Job Strain and Ambulatory Work Blood Pressure in Healthy Young Men and Women
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The effect of high job strain (defined as high psychological demands plus low decision latitude at work) on blood pressure was determined in 129 healthy, nonhypertensive men (n=65) and women (n=64). Blood pressure measures included mean screening levels obtained in a clinical environment, mean ambulatory levels from one 8-hour workday, and the change in levels from screening to mean work levels. In male workers, men with high and low job strain showed similar blood pressures at screening, but men with high job strain showed greater increases from screening to work, resulting in higher mean work blood pressure. Occupational status was unrelated to job strain or blood pressure in men. In female workers, women with high and low job strain did not differ in any measure of blood pressure; however, there were trends for higher occupational status and greater skill discretion to be associated with higher blood pressure responses at work in women. (Hypertension 1992;20:214–218)

KEY WORDS • blood pressure • stress, psychological • sex differences • job satisfaction • blood pressure monitoring, ambulatory

Exposure to environmental stress, particularly when chronic, has long been identified as a probable contributor to the pathogenesis of essential hypertension in susceptible individuals.1,2 Higher levels of stress at work, where people spend many of their waking hours, were recently identified as a source of life stress with significant impact on blood pressure.3 Investigations that used ambulatory blood pressure monitoring documented that blood pressures are typically higher at work than at home or in the physician’s office4 and that blood pressure levels at work are more strongly correlated with left ventricular mass than are levels obtained in the other two contexts.5 Furthermore, in healthy, normotensive women, those who report more stress at work than at home on the day of ambulatory monitoring demonstrate higher work blood pressure levels than those reporting equal or higher levels of stress at home.6,7

One potentially powerful approach to the assessment of stress at work is the “job strain” model. Karasek et al8 defined high job strain as the combination of high psychological demands together with low decision latitude at work. Karasek and Theorell9 reported that 10 of 11 studies examining the relations of these or similar job strain elements to risk of coronary heart disease have generated at least partial support for the job-strain model. In regard to hypertension, however, the evidence is less strong. In a meta-analysis involving five US data bases in which aspects of job strain and blood pressure information could be correlated, Pieper et al10 found that lack of job control (similar to low decision latitude) was associated with higher blood pressure, but the combination of high psychological demand and low control was not.

Recently, however, Schnall et al,11 using a case-control design, provided documentation that high job strain in men is associated with hypertensive status (defined by workplace screening blood pressures), higher ambulatory diastolic blood pressure at work, and greater left ventricular mass index. These results, although quite compelling, were limited in their general applicability because women were not included as subjects. Furthermore, the study sample did include patients with established hypertension, both untreated patients and previously treated patients who were withdrawn from drug therapy during the study. Thus, it is possible that job strain scores or work blood pressure levels might have been influenced by subjects’ awareness of their blood pressure status. The purpose of the present investigation was to reexamine the relation of high job strain to ambulatory blood pressure at work in a sample of healthy, young working women and men without established hypertension.

Methods

Subjects

The participants in this study consisted of a biracial sample of 129 healthy working men and women aged 18–47 years (mean ages, 32.9 and 31.3 years for men and women, respectively). Recruitment efforts were aimed at achieving roughly equal representation by race and gender. As a result, this total included 65 men (38 white, 27 black) and 64 women (34 white, 30 black). Each subject was required only to be employed full-time outside the home; no minimum duration of current employment or selection by the nature or status of
occupation was used in sample selection. Each volunteer read a detailed description of the protocol approved by the local review board and provided written informed consent. Each also underwent a physical examination supervised by a cardiologist and provided medical history information. Individuals with average diastolic pressure >95 mm Hg at screening examination; any serious cardiovascular, renal, or pulmonary problem; chronic physical or psychological disorder; or history of substance abuse were excluded from participating. Women were tested during days 3–8 of their menstrual cycle, and none were taking oral contraceptives at the time of testing.

Physiological Recording Procedures

Initially, subjects scheduled appointments to visit the university medical center for screening after work (4–6:30 PM weekdays). After arrival, subjects were seated for 10 minutes while they read and completed the consent form and medical history questionnaire. Next, a nurse or trained technician measured blood pressure with a mercury manometer, using the first and fifth phases of Korotkoff sounds. The first four measurements were averaged to yield mean screening systolic (SBP) and diastolic (DBP) blood pressures.

Between 1 and 6 weeks after screening, subjects returned to the medical center between 6 and 8 AM on a typical working day to be fitted for ambulatory blood pressure monitoring with the Accutracker 103 monitor (Suntech, Raleigh, N.C.). After instrumentation, a minimum of three sitting and three standing readings were taken with the Accutracker while concurrent readings were obtained by auscultation to ensure standardization against usual clinical determination methods. Subjects then wore the monitor throughout their 8-hour working day, and it made blood pressure determinations four times per hour at variable intervals. Each determination was accompanied by an entry in a diary in which the subject recorded his current posture, environment, recent physical and mental activities, and mood state, including levels of stress, tension, and anger. At the end of the 8 hours, subjects returned to the laboratory, where monitors were removed and the data downloaded. As recommended by Harshfield et al., blood pressure records were subsequently reviewed by an experienced observer to exclude artifactual readings; specific criteria for data exclusion have been described previously by Hinderliter et al. On average, 29 of the 32 readings obtained from each subject were deemed acceptable (91%), and these were subsequently averaged to yield 2-hour means for SBP and DBP from 8 to 10 AM, 10 AM to 12 noon, 12 noon to 2 PM, and 2 to 4 PM, as well as mean SBP and DBP levels for the full working day.

Assessment of Job Strain and Occupational Status

During the screening visit, subjects were given a set of questionnaire items to be completed at home and returned on the next visit. These included a laboratory-constructed questionnaire on demographic information that included an item on current occupation and the Job Content Questionnaire developed by Karasek et al. This questionnaire has been described in detail by Schnall and colleagues. Briefly, it consists of items relating to 1) psychological work demands (score range, 12–48) and 2) job decision latitude (score range, 12–48), which includes equal contributions from two subcomponents, skill discretion and decision authority. Subjects who score high on psychological demands but low on decision latitude are considered to have high job strain.

A wide range of occupations was included, from physicians and executive officers to janitors and factory shift workers, but white-collar workers predominated for both men (71%) and women (72%). Occupational status was quantified more specifically by the Hollingshead rating system. This index was used to assess whether differences in job status, which might be correlated with job strain, were in fact the primary factors relating to blood pressure differences on the job.

Data Analysis

The relations of job strain, its subcomponents (psychological demands, skill discretion, and decision authority), and occupational status to mean screening levels of SBP and DBP and mean work levels of SBP and DBP were analyzed by repeated-measures analysis of variance (ANOVA) and with Pearson correlation coefficients generated via the Statistical Analysis System (SAS Institute, Cary, N.C.) programs. Level of significance was set at α=0.05. Separate analyses were performed for men and women when preliminary analyses yielded a significant interaction between gender and job strain groups (p<0.027).

Results

Classification of Subjects With Versus Without Job Strain

The criteria for defining job strain were adapted from Schnall et al. and followed their guideline that approximately 20% of individuals in a working population typically have high-strain jobs. To achieve this percentage for men and a similar percentage for women, gender-specific cutoff points for psychological work load and decision latitude were necessary. Men scoring above 32 for psychological work load and below 40 for decision latitude (23% of men tested) and women scoring above 32 for psychological work load and below 37 for decision latitude (29% of women tested) were classified as high job strain subjects. All other subjects were labeled low job strain subjects. For men, those with high job strain included nearly equal proportions of white and black subjects (47% versus 53%). For women, the high job strain group included slightly fewer white than black subjects (42% versus 58%). Men with high and low job strain reported equivalent years at their present job (5.6 versus 5.3 years, p=NS), whereas women with high job strain showed a weak trend toward more years at their present job than women with low job strain (4.6 versus 3.7 years, p=0.10).

Job Strain and Blood Pressure in Men

Men with high versus low job strain did not differ in screening blood pressure levels, but those with high-strain jobs showed higher ambulatory blood pressure while at work. Repeated-measure ANOVAs for both SBP and DBP yielded significant main effects of monitoring condition (F1,6=21.57 and 25.56, p<0.0001), reflecting the fact that both groups showed higher blood pressure at work than at screening. However, the rise in
both SBP and DBP from screening to work was different for men with high and low job strain, resulting in significant group x monitoring condition interactions ($F_{1,60} = 5.18$ and 4.89, $p < 0.03$). Subsequent comparisons of means indicated that men with both high and low job strain had similar screening levels of SBP (126.4 versus 126.9 mm Hg, $p = NS$) and DBP (78.4 versus 79.2 mm Hg, $p = NS$). However, men with high job strain showed significantly greater increases than men with low job strain from mean screening levels to average full-day work levels for both SBP (+9.9 versus +3.4 mm Hg, $p < 0.03$) and DBP (+7.9 versus +3.1 mm Hg, $p < 0.03$), resulting in higher blood pressures throughout the 6-8 hour period spent at work (Figure 1). Mean blood pressure levels averaged over the full work day were 136.3/86.3 versus 130.3/82.3 mm Hg, respectively, for the two groups ($p < 0.05$).

As expected, higher occupational status in men was associated with greater job skill discretion ($r = +0.34$, $p < 0.008$) and greater decision authority ($r = +0.31$, $p < 0.015$). However, because higher occupational status was also related to greater psychological demands ($r = +0.35$, $p < 0.006$), the composite job strain index was not related to occupational status ($r = -0.01$, $p = NS$).

Thus, men with high and low job strain did not differ in occupational status; they also did not differ in age, body mass index, or in the mean number of blood pressure readings obtained at work ($p = NS$ for all). Furthermore, based on the diary information obtained concurrently with each reading, men with high and low job strain did not differ in the percentages of readings obtained after walking or other exercise or during episodes of reported high stress, tension, or anger ($p = NS$ for all). However, men with high job strain reported more readings in the standing posture than men with low job strain (52% versus 41%, $p < 0.05$). A greater proportion of readings in the standing posture was marginally correlated with higher work diastolic pressure ($r = +0.22$, $p = 0.078$), but adjustment for these modest group differences in posture did not substantially change the relations of job strain to blood pressures. Likewise, adjusting for race did not substantially alter these observed relations. Finally, in the men, none of the individual components of job strain (psychological work load, skill discretion, or decision authority) were independently correlated with work SBP or DBP; only the combination of high psychological work load and low decision latitude was predictive of blood pressure at work.

**Job Strain and Blood Pressure in Women**

Women with high versus low job strain did not differ in their blood pressures at screening or at work. Repeated-measure ANOVAs for SBP and DBP yielded significant main effects of monitoring condition ($F_{1,6} = 31.45$ and 21.72, $p < 0.0001$), reflecting the fact that women, like men, showed consistently higher blood pressures at work than at screening. However, no effects comparing job strain groups reached significance. Blood pressures of women with high versus low job strain were similar at screening (113.8/71.7 versus 115.5/73.8 mm Hg, $p = NS$) and averaged across the working day (122.1/76.6 versus 123.1/78.8 mm Hg, $p = NS$), with both groups showing equivalent increases from screening to work (Figure 2).

Women with high and low job strain did not differ in age, body mass index, or number of ambulatory readings obtained at work ($p = NS$). Likewise, both groups reported equivalent percentages of readings while standing, after exercise, and during stress ($p = NS$). However, unlike the male job strain groups, in women, those with low job strain had significantly higher status occupations on average ($p < 0.015$). Furthermore, there was a trend for women with higher job strain to show greater increases in DBP from screening to mean levels at work ($r = +0.22$, $p = 0.078$). Also, when the individual components involved in determining job strain were evaluated as predictors of work blood pressure, higher rather than lower level of skill discretion was found to correlate with higher mean DBP at work ($r = +0.27$, $p = 0.03$).

**Discussion**

The results of the present investigation confirm the previous findings of Schnall and colleagues showing that high job strain is associated with higher blood pressure on the job in working men. These findings further indicate that the previously obtained relation was not a consequence of the inclusion of diagnosed hypertensive men, whose beliefs or expectations about their patient status could potentially have altered either their work blood pressures or their job strain scores.
job strain on blood pressure. Alcohol use also interacted
with job strain; further study of this relation is indicated.

These results also indicate that the relation of job
strain to work blood pressure in men is not simply a
result of differences in occupational status. However,
recent work by Theorell et al\(^6\) has shown that Swedish
men with occupations that are defined as typically
involving high psychological demands but low control
also show higher ambulatory diastolic pressure at work,
thus validating an occupational (as opposed to individ-
ual) classification of job strain. Furthermore, the pres-
cent findings demonstrate that in young, healthy, nonhy-
pertensive working men, high job strain is not associated
with higher blood pressures taken stethoscopically in a
clinical environment, but it is associated with a greater
increase from clinical levels to average levels obtained
over a full working day. This limitation of the effect of
job strain on blood pressure at work is probably because
these men were young (mean age, 32.9 years), with
relatively few years of previous exposure to their high-
strain jobs. Recently, Schnall and coworkers\(^7\) reported
that in an older sample (mean age, 44), home and sleep
as well as work blood pressures were equally elevated in
men with high job strain. Their results also revealed a
powerful interaction between age and job-strain effects,
with men older than 40 years showing greater impact of
job strain on blood pressure. Alcohol use also interacted
with job strain; further study of this relation is indicated.

In contrast to the men, women with high job strain in
this investigation did not show higher blood pressures at
work or greater increases in pressure from the clinic to
the work environment. These findings appear to be at
variance with previous reports by James et al\(^6,7\) showing
that women reporting higher stress at work than at
home had higher ambulatory blood pressure during
working hours. This assessment of job stress, however,
was quite different from the way in which the construct
of job strain is determined. The James et al\(^6,7\) work-
stress rating did not rely on the specific components of
psychological demands, decision authority, and skill
discretion. Furthermore, theirs was a rating specific to
the day of testing rather than a rating of sustained job
stress.

Among the men, high job strain was not associated
with a higher proportion of blood pressure readings
obtained concurrently with diary reports of high stress,
tension, anger, or recent exercise. Men with high job
strain reported standing more often than men with low
job strain, but adjustment for postural differences did
not alter relations to blood pressure. The relation of job
strain to blood pressure was also not altered by adjust-
ment for race, because the high-strain group included
nearly equal numbers of black and white men. It is
worth noting, however, that because fewer black sub-
jects were recruited, the percentage of those studied
who had high job strain was greater in blacks than
whites (30% versus 18% for men and 37% versus 24% for
women). This observation suggests that more fre-
cquent exposure to job strain may be one environmental
factor contributing to the greater incidence of hyper-
tension among the American black population.

Among the women, high job strain was associated
with a lower status occupation. This association was almost
certainly a consequence of the fact that women in higher
status jobs rarely reported low scores for job decision
authority or skill discretion. Yet, even with apparently
higher decision authority and skill discretion, women in
high-status jobs may experience a different form of job
strain not assessed by the Job Content Questionnaire. This
strain could result from the demands of work competing
with the demands at home as wife and mother, from
greater potential conflicts derived from having supervi-
sion over other workers including men, or even from
inequities in salary or treatment that are perceived as
resulting from being female in male-dominated occupa-
tions. Perhaps other sources of strain may partially explain
why in these women, high job skill discretion was associ-
ated with higher, not lower, blood pressure at work and
why high occupational status tended to be associated with
greater diastolic increases from the clinic to the work
environment.

These observations encourage further investigation
of the hypothesized influence of high psychological
demands at work combined with low decision latitude
and low control on the development of hypertension.
Possibly the strongest strategy would be prospective
longitudinal research, in which the duration of exposure
to high job strain could be directly measured and its
impact on within-patient change in blood pressure
evaluated. In addition, the present findings involving
women suggest that other elements that modulate the
experience of environmental stress must be considered
as well. Among other factors, the potential buffering

**FIGURE 2.** Line graphs show mean blood pressure levels of
women with high versus low job strain at screening and at
work. Work levels are depicted using averages for each 2-hour
period from beginning to end of the 8-hour workday.
effects of a high level of social support both at work from supervisors and coworkers and at home from family and friends appears valuable to incorporate in future research. In addition, for working women in particular, the degree of strain resulting from the double burden of greater unpaid responsibilities at home and paid duties at the workplace must be assessed and related to blood pressure. Recent research indicates that, on average, married working women spend roughly 20 more hours per week on household duties than their husbands do. When superimposed onto the traditional 40-hour work week outside the home, perceived strain in managing this added burden may be highly significant for health outcomes, including hypertension. Finally, because of the trend observed here for women with higher job status to demonstrate greater diastolic pressure increases at work, issues associated with being female in typically male-dominated high-status occupations deserve more direct study.

In summary, high job strain (defined as high psychological demands combined with low decision latitude on the job) was associated with higher ambulatory blood pressure at work and greater mean pressure increases from clinic to work environments in young, nonhypertensive men. High job strain was not associated with any enhancement of blood pressure in women. Instead, women showed higher blood pressure responses at work if their job skill discretion (an index of decision latitude) or their occupational status, or both, was high.

References
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Hypertension. 1992;20:214-218
doi: 10.1161/01.HYP.20.2.214

Hypertension is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0194-911X. Online ISSN: 1524-4563

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