Job Strain and Prevalence of Hypertension in a Biracial Population of Urban Bus Drivers

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ABSTRACT

Objectives. In this study we tested the association between occupational stress—as measured by job demands, decision latitude, and job strain—and hypertension in a population of 1396 Black and White bus drivers.

Methods. Height, weight, blood pressure, and medical history were assessed by physical exam. Drivers completed a questionnaire assessing their work schedules, personal habits, and self-perceptions about job demands and decision latitude.

Results. Univariate analyses revealed significant inverse associations; lower levels of job demands and job strain were associated with a higher prevalence of hypertension for Blacks and Whites. After 12 confounding variables were controlled for, the association between these two measures of occupational stress and hypertension became nonsignificant. Decision latitude was also not significantly associated with hypertension.

Conclusions. Our findings are inconsistent with previous studies' findings of a positive association between job strain and chronic diseases. The difference in results may be explained by our incorporation of individuals' perceptions in the measurement of occupational stressors and our use of individuals from a single occupation with comparable job responsibilities and income, thus controlling for potential confounding by social class. (*Am J Public Health.* 1992:82:984–989)

Introduction

Since the 1930s, social scientists have conducted research to examine how psychosocial stressors such as life events,[1,2] daily hassles,[3] behavioral characteristics,[4–6] and stressful working conditions[7–12] may be associated with the incidence and prevalence of various chronic diseases. Particular interest has been focused on the relationship between hypertension and/or coronary heart disease and occupational stressors, operationalized as specific job problems, high job demands, job dissatisfaction, and low job rewards.[13–15] This work has yielded inconsistent findings, with some studies showing positive associations[13,14,16–25] and others indicating null or negative associations.[6,12,15,26–29]

Work by Karasek and his colleagues suggests that there is a strong association between job strain, conceptualized as the joint effect of high job demands and low decision latitude or control, and an increased prevalence and/or incidence of coronary heart disease and myocardial infarction when traditional risk factors such as age, race, cholesterol, and smoking are controlled for.[14,18,20] Also, job strain has recently been shown to be positively associated with elevated diastolic blood pressure and a higher left-ventricular-mass index in a case-control study of employees from several occupations (odds ratio of 3.1).[25]

Although some studies have used case-control or prospective designs,[18,25] most of the studies using Karasek's job-strain variable have employed an ecologic study design.[14,15,20,21,30–32] In these studies an imputation method assigns job-strain scores to individuals within the same occupational census code (data obtained from large surveys such as the Health Examination Survey and the Health and Nutrition Examination Survey), then compares rates of myocardial infarction, for example, between high- and low-strain occupations.[14,20,21,30] This methodology does not permit evaluations of the associations between workers' self-perceptions of their jobs and disease status. In addition, it does not allow assessment of whether workers performing the same job duties have different perceptions of their job experience and different disease prevalence rates.

The present study was designed to test the association between self-reported job strain and clinically diagnosed hypertension within a population of bus drivers. Bus driving is an occupation characterized as having a high level of job strain as well as high rates of hypertension.[33,34]

We hypothesized that drivers who perceived their job as demanding, with little opportunity for control or decision latitude, would exhibit a higher prevalence of hypertension than would drivers who did not perceive their job in this way. In addition, we hypothesized that the association would persist after we controlled for other biobehavioral risk factors related to hypertension, such as age, race, sex, ed-

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ucation, body mass index, family history of heart disease, and alcohol intake.

Methods

The present analysis was conducted as part of a larger occupational health study of urban bus drivers employed by the San Francisco Municipal Railway system. Data collection was incorporated into an existing system of medical examinations conducted as part of the drivers' required biannual license renewal process. Drivers who were examined from December 1983 to September 1985 were eligible for recruitment into the study.

Study Population

The target population consisted of 1845 San Francisco bus drivers, all of whom completed a medical examination (28 with nonstandardized blood pressure data were excluded). Seventy-seven percent completed the optional occupational psychosocial questionnaire, yielding a final study population of 1396 drivers for whom both the medical examination and optional questionnaire data were complete. A previous comparison of the drivers who completed the questionnaire with those who did not revealed no statistically significant differences between respondents and nonrespondents in prevalence of hypertension and selected demographic and behavioral characteristics.[26]

Measurement of Variables

Detailed descriptions of the data collection methods and medical procedures have been published previously.[26] Briefly, the medical examination included assessments of height, weight, blood pressure, medical history, and personal health habits. All physiological assessments were obtained in a clinic setting during normal working hours (i.e., 8 AM to 5 PM). Three standardized blood pressure measurements were taken by physicians and nurses according to the protocol defined by the Hypertension Detection and Follow-up Program.[35] All readings were obtained from the right arm with standard mercury manometers while the participants were seated. Drivers were classified as hypertensive if (1) the mean of their second and third systolic readings was equal to or greater than 140 mm Hg, (2) the mean of the second and third diastolic readings was equal or greater than 90 mm Hg, or (3) they were currently using antihypertensive medication.

After the medical examination, drivers completed a questionnaire assessing their work schedules, personal habits (health and job-related), self-perceptions about specific job problems,[26] and the 37-item job-content instrument developed by Karasek.[36,37] The present analysis focused on the three composite scales assessing psychological job demands, decision latitude, and job strain, the latter being a composite scale that represents the interaction between demands and decision latitude.[14,18,30] For each question in the scales, respondents rated (on a scale of one to four) the degree to which they agreed or disagreed with statements describing their job or job environment. A high score represents a high level of perceived job demands and/or a high level of perceived decision latitude over the job.

Measurement of Covariables

Biobehavioral factors potentially related to hypertension and assessed as confounding factors included the following: (1) age, (2) martial status, (3) education, (4) income, (5) number of years employed as a bus driver, (6) race, (7) body mass index, (8) family history of heart disease, (9) smoking (pack years), (10) fitness, (11) alcohol consumption in a week, and (12) caffeine intake per day (see Appendix A for definitions of covariables).

Statistical Analyses

Logistic analyses were conducted with hypertension status as the outcome variable. Univariate analyses were performed initially, followed by multivariate logistic analyses that included job demands and decision latitude as the main effects, the job strain variable as the interaction term, and the potential 12 confounding factors. Job demands and decision latitude were tested separately as continuous variables and as dichotomous "median split" variables with high job demand > 31.5 and low decision latitude ≤ 30.9. These two categorical variables were used to create the four-level rank-ordered job-strain variable that corresponded to Karasek's 2×2 model of job strain, with low job demand and low decision latitude representing the passive job category; low job demand and high decision latitude representing the low-strain category; high job demand and high decision latitude representing the active category; and high job demand and low decision latitude representing the high-strain category. The latter category was hypothesized to carry the greatest risk.[14,20,25]

Results

The sample was predominantly male (91%) and was 60% Black, 17% White, 13% Asian, and 8% Hispanic. The drivers' ages ranged from 20 to 65 years; the mean age was 42. The majority (63%) had been employed by the San Francisco bus company for 9 years or longer.

The mean and standard deviation was 32.0 ± 6.04 (range, 12 to 48) for the job demands scale and 30.8 ± 5.00 (range, 14 to 45) for the decision latitude scale. The mean value for job demands is similar to those reported previously, but the mean value for decision latitude is somewhat lower[15,25,37] (see Appendix B).

Table 1 presents the descriptive statistics for the drivers according to job strain category. The active job strain category contained the lowest proportion of hypertensives. Chi-square analyses were significant for these descriptive variables; higher percentages of younger drivers, women, and drivers with less than 10 years of employment fell into the active and high-strain categories. (When we examined social-class variables, our correlational analyses revealed a positive association between income and hypertension [$r = .07$, $P < .02$], but a negative association between education and hypertension [$r = -.060$, $P < .02$].)

Table 2 shows the percentage of hypertensives within each quintile of job demands and decision latitude. According to our hypothesis, hypertension rates should be higher within the higher levels of job demands and lower within the higher levels of decision latitude. Although not statistically significant, the trend for decision latitude was in the hypothesized direction. Job demands yielded a significant chi-square with a P value of less than .01; however, the trend was the opposite of the hypothesized relationship. Analyses by race revealed similar trends in prevalence of hypertension across the job-demands quintiles for Black and White drivers (sample sizes for Asian and Hispanics drivers were insufficient for analyses).

Because drivers with more seniority are allowed to select their bus routes (i.e., they have more latitude to select less demanding routes), it is possible that older drivers with more hypertension might perceive fewer job demands. This possibility is supported by the data reported in Table 1. Of those drivers in the passive category, 24% were older than 50, whereas of those in the active or high-strain category, only 12% were older than

TABLE 1—Characteristics of Respondents by Job-Strain Category (%)

	Job-Strain Category					
	Passive (n = 295)	Low Strain (n = 409)	Active (n = 357)	High Strain (n = 346)	χ^2	Significance
Age						
20–29 y	.3	2	3	2	42.2 (*df* = 12)	*P* < .0001
30–39 y	34	38	50	48		
40–49 y	42	40	35	38		
50–59 y	20	17	11	10		
60–69 y	4	3	1	2		
Male	94	94	88	88	14.4 (*df* = 3)	*P* < .002
Race						
Black	62	57	61	62	30.9 (*df* = 12)	*P* < .002
White	18	14	15	20		
Asian	11	14	14	12		
Hispanic	6	13	9	5		
Other	3	2	1	1		
Years employed						
< 4	28	34	38	25	78.9 (*df* = 21)	*P* < .0001
5–9	22	26	30	37		
10–14	18	16	16	23		
15–19	14	12	10	9		
20–24	13	7	5	3		
25–29	3	4	1	2		
30–34	1	2	0	.3		
> 35	1	.2	1	0		
Hypertensive, %	36	35	25	31	12.7 (*df* = 3)	*P* < .005

TABLE 2—Prevalence of Hypertension (% Hypertensive) by Quintiles of Job Demands and Decision Latitude

Quintile	Job Demands[a]	Decision Latitude[b]
1 (Lowest)	39	36
2	36	32
3	29	31
4	30	31
5 (Highest)	27	29

[a]χ^2 = 12.7 (*df* = 4), *P* < .01.
[b]χ^2 = 2.7 (*df* = 4), *P* = .61.

50. Thus, a multivariate logistic analysis was needed to investigate this association both by controlling for age and length of employment and to test any interaction between job strain and length of employment.

As shown in Table 3, univariate analyses revealed significant inverse associations between the prevalence of hypertension and job demands and job strain (odds ratios of .84 and .88, respectively). The univariate test for decision latitude was in the hypothesized inverse direction but was not statistically significant. Multivariate logistic regression analyses in which age, years of employment, body mass index, and nine other factors were controlled for revealed no significant associations between any of the three occupational stressors and the prevalence of hypertension. Similar results were found for both the continuous and dichotomous quantifications of the three variables.

To examine whether an interaction existed between perceived job strain and covariables such as age, sex, and race, we assessed evidence of a first-order multiplicative interaction, using unconditional maximum-likelihood estimation methods.[38] Product interaction terms (between each of the covariables and job strain) were added to the multivariate model and the model was compared with a reduced model without interaction terms. A chi-square statistic, used to test the difference between the two models' log likelihood ratios, revealed no significant interaction between the job stress variables and any of the covariables.

Separate multiple regression analyses examining the impact of the three occupational stress indices on mean systolic and mean diastolic blood pressures within the subsample of normotensives (systolic blood pressure < 140 and diastolic blood pressure < 90) were also not statistically significant.

Discussion

We found univariate inverse relationships between job demands, job strain, and the prevalence of hypertension in a biracial blue-collar population of urban bus drivers. These negative associations were opposite to our a priori hypothesis of a positive relationship between these variables. The univariate inverse associations were not, however, supported by the multivariate logistic analysis that adjusted for 12 covariables. Thus, in the present study we found no association between subjective reports of occupational stress and prevalence of hypertension.

Previous studies using subjective self-reported measures of occupational stress have yielded inconsistent results. Some have yielded positive associations with diastolic or systolic blood pressure,[13,16,22,25] whereas others have found no associations with elevated blood pressure or hypertension.[6,12,29,32] These inconsistencies in the literature could be related to differences in populations, study design, job stress instruments, and/or outcome measures. However, the similarities between our study and the recent case-control investigation of job strain, diastolic blood pressure, and left-ventricular-mass index conducted by Schnall et al.[25] warrants discussion. Both studies used the same instruments to assess job strain and similar statistical analyses. Schnall et al. found that individuals from different occupations with high-strain jobs had an increased likelihood of having elevated diastolic blood pressure, whereas our analyses revealed that, within one occupation, there was no significant association between job strain and prevalence of hypertension or systolic/diastolic blood pressure. Although there were methodological differences between these two studies (e.g., selection of subjects and blood pressure measures), two major differences between our study and that of Schnall et al. require elaboration. Our study population was largely Black (60%), whereas that of Schnall et al. was largely White (80%). Schnall and colleagues examined job strain across a variety of occupations, whereas our study included only bus drivers. Previous analyses of bus drivers' work have shown that drivers are exposed to a wide range of psychological as well as physical stressors,[33] and comparisons across occupations have shown bus drivers to have higher rates of hypertension and other diseases than do workers in other blue-collar occupations.[33,34]

One explanation for the divergent findings of these two studies is that our study population, which was from one occupational group, could have exhibited insufficient variability in the assessments of job strain. We found, however, that the mean value for job demands for our study population was quite similar to that reported by Reed et al. and Karasek et al. in cross-occupational studies[15,37] and by Schnall et al. in their recent case-control study[25] (the mean value for decision latitude was somewhat lower in the present study; see Appendix B). Although our standard deviation for decision latitude was considerably lower than those reported by Karasek et al.,[37] it was similar to those reported by Reed et al.[15] and Schnall et al.[25]; thus, the within-occupation variability of self-reported job stress in the present study is similar to the between-occupation variability found in the latter two studies. This similarity indicates that individuals working in jobs with similar duties can have different perceptions of their duties and can cope with them with varying degrees of success. And although the duties may be similar, there may be many factors that vary between workers (e.g., for bus drivers, the number of passengers or the traffic volume on different bus routes). Thus there does not appear to be bias from limited variability in our measure of occupational stress.

Another reason for the inconsistency between the present study and Karasek's earlier studies may be the different socioeconomic status (SES) of the respondents. In the analyses of Karasek and his coworkers, education is often used as a covariable[14,18,20,25,32]; however, factors other than education that are related to SES (e.g., income, job status) may confound the association between occupational stress and chronic disease. For example, Marmot and his coworkers found that low SES, as measured by grade of employment, was associated with increased mean blood pressure, prevalence of hypertension, and stroke mortality.[39,40] Several similar investigations in which occupation has been used as an indicator of SES have found that blood pressure rises as SES decreases.[41,42] In contrast to the work of Karasek and his colleagues, the present study involved a population that was similar in socioeconomic status, and individual differences in education and income were controlled for in the analysis. This method of controlling for SES in both the design and analytic phases of the study may explain some of the disparities in results.

TABLE 3—Logistic Analyses of Hypertension and Occupational Stressors

	Regression Coefficient	Odds Ratio (95% CI)	*P* Value
Univariate analyses			
Job demands	−.028	0.84 (.75, .94)	<.01
Decision latitude	−.018	0.91 (.82, 1.02)	.12
Job strain[a]	−.119	0.88 (.78, .98)	.03
Multivariate analyses[b]			
Job demands	−.008	0.95 (.84, 1.03)	.46
Decision latitude	−.017	0.92 (.81, 1.04)	.19
Job strain[a]	−.011	0.98 (.86, 1.13)	.85

[a]Job strain was measured by a four-level rank-ordered combination of job demands and decision latitude.
[b]Multivariate analyses tested the association between occupational stressors and prevalence of hypertension with adjustment for age, race, sex, education, income, marital status, years employed, body mass index, smoking, caffeine, alcohol, and fitness.

Differences between the present study and previous studies are unlikely to be due to inadequate sample size. Of the 1407 subjects in our sample, 448 were classified as hypertensive. This number is more than the total sample size used in two similar studies of occupational stress and diastolic blood pressure (n = 288 and n = 215).[13,25] Thus, compared with two studies that found a positive association between occupational stress and diastolic blood pressure, our study had almost six times as many subjects and five times as many hypertensives.

Inconsistencies could have, however, occurred because of selection or measurement bias. Selection bias could have occurred if the subjects in the present study were atypical with regard to their perceptions about their job or their risk factors for hypertension, or if those hypertensives with the highest level of job stress were more likely to terminate employment. As discussed above, the mean values for the occupational stress variables were quite similar to those reported in previous studies; thus the drivers' job scores were not unusual. Furthermore, our study population and that used by Schnall et al. were extremely similar in terms of risk factors for hypertension, such as age, body mass index, prevalence of smokers, and systolic and diastolic blood pressures. Finally, in a previous study of the same sample in which drivers were asked to rate specific job stressors, we found no significant differences between the job-stress scores of hypertensives who left the job and the scores of those who remained.[26] Although measurement bias is possible, it was minimized by (1) distinct separation, both in time and in setting, of blood pressure measures and driver's ratings of job strain; (2) fidelity to the Karasek instrument; and (3) strict adherence to standardized protocols for measuring blood pressure.

Therefore, these potential biases do not appear to account for our negative findings. Bus drivers' self-perceptions about the level of job demand and decision latitude involved in their job does not appear to be associated with hypertension or high blood pressure. In fact, there may even be an inverse association between job stress and hypertension. Significant inverse relationships between subjectively assessed job stressors and hypertension or blood pressure were recently found in two studies.[26,32] In the first study,[26] Winkleby et al. found an inverse association between specific work-related stressors (e.g., accidents, traffic, and tight schedules) and hypertension (odds ratio = 0.84; CI = 0.75, 0.99; $P < .04$), using the same sample of bus drivers as the current study. In the second study an inverse association between job demands and systolic blood pressure (regression coefficient = −.79; $P < .05$) was found in one of the five databases reviewed in a meta-analysis by Pieper et al.[32] These studies suggest that low levels of job strain may be associated with higher hypertension or that hypertensives may suppress their feelings toward job stressors by underreporting the frequency of specific stressful situations and the levels of emotional reactivity associated with these events.[26]

Summary and Implications

In summary, we studied workers with comparable job responsibilities and similar income levels in an objectively defined high-stress occupation and found no significant association between hypertension and job demands, decision latitude, or job strain. This lack of association is in contrast to the findings of Karasek et al., who examined workers from a wide range of social classes. If the studies of Karasek et al. did not adequately control for SES, then it may *not* be high demand/low decision latitude that is associated with high coronary heart disease morbidity or mortality, but the low SES that accompanies occupations with such stressors. We hypothesize that social class could confound the association between occupational stress and chronic disease, or that SES and occupation may be so highly correlated that it is difficult to separate their independent effects. Therefore, until the effects of SES can be distinguished more precisely from occupation-based indicators of job stress, ecologic investigations of different occupations should be interpreted cautiously.

Our results raise questions about the relationship between Karasek and his colleagues' operationalization of occupational stress and the prevalence of hypertension. In addition, the interrelationships between coping strategies (denial and repression), occupational stress, social class, and chronic disease remain unclear. Future investigations should rigorously evaluate coping styles, how they interact with occupational stressors, and whether they precede or follow the development of hypertension.

To fully address the inconsistencies evidenced in this study, future studies should use prospective designs that assess objective as well as subjective measures of occupational stress; evaluate coping styles (especially repressive coping styles); control for the various dimensions of social class; and follow workers for the development of multiple chronic diseases such as hypertension, coronary heart disease, and stroke. Obviously this type of study would be expensive and difficult to implement, but smaller studies investigating how hypertensives explicitly deal with various occupational stressors, measured both subjectively and objectively, may provide insights into the inverse and null associations found between occupational stressors and hypertension. □

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APPENDIX A—Definitions of Covariables

Marital Status = married, separated, divorced, widowed, and single/never married.
Education = less than 11th grade, high school graduate, technical school/some college, college graduate or higher.
Income = rank-ordered into four categories, less than $25,000 to $35,000 or more.
Race = Black, White, Asian, Hispanic, and other.
Body Mass Index = Weight in kilograms, divided by height in meters squared.
Family History of Heart Disease = positive if participant's mother, father, or siblings ever had high blood pressure, heart disease, stroke, or a cardiovascular disease-related death.
Fitness = hours per week of moderately hard physical activity.
Alcohol Consumption = total drinks of wine, beer, or hard liquor in an average week.
Caffeine Intake = total cups of coffee or soft drinks per day.

APPENDIX B—Comparison of Means and Standard Deviations

Study	Job Demands	Decision Latitude
Karasek et al.[34]	34.5[a] ±8.5	72.9[a] ±13.1
	30.5[a] ±8.5	71.3[a] ±13.5
Reed et al.[15]	30.3 ±6.1	71.9 ± 8.1
Schnall et al.[25]	30.9 ±6.1	35.4 ± 6.1
Albright et al. (present study)	32.02±6.0	30.8 ± 5.0

[a]These figures are the computed averages of aggregated scores for different occupations.