Impact of Job and Marital Strain on Ambulatory Blood Pressure

Results from the Double Exposure Study

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Background: Psychosocial stressors such as job strain and marital stress have been associated with a sustained increase in blood pressure (BP).

Methods: We evaluated whether job strain and marital cohesion were associated with ambulatory BP in workers with normal or untreated elevated BP using baseline data from the Double Exposure study. The study population included 248 male and female volunteers who were nonmedicated, employed, and living with a significant other, all for a minimum of 6 months. Blood pressure was measured with an ambulatory BP monitor and participants completed a diary that recorded time during work, spousal contact, and sleep. Job strain and marital cohesion were calculated from the Job Content Questionnaire and the Dyadic Adjustment Scale, respectively.

Results: Of the subjects, 54.4% were female with a mean age of 50.8 years (6.6, SD). In all, 21.3% reported job strain. Significant associations were found between 24-h systolic BP (SBP) and alcohol consumption (P = .033), job strain (P = .007), male gender (P = .004), and age (P = .039) and was inversely associated with exercise (P = .037). An interaction between 24-h SBP, job strain, and marital cohesion was found such that greater marital cohesion was associated with lower SBP in subjects with job strain.

Conclusions: Psychosocial factors may influence the development of early hypertension. This should be clarified by the cohort phase of the Double Exposure study.

Hypertension is highly prevalent worldwide, and yet the early determinants of this condition are presently not well identified. The impact of psychological factors on the development of hypertension can be best understood in the context of daily life at work and at home. Furthermore, physiologic changes that result from recurrent stressors may predispose individuals to the onset of hypertension at an earlier age. A greater understanding of these factors will help to identify those individuals who are at increased risk for this condition and will suggest therapies to prevent its onset. Longer durations of hypertension are linked to increasingly severe target organ damage. Previous research has mainly focused on job strain, defined as low (ie, the lower 20%) job latitude, and high (ie, the upper 20%) job demands, which has been associated with hypertension and more severe cardiovascular outcomes. In recent years, however, there has been a closer examination of the impact of marital relationships with respect to cardiovascular outcomes. For instance, we have recently shown that marital cohesion was associated with 24-h diastolic blood pressure (DBP) and night-time blood pressure (BP) in 205 subjects with mild hypertension. Furthermore, marital adjustment at baseline was associated with left ventricular mass index after 3 years of follow-up, and marital support at baseline was associated with diastolic BP after 3 years. The term “double exposure,” which has been used before to describe the interplay between domestic and work stressors, is used in this study to denote the interaction of job strain and marital adjust-
The current study used both normotensive and hypertensive subgroups of individuals to examine how marital and job factors interact to affect ambulatory BP (ABP).

Methods

From July 2001 to August 2003, subjects were recruited for participation in a study to examine the association of marital and job factors on ABP over a 1-year period. The study population included men and women 40 to 65 years of age who had not taken antihypertensive medications during the preceding 6 months. The participants displayed no clinical evidence of coronary artery disease, diabetes, or kidney disease as diagnosed by history, routine blood tests, and urinalysis. In addition, subjects were in a cohabiting relationship, had been continuously employed for a minimum of 6 months, and were employed full-time. Information on their partners was not collected. Subjects were recruited from a large university teaching hospital in response to local advertisements and seminars that discussed cardiovascular risks. Eligible subjects were excluded if they became ill and required medical therapy (one subject), if they did not complete the required components for baseline (three subjects), or if they withdrew from the study (one subject). No subject refused to fill out the questionnaires. Variables elicited under supervision included gender, age, ethnic background, premature coronary artery disease (first-degree relative), education level, body mass index (BMI), smoking, alcohol use, participation in a stress management or relaxation technique program more than once per week, regular exercise (participation in any aerobic exercise >30 min/week), and total family income. Marital cohesion was measured by the Dyadic Adjustment Scale (DAS), and job strain was measured using the Job Content Questionnaire (JCQ). Both instruments are well validated, reliable methods of measurement.

The DAS is a 32-item measure that is widely published as an instrument of marital adjustment. It has high internal consistency and test–retest reliability, as well as established concurrent and predictive validity. In an earlier study of individuals with mild hypertension, we demonstrated that a small noncohesive group (ie, those with cohesion below the mean as measured by the DAS) had an elevated night-time and 24-h ambulatory DBP of 6 mm Hg when compared with the other study participants. The results demonstrated that lower cohesion was related to elevated night-time SBP and increased 24-h and night-time DBP.

Job strain, that is, the combination of excessive job demands and diminished job latitude, is a construct developed by Karasek et al and has been shown to be associated with cardiac events such as myocardial infarction and essential hypertension. Job demands and latitude were assessed by the JCQ, a self-administered instrument designed to measure social and psychological characteristics of work. Measures of exhaustion and burnout are more consistently associated with high psychological demands, whereas depression and anxiety measures are more strongly associated with low decision latitude.

A power analysis determined that a sample size of 250 would be sufficient to detect an $R^2$ of 2% attributed to one independent variable using an $F$-test with a significance level ($\alpha$) of 0.05 and 81% power. The analysis was based on statistical results from the recently completed, 3-year, prospective trial that examined the effects of marriage and job stress on ABP and left ventricular mass. The variables tested were adjusted for four additional independent variables with an $R^2$ of 0.36. A total of 608 individuals were screened for participation and 327 were found to be eligible for participation. A total of 254 subjects consented and were enrolled, and 248 completed all of the baseline studies. Of the subjects, 150 were health care workers and 98 were volunteers and visitors. All subjects gave informed consent after written and oral discussions of the protocol with study personnel. The Research Ethics Board of Sunnybrook and Women’s Health Sciences Centre, Toronto, ON, approved this study.

Measurement of BP

The ambulatory blood pressure (ABP) monitoring was performed on a typical working day using an ambulatory monitor (model 90207; SpaceLabs, Redmond, WA) with BP recorded every 15 min during daytime hours and every hour between 11 PM and 7 AM. Mean values were obtained for SBP and DBP for the entire 24-h period, which was separated further into sleep and daytime. Work time and waking contact time with the spouse was determined by diary recordings and were separated using the calliper function of the ABP Report Management System 1.03.11 (SpaceLabs, Redmond, WA).

Procedure

After subjects were determined to be eligible, informed consent was obtained, followed by office measurement of BP and ABP monitoring during a working day. In addition, subjects completed a battery of questionnaires including an assessment of job strain with the JCQ and marital cohesion using the DAS.

Statistical Analyses

Multiple regression analyses were performed. The following were selected as predictors of the dependent variables: age, gender, BMI, ethnicity (white or otherwise), family history of cardiovascular disease, current smoker, drinker (>10 drinks/week), education level (more than high school education versus less), regularly practiced relaxation techniques, regular exercise, and total family income. Job strain was defined as those in the highest 20th percentile for job demands and the lowest 20th percentile for job latitude on the JCQ. Marital cohesion is a sub-scale of
the DAS and is coded as a continuous variable with higher scores representing more cohesive relationships.

Dependent variables were SBP and DBP recorded over 24 h, during work and during face-to-face contact with the spouse. Hypertension was defined as 24-h ABP ≥130/80 mm Hg.19 To test an interaction of BP and the strain variables, mean 24-h SBP was added to a model as a covariate along with the interaction terms with job strain and marital cohesion. Dependent variables for this analysis were the SBP during work, spousal contact, and sleep. All results are presented as the mean ± standard deviation.

Results

There were 248 subjects (135 women and 113 men), with a mean age of 50.8 years (±6.6 years). In all, 77% were of white ethnicity and 5.6% were African American; 91% had post-secondary education, 11.6% consumed >10 alcoholic drinks/week, 8.1% were smokers, 21.3% had job strain, 72% had satisfactory marital adjustment (DAS score >100), and 34% had 24-h ABP ≥130/80 mm Hg. Of these, 129 worked inside the Health Sciences Centre. These included 56 clerical, technical, and administrative workers, 36 nurses, 19 secretarial staff, and 18 physicians. The remaining 119 worked outside the Health Sciences Centre (for characteristics of the study participants, see Table 1). Overall, the cohort was highly educated, with large family incomes. Slightly more than three quarters were of white ethnicity, with relatively low rates of smoking and alcohol intake. The highest levels of BP for both normotensive and hypertensive subjects were recorded during work, followed by contact with the spouse (Table 2). A multiple regression analysis, with 24-h SBP as the dependent variable, demonstrated that age (P = .039), alcohol consumption (P = .033), job strain (P = .007), male gender (P = .004), and marital cohesion (P = .048) were significant variables for higher BP. Regular exercise, on the other hand, was found to be associated with lower BP (P = .037). Similar results were obtained with work SBP as the dependent variable, with alcohol (P = .009), BMI (P = .037), gender (P < .001), and job strain (P = .025) also emerging as significant variables. SBP during spousal face-to-face time, when considered as the dependent variable, was also found to be significantly associated with age (P = .017), alcohol (P = .002), job strain (P = .012), and gender (P = .001). Marital cohesion was associated with 24-h SBP but not during work or during spousal contact (Table 3). To investigate this finding and to test for a possible interaction among BP, job strain, and marital cohesion that would explain it, a regression analysis including this interaction term was carried out. With SBP at work as the dependent variable, the interaction was statistically significant in the negative direction. Therefore, in subjects with the highest 24-h SBP and job strain, high marital cohesion was associated with lower BP (P = .008). This interaction term was also found to be significant in models looking at SBP during spousal contact (P = .035) and during sleep (P = .021). The moderating interaction of marital cohesion on BP in people with job strain explains the unexpected finding of an association of marital cohesion with higher BP in the main effects model.

The multiple regression analyses found in Table 3 demonstrate the independent associations between SBP over 24 h, at work, and during face-to-face contact with the spouse. The regression coefficients in Table 3 demonstrate the unique contribution of this variable. For the different models, the overall adjusted $R^2$ for 24-h SBP was 0.1077; for SBP at work, 0.1506; and for SBP with the spouse, 0.1290. Ambulatory SBP was found to increase >4 mm Hg in the presence of job strain over 24 h. In addition, SBP was found to increase by 2.1 mm Hg for every decade of life in the study population (age 40 to 65 years) and with increasing BMI.

**Table 1.** Demographic characteristics of all subjects and by classification hypertensive status (mean ± SD)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>N (male/female)</td>
<td>113/135</td>
</tr>
<tr>
<td>Age, mean (SD)</td>
<td>50.8 (6.6)</td>
</tr>
<tr>
<td>BMI (kg/m²), mean (SD)</td>
<td>26.54 (4.73)</td>
</tr>
<tr>
<td>Family history of hypertension (%)</td>
<td>72.5% (2.8)</td>
</tr>
<tr>
<td>Further education (yes/no)</td>
<td>91.5% (1.8)</td>
</tr>
<tr>
<td>Family income ($ 1000s)</td>
<td>55.6 (35.4)</td>
</tr>
<tr>
<td>Current smoker</td>
<td>8.1% (1.7)</td>
</tr>
<tr>
<td>Drinks &gt;10/week</td>
<td>11.6 (2.0)</td>
</tr>
<tr>
<td>Relaxation techniques used</td>
<td>17.1% (2.4)</td>
</tr>
<tr>
<td>Family history of coronary artery disease</td>
<td>35.5% (3.0)</td>
</tr>
<tr>
<td>Exercise regularly</td>
<td>88.3% (2.0)</td>
</tr>
<tr>
<td>White ethnicity</td>
<td>77% (2.7)</td>
</tr>
</tbody>
</table>

Data are means ± SD. Income is in $ US at the time that the study was conducted (2001 to 2003).

**Table 2.** Ambulatory blood pressure (ABP) monitoring results over 24 h, at work, during face-to-face spousal contact and during sleep

<table>
<thead>
<tr>
<th>ABP</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-h BP (mm Hg)</td>
<td>121.1 (10.4)/75.2 (7.6)</td>
</tr>
<tr>
<td>24-h HR (beats/min)</td>
<td>73.3 (8.5)</td>
</tr>
<tr>
<td>Work BP (mm Hg)</td>
<td>127.3 (11.7)/81.3 (8.5)</td>
</tr>
<tr>
<td>Sleep BP (mm Hg)</td>
<td>107.6 (10.2)/63.3 (8.2)</td>
</tr>
<tr>
<td>Spousal contact BP (mm Hg)</td>
<td>124.6 (11.1)/77.8 (8.6)</td>
</tr>
</tbody>
</table>

BP = blood pressure; HR = heart rate. Data are means ± SD.

**Discussion**

The findings from the baseline Double Exposure study reveal a robust association between job strain and sustained BP, as noted by elevations in SBP over 24 h, during
Table 3. Parameter estimates and $P$ values for regression analysis main effects model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter estimate</th>
<th>$P$</th>
<th>Variable</th>
<th>Parameter estimate</th>
<th>$P$</th>
<th>Variable</th>
<th>Parameter estimate</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-h SBP</td>
<td></td>
<td></td>
<td>SBP at work</td>
<td></td>
<td></td>
<td>SBP with spouse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>91.93</td>
<td>&lt;.0001</td>
<td>Intercept</td>
<td>-94.92</td>
<td>&lt;.0001</td>
<td>Intercept</td>
<td>91.56</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Smoking</td>
<td>.14</td>
<td>.954</td>
<td>Smoking</td>
<td>.604</td>
<td>.831</td>
<td>Smoking</td>
<td>3.17</td>
<td>.263</td>
</tr>
<tr>
<td>Degree</td>
<td>2.89</td>
<td>.269</td>
<td>Degree</td>
<td>3.24</td>
<td>.253</td>
<td>Degree</td>
<td>3.59</td>
<td>.209</td>
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<tr>
<td>Relaxation tech</td>
<td>-.61</td>
<td>.736</td>
<td>Relaxation tech</td>
<td>-.81</td>
<td>.679</td>
<td>Relaxation tech</td>
<td>1.12</td>
<td>.574</td>
</tr>
<tr>
<td>White</td>
<td>1.86</td>
<td>.276</td>
<td>White</td>
<td>3.94</td>
<td>.035</td>
<td>White</td>
<td>3.59</td>
<td>.571</td>
</tr>
<tr>
<td>Income/$1000</td>
<td>.01</td>
<td>.446</td>
<td>Income/$1000</td>
<td>.005</td>
<td>.529</td>
<td>Income/$1000</td>
<td>.01</td>
<td>.932</td>
</tr>
<tr>
<td>Alc drink &gt;10/week</td>
<td>4.46</td>
<td>.033</td>
<td>Alc drink &gt;10/week</td>
<td>5.96</td>
<td>.009</td>
<td>Alc drink &gt;10/week</td>
<td>7.14</td>
<td>.002</td>
</tr>
<tr>
<td>Fam HX CVD</td>
<td>2.65</td>
<td>.062</td>
<td>Fam HX CVD</td>
<td>4.22</td>
<td>.008</td>
<td>Fam HX CVD</td>
<td>2.27</td>
<td>.151</td>
</tr>
<tr>
<td>Exercise (Yes)</td>
<td>-4.19</td>
<td>.037</td>
<td>Exercise (Yes)</td>
<td>-4.27</td>
<td>.054</td>
<td>Exercise (Yes)</td>
<td>-3.27</td>
<td>.141</td>
</tr>
<tr>
<td>Marital cohesion</td>
<td>.31</td>
<td>.048</td>
<td>Marital cohesion</td>
<td>.27</td>
<td>.111</td>
<td>Marital cohesion</td>
<td>.15</td>
<td>.385</td>
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<tr>
<td>Job strain</td>
<td>4.53</td>
<td>.007</td>
<td>Job strain</td>
<td>4.11</td>
<td>.025</td>
<td>Job strain</td>
<td>4.59</td>
<td>.012</td>
</tr>
<tr>
<td>Male</td>
<td>4.18</td>
<td>.004</td>
<td>Male</td>
<td>5.64</td>
<td>.0003</td>
<td>Male</td>
<td>5.15</td>
<td>.001</td>
</tr>
<tr>
<td>Age (Y)</td>
<td>.21</td>
<td>.039</td>
<td>Age (Y)</td>
<td>.20</td>
<td>.073</td>
<td>Age (Y)</td>
<td>.27</td>
<td>.017</td>
</tr>
<tr>
<td>BMI (units)</td>
<td>.30</td>
<td>.054</td>
<td>BMI (units)</td>
<td>.35</td>
<td>.037</td>
<td>BMI (units)</td>
<td>.32</td>
<td>.05</td>
</tr>
</tbody>
</table>

Alc drinks >10/week indicates >10 alcoholic drinks per week (one drink = one bottle of beer, one glass of wine, or one shot of hard liquor). Fam HX CVD = family history of cardiovascular disease; BMI = body mass index; SBP = systolic blood pressure; tech = techniques.

Each parameter estimate indicates the estimated effect on blood pressure in mm Hg by that variable and its direction, for a unit change in the score the regression coefficient is the change in the dependent variable while adjusting for other variables in the model.
work, and during spousal contact. Job strain has been positively associated with high BP levels in men,20–25 and more recently such an association has also been found in women.26,27 The term “job strain” applies to individuals that Karasek et al would have referred to as experiencing high strain with high job demands and low job control.13

The homogeneity of the present sample (high status, high income) and a majority of women who had achieved a high education level may affect the generalizability of these findings; however, these factors were controlled for in the regression analyses. The pressor effect of job strain in highly educated women has been previously described.28 In the current study, there was no direct effect of marital cohesion on sustained BP in the main effects model, yet our previous study demonstrated that low marital cohesion was associated with elevated DBP.29 This earlier study, however, included only individuals with mild hypertension, and no normotensive control subjects were included. More than one third of the Double Exposure cohort had BP >130/80 mm Hg. The cohort of the Double Exposure study (namely, individuals with early untreated hypertension and a large group of normotensive individuals who participated in a study to evaluate cardiovascular risk involving ABP monitoring) were likely to be vulnerable to the impact of psychosocial factors on BP before other physiologic factors became established. In the current study, a robust effect on sustained BP is less likely to occur as in our study of individuals with mild hypertension, because of the predominantly normotensive population. However, marital factors may have more of an impact when the elevation of BP is already present.

The acute impact of mental stress on BP shows a greater association with SBP and may explain in part the association between marital cohesion and sustained BP in the current study.20–25 This earlier study, however, included only individuals with mild hypertension, and no normotensive control subjects were included. More than one third of the Double Exposure cohort had BP >130/80 mm Hg. The cohort of the Double Exposure study (namely, individuals with early untreated hypertension and a large group of normotensive individuals who participated in a study to evaluate cardiovascular risk involving ABP monitoring) were likely to be vulnerable to the impact of psychosocial factors on BP before other physiologic factors became established. In the current study, a robust effect on sustained BP is less likely to occur as in our study of individuals with mild hypertension, because of the predominantly normotensive population. However, marital factors may have more of an impact when the elevation of BP is already present.

The interactional relationship between marital cohesion, job strain, and higher BP in the current study supports the double exposure hypothesis. That is, marital cohesion was shown to be a moderating factor on participants with the highest concurrent SBP and job strain. This suggests a “double exposure” effect as marital cohesion interacted with job strain to influence BP. Thus, marital cohesion may protect against the pressor effect of job strain. This interaction explains the finding of a weak association between marital cohesion and higher 24-h BP in the main effects model. Indeed, higher ABP at work and during face-to-face contact with the spouse indicates that activities that involve job stress and interpersonal interactions can effect elevations in BP. The exact mechanism responsible for this finding is unknown and needs to be further explored.

In summary, this study shows an association between job strain, marital cohesion, and BP in which marital cohesion has a moderating influence on the elevation of BP resulting from job strain.

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