted in the US. Therefore, we (1) examined the levels of macro- and micronutrient intake among workers in four occupational groups and (2) described the level of adherence to dietary recommendations in those nutrients using a nationally representative sample of the US population. We hypothesized that differences in nutrient intake and adherence to guidelines existed across occupations and that lower social status occupations (ie, blue-collar workers, farmers, service workers) would have lower levels of adherence than white-collar workers.

SUBJECTS AND METHODS

Sample

As a part of the ongoing stratified multistage probability sample of the US civilian noninstitutionalized population, the 1999 to 2004 NHANES asked participants to provide two 24-hour dietary recalls by interviews conducted on nonconsecutive days. Household interviews were conducted on persons aged 17 years or older to determine responses to dietary behavior questions. A total of 8987 respondents were used for analysis in this study, representing approximately 134 million people. See Table 1 for the demographic characteristics of the sample. The NHANES sampling design and data collection procedure are described in detail on the Centers for Disease Control and Prevention Web site.[24,25] This study was approved by the University of Miami institutional review board for human subjects.

Occupational Groups

The NHANES collects employment information, which is coded by occupation and industry into 40 categories, not including military service. Because of limited sample sizes in some of the categories, we collapsed the occupational groups into four broad sectors as per the National Center for Health Statistics: white-collar, blue-collar, service, and farm workers.[26]

Reported Dietary Intake

Participants were asked to recall their dietary intake for two nonconsecutive 24-hour periods. These data were used to derive total calories and fiber in grams; cholesterol, calcium, and sodium in milligrams; and the percentage of total calories for protein, carbohydrate, total fat, saturated fat, monounsaturated fat, and polyunsaturated fat.[27] To analyze how participants in each occupational group were actually eating compared to national recommendations for protein, carbohydrates, total fat, saturated fat, fiber, cholesterol, calcium, and sodium, the 2-day average for each of these variables was utilized. The 2-day average of total calories was used as the denominator for the macronutrients in these calculations. Grams of protein, carbohydrate, fat, and saturated fat were converted into calories, which were then divided by total calories to get the percent daily intake for each nutrient. We utilized the following ranges for participants to fall within recommended guidelines according to the Institute of Medicine,[5] the US Departments of Agriculture and Health and Human Services,[6] and the American College of Sports Medicine and the American Dietetic Association[7] for each nutrient: (1) protein 10% to 14% of daily calories, (2) carbohydrate 52% to 64% of daily calories, (3) total fat 30% or less of daily calories, (4) saturated fat 10% or less of daily calories, (5) fiber 25 g/d or more, (6) cholesterol 300 mg/d or less, (7) calcium 1000 mg/d or more, and

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TABLE 1. Demographic Characteristics of Employed Adult Participants of the National Health and Nutrition Examination Survey, 1999–2004

Sample Characteristics	NHANES Sample	Estimated Population	Percent of Total	SE
Total	8987	134,047,451	100	
Race/ethnicity				
Non-Hispanic white (1)	4136	95,473,029	71.22	1.57
Non-Hispanic black (2)	1834	13,818,271	10.31	0.92
Hispanic (3)	2663	18,290,900	13.65	1.38
Other (4)	354	6,465,252	4.82	0.45
Education				
Less than high school (1)	2713	23,270,470	17.36	0.61
High school or equivalent (2)	2141	33,558,846	25.04	0.89
Greater than high school (3)	4133	77,218,136	57.61	1.11
Occupation				
White collar	4495	76,577,879	57.13	1.25
Service worker	1760	20,296,780	15.14	0.54
Farmer	348	3,622,144	2.70	0.25
Blue collar	2384	33,550,648	25.03	1.03
Sex				
Male	4819	72,802,630	54.31	0.63
Female	4168	61,244,821	45.69	0.63

NHANES indicates National Health and Nutrition Examination Survey; SE, standard error of percent.

(8) sodium 2000 mg/d or less. Participants were then dichotomized as being either "adherent" or "non-adherent" to the guidelines for each of these nutrients based on their score.

Statistical Analysis

Frequency and descriptive statistics were calculated on all nutrient variables by ethnicity/race, age, gender, body mass index (BMI), and education level for each of the four occupational groups. We used an analysis of covariance with pairwise comparisons to evaluate the mean nutrient values among all four occupational groups. Logistic regression was used to calculate the percent and standard errors for the nutrient variables adjusted for the demographic variables. Analysis of covariance is a standard test used for comparing means of groups in a model with both categorical and continuous explanatory variables, and logistic regression is a common test used to model the relationship between a binary response variable and several explanatory variables.[28] Statistical Analysis System (SAS) 9.2 (SAS Institute, Inc, Cary, NC) was used for data management and all analyses. Statistical Analysis System SURVEY procedures were used to perform weighted analyses that adjusted for the design effects of the complex sampling used for NHANES. The means, standard errors, and comparison *P* values in Table 2 were computed by the ESTIMATE statement in PROC SURVEYREG and adjusted for race/ethnicity, age, gender, BMI, and education. The percentages in Table 3 were computed from the log odds of a logistic regression performed by PROC SURVEYLOGISTIC also adjusted for race/ethnicity, age, gender, BMI, and education. These covariates were included in the analyses because they were previously shown to be associated with nutrient intake,[29–35] and they were significantly correlated with the outcome variables in the sample we used (results not shown). The comparison *P* values in Table 3 are from CONTRAST statements in the SURVEYLOGISTIC procedure. Missing values were excluded from the analysis using list wise deletion. Statistical significance was defined as $P < 0.05$. Because of the multistage sampling design, all analyses were performed with adjustment for sample weights and design effects.

RESULTS

Analysis of Covariance Between Nutrients and Occupational Groups

Table 2 shows the mean and standard error for each macro- and micronutrient by the white-collar, blue-collar, service, and farm worker occupational groups. In addition, the results of the analysis of covariance pairwise analyses show each unique comparison between the occupational groups.

For fiber, white-collar workers consumed more (15.5 g) than service workers (14.5 g) and blue-collar workers (14.1 g). Service workers consumed less sodium (3334 mg) than white-collar workers (3512 mg) and blue-collar workers (3520 mg). Blue-collar workers ate more calories (2330) than white-collar (2244) or service workers (2201). White-collar workers consumed a higher percentage of their calories from saturated fat (7.1%) than did service workers (6.7%) and blue-collar workers (6.6%). Service workers consumed a higher percentage of calories from carbohydrate (51.8%) than did white-collar workers (50.3%) and blue-collar workers (50.6%). White-collar workers consumed a higher percentage of their calories from polyunsaturated fat (12.3%) than did service workers (11.8%). White-collar workers consumed a higher percentage of their calories from total fat (32.6%) than did service workers (31.7%). Blue-collar workers consumed more cholesterol (320 mg) than service workers (294 mg).

Level of Adherence to Dietary Recommendations in Occupational Groups

Table 3 shows the percentage (adjusted for race/ethnicity, age, gender, BMI, and education) of participants who were adherent to dietary guidelines for each nutrient according to the methodology described earlier, and then pairwise comparisons are displayed between each of the occupational groups. Overall, for saturated fat and cholesterol, most workers across all occupational groups were adherent to recommendations, but all other nutrients showed poor adherence. Less than 5% of all workers were adherent to the daily recommendations for fiber. For the remaining nutrients (sodium,

TABLE 2. Comparison of Adjusted Nutrient Means by Four Major Occupational Groups Among Participants of the 1999–2006 National Health and Nutrition Examination Survey*

	White Collar (1)		Service Worker (2)		Farmer (3)		Blue Collar (4)		Comparison *P* Values					
Nutrient	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**1 vs 2**	**1 vs 3**	**1 vs 4**	**2 vs 3**	**2 vs 4**	**3 vs 4**
Cholesterol, mg	302.4	6.3	293.9	7.2	323.4	20.4	319.9	7.6	0.178	0.336	0.064	0.159	0.016	0.878
Fiber, g	15.5	0.3	14.5	0.5	14.7	0.8	14.1	0.3	0.012	0.376	0.001	0.799	0.437	0.443
Calcium, mg	796.8	20.9	802.6	37.1	770.4	59.4	774.9	21.1	0.841	0.688	0.322	0.666	0.465	0.944
Sodium, mg	3,511.5	47.9	3,339.9	54.1	3,291.9	158.1	3,519.9	54.5	0.003	0.200	0.890	0.770	0.004	0.188
Total calories	2,243.6	23.9	2,201.3	30.8	2,255.2	109.4	2,329.9	32.6	0.229	0.921	0.013	0.635	0.003	0.520
% Cal protein	15.3	0.2	15.2	0.3	15.8	0.5	14.8	0.3	0.446	0.339	0.022	0.196	0.171	0.041
% Cal total fat	32.6	0.4	31.7	0.5	31.9	0.9	32.2	0.4	0.013	0.483	0.338	0.766	0.187	0.761
% Cal monounsaturated fat	10.3	0.2	10.2	0.2	10.3	0.4	10.5	0.2	0.717	0.871	0.220	0.776	0.122	0.748
% Cal polyunsaturated fat	12.3	0.2	11.8	0.3	11.7	0.5	12.1	0.2	0.001	0.141	0.324	0.859	0.061	0.249
% Cal saturated fat	7.1	0.2	6.7	0.2	6.7	0.3	6.6	0.2	0.005	0.110	0.002	0.959	0.605	0.667
% Cal carbohydrate	50.3	0.3	51.8	0.5	51.4	1.0	50.6	0.4	0.001	0.312	0.503	0.742	0.025	0.473

*Values were adjusted by age, body mass index, race/ethnicity, gender, and education.
Cal indicates calories; NHANES, National Health and Nutrition Examination Survey; SE, standard error.

TABLE 3. Percentage of Participants Meeting the Dietary Guidelines for Cholesterol, Calcium, Sodium, Protein, Carbohydrate, Fat, Saturated Fat, and Fiber by Four Major Occupational Groups*

					Comparison *P* Values					
Nutrient	**White Collar (1)**	**Service Worker (2)**	**Farmer (3)**	**Blue Collar (4)**	**1 vs 2**	**1 vs 3**	**1 vs 4**	**2 vs 3**	**2 vs 4**	**3 vs 4**
Cholesterol	64.7	64.5	58.7	62.0	0.903	0.156	0.098	0.142	0.239	0.422
Calcium	23.3	23.1	22.8	23.1	0.883	0.860	0.885	0.946	0.965	0.917
Sodium	17.6	21.0	25.4	21.8	0.024	0.019	0.016	0.226	0.676	0.269
Protein	33.6	31.7	26.6	33.8	0.235	0.039	0.943	0.140	0.361	0.039
Carbohydrate	32.7	33.9	37.7	34.0	0.493	0.227	0.497	0.347	0.974	0.356
Total Fat	32.7	33.5	32.9	32.5	0.651	0.975	0.893	0.859	0.617	0.935
Saturated Fat	72.9	70.5	71.8	70.5	0.236	0.761	0.106	0.738	0.986	0.709
Fiber	3.4	2.8	4.8	2.8	0.174	0.150	0.188	0.040	0.993	0.026

*Percents were adjusted by age, body mass index, race/ethnicity, gender, and education.

calcium, carbohydrate, total fat, and protein), only 18% to 34% of workers were adherent to the daily recommendations. For sodium, a smaller percentage of white-collar workers were adherent to the daily recommendation compared with all other occupational groups (3.4% to 7.8% difference). For protein, a smaller percentage of farmers were adherent to the daily recommendation compared with white-collar workers or blue-collar workers (7.0% and 7.2% difference, respectively). For fiber, a higher percentage of farmers met the daily recommendation than service workers and blue-collar workers (2.0% difference for each comparison).

DISCUSSION

In this population-based study of US workers in different occupational groups, we examined nutrient intake of all macronutrients and several micronutrients. We also compared workers' reported dietary intake with the US daily recommendations and the percentage of those who were adherent with standard recommendations. The results of our study are strengthened by utilizing the NHANES, which provides a data set that is generalizable to the US population. Overall, we noted several statistical, but not clinical, differences in nutrient intake by occupational group, such as, white-collar workers consuming more fiber, sodium, and total, saturated, and polyunsaturated fat; blue-collar workers consuming more cholesterol and calories; and service workers consuming more carbohydrates. In addition, we noted that most workers were adherent to the recommendations for saturated fat and cholesterol, but not for all other nutrients. In particular, less than 5% of all workers met the daily recommendation for fiber. Small, yet statistically significant, differences were noted for some occupational groups being adherent to dietary recommendations compared with others, for example, a higher percentage of farmers met the recommendation for fiber than service workers and blue-collar workers. Thus, we would conclude that US workers are typically not adherent to dietary recommendations. Given the various chronic diseases now at epidemic levels in the US (eg, heart disease, obesity, type 2 diabetes, and various cancers) and that poor nutrition contributes to the development of these diseases, our findings of an almost unequivocal lack of adherence to dietary recommendations by American workers is unsurprising.[1–4] Although dietary recommendations are made by various expert organizations,[5–7] the message is obviously not reaching the average US worker and/or if he or she is receiving the message, then it is being ignored. Because all workers are poorly adherent to dietary recommendations suggests

that this tremendous problem affects every occupational group, thus demonstrating that this nationwide problem does not discriminate by socioeconomic status. The question of how to get this dietary information to the US worker, and then to ensure that he or she is adherent to the guidelines, is a larger, systemic problem outside the scope of this analysis.

Currently, the scarcity of literature on population-level estimates of nutrient intake by major worker groups creates a gap in our understanding of occupational health and nutrition. The Scottish Heart Health Study showed differences in calorie, nutrient, and food group intake between different occupational groups, such as manual versus nonmanual workers.[36] Manual workers had a higher intake of calories and most nutrients, except vitamins C, E, A, and fiber. Women doing manual work had the highest proportion of energy coming from total and saturated fats, and male manual workers had the lowest proportion of polyunsaturated fats and lowest densities of fiber and vitamins A, C, and E in their diets.

Most other investigations into the difference in nutrient intake among occupational groups have only considered employment as a determinant of socioeconomic status. In several studies of Australian and European adults, workers of higher occupational status have been found to have lower intakes of total fat and saturated fat,[37–39] both of which are associated with a lower obesity rate.[40] Higher occupational status has been also associated with more fiber and less total energy intake in studies of Canadian, Australian, European, and US adults.[38,39,41] Lower occupational status has been associated with a higher proportion of energy coming from saturated and monounsaturated fats and refined sugars and higher cholesterol intake in Australian and New Zealand workers.[38,42] In previous studies, differences in vitamin intake by occupational status have also been observed[41]; however, no differences by occupational status have been found in proportions of energy from protein, polyunsaturated fat, and complex carbohydrates.[38]

The results of our study may provide useful information for health care providers, employers, and dietitians, who are interested in improving the overall health status of their employees through worksite wellness initiatives by targeting dietary behaviors that appear to be quite deficient. While national campaigns to educate consumers about the benefits of consuming saturated fat and cholesterol in moderation may be reflected in our findings, clearly the message has not been received for the benefits of eating the proper amounts of fiber, sodium, calcium, and total fat. As we have demonstrated in a previous study, persons with chronic disease (especially heart disease, diabetes, and overweight/obesity) are more aware of dietary recommendations,[43] so perhaps worksite education sessions focusing on understanding food labels targeted at workers with chronic diseases would be an effective way of improving the intake of these nutrients. Worksite education campaigns about proper dietary intake of macro- and key micronutrients may prove beneficial for workers in various occupational settings to encourage adoption of healthier dietary behaviors.

LIMITATIONS

Limitations of this study include being unable to ascertain causality, given the cross-sectional nature of the data. It is unclear whether the dietary behaviors of these occupational groups are consistent overtime or if they are changing. The relationship between dietary behaviors and knowledge and awareness of dietary recommendations, as well as the potential impact of recommendation awareness on adherence to them, is also unclear. We also do not know if study participants would be receptive to improving dietary behaviors, given that attitudinal determinants likely would play a key role in changing behaviors. Just because people know about and use dietary information does not necessarily translate into healthy dietary behavior.[43] In addition, utilizing a 24-hour recall for dietary assessment is subject to unbiased systematic and random sources of measurement error that you suspect in collecting data of this type.[44,45]

CONCLUSIONS

Across the US workforce, opportunities exist to improve dietary intake patterns through worksite wellness and education initiatives utilizing tailored, nutrient-specific messages, and thereby potentially improving dietary behaviors. Given that higher intakes of certain nutrients (eg, fat, trans fat, and saturated fat) and lower intakes of others (eg, fiber) are linked to a greater risk of heart disease and other chronic conditions, workers could reduce their risk of getting these diseases by adopting healthier dietary behaviors.[46,47] Given that work sites offer a large milieu to promote dietary recommendations through health promotion activities, employers could take the lead in a nationwide education campaign that improves the ability of US workers to improve their eating habits. In an increasingly distressed US economy, workers may be focused even less on their health, as opposed to their employment or financial status, but nonetheless employers have an opportunity to help raise awareness of the importance of adherence to dietary adherence, as workers are a reflection of all Americans who overall do not adhere to the guidelines. Workers also need to understand the link between poor adherence to dietary recommendations and the prevalence of chronic disease, given that sustaining health is linked to being able to work, which is crucial in a climate of increasing unemployment at this time. The lack of adherence to dietary recommendations also suggests that the average US worker likely needs ongoing support in his or her efforts to improve eating habits, even with having the information about how to eat properly. Continued efforts at promoting awareness of proper dietary behaviors and recommendations are critically important for attempting to curtail the epidemics of chronic disease that the US currently faces.

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