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Changes in job strain in relation to changes in physiological state

A longitudinal study

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THEORELL T, PERSKI A, ÅKERSTEDT T, SIGALA F, AHLBERG-HULTÉN G, SVENSSON J, ENEROTH P. Changes in job strain in relation to changes in physiological state: A longitudinal study. *Scand J Work Environ Health* 14 (1988) 189–196. A sample of 73 men and women aged 22–63 years and working in six different occupations (air traffic controllers, waiters, physicians, symphony orchestra musicians, baggage handlers, and airplane mechanics) participated in a longitudinal study four times during a year. The spontaneous variations in job strain (determined as the self-reported ratio between psychological demands and decision latitude) were substantial. The average difference between the occasion with the highest level of strain and the occasion with the lowest level was 25 % of the total mean. Systolic blood pressure during workhours, as well as self-reported sleep disturbance, increased when demands increased in relation to decision latitude. Among men with a depressive tendency (according to a diary) morning plasma prolactin levels increased markedly with increasing job strain. Among subjects with a positive family history of hypertension the increase in systolic blood pressure at work was particularly pronounced, and among the men in this group a lower than expected level of morning cortisol was found measured during the period with the highest level of strain.

Key words: blood pressure, cortisol, depression, heredity, occupation, prolactin, psychological stress, work.

Job situations described as psychologically demanding and at the same time with few possibilities for the workers to influence decisions and/or to find intellectual discretion have been described as “strained.” Persons in such jobs have been shown to have an elevated risk of having (cross-sectional) or developing (prospective) cardiovascular illness (3, 4, 10, 13, 16, 18). In a theoretical paper we attempted to formulate a hypothesis explaining this association (14). Some of the association may be due to health habits — such as smoking, eating and drinking habits — which may be adversely influenced by a boring life situation in general. But some of the association may also be due to direct effects of the job strain on physiological variables. In the present paper we have focused on the second possibility.

Our previously formulated hypothesis regarding the physiological consequences of job strain implies that strain activates the sympathoadrenomedullary system, as well as the hypophyseoadrenocortical system.

Previous studies have related measures of job strain at one point in time to illness outcome at the same time or some time in the future. In the present study we have

studied spontaneous fluctuations in job strain on four occasions during a year in a group of working men and women. Then we have related these changes to changes in physiological parameters. Individual associations between job strain and physiology have then been statistically summarized at the group level. Thus, in the present study, the objective was to explore associations between changes in job strain on one hand and changes in physiological states on the other.

Subjects and methods

Subjects

The present study was part of a larger investigation aimed at exploring cardiovascular risk factors in contrasting occupations. A stratified sample of men and women in six different occupations (symphony orchestra musicians, air traffic controllers, physicians, baggage handlers, waiters, and airplane mechanics) was recruited, altogether 327 persons. For the purpose of the present study only those subjects were included who had completed questionnaires four times during the study. In order to exclude systematic effects of seasonal variations, we recruited the subjects in three different groups with an equal number in each. In all, 73 subjects (22 % of the total sample) filled the requirement of having completed four questionnaires. Table 1 shows the sex distribution of the subjects by occupation.

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Table 1. Number of men and women in the different occupational groups.

Occupation	Men	Women
Symphony orchestra musicians	8	3
Air traffic controllers	11	5
Physicians	10	7
Baggage handlers	7	—
Waiters	3	7
Airplane mechanics	12	—

The men had a mean age of 41.4 (SD 10.0, range 26–60) years, and the age of the women averaged 36.6 (SD 9.6, range 22–63) years. The age distribution was similar in the different occupational groups with the exception of that of the air traffic controllers, who had a slightly lower mean age than other groups since no air traffic controllers older than 52 could be sampled.

The musicians were recruited from the Swedish Radio Symphony Orchestra, which is a highly professional orchestra with an international reputation. This orchestra has to play many pieces of extremely difficult contemporary music that demand a high degree of attention. The physicians were recruited from a group of clinically active physicians from a suburban area with both rural and metropolitan sections. The air traffic controllers, baggage handlers, and airplane mechanics were recruited from the Stockholm Arlanda airport, which serves both international and domestic traffic. By European standards the Arlanda airport is relatively large. The waiters were recruited from three different locations in Stockholm and represented widely different kinds of restaurants.

Questionnaires

Job strain was measured by means of a self-administered questionnaire, a Swedish modification of the questionnaire introduced by Karasek and based upon a factor analysis of the American Quality of Employment Survey in 1977 (12). The version used in this study had four response alternatives for each item, and each item was given a grade of one to four. The items were not weighted. The demand dimension was computed from five items, and the decision latitude dimensions, a summation of skill discretion and authority over decisions, from six items. Job strain was computed by means of dividing the demand scores by those for decision latitude. For each subject the results of the ques-

tionnaires on the four different occasions were used to determine the degree of job strain on the occasion in question. Table 2 shows the mean job strain scores for the four occasions. There was no difference between the men and women with regard to reported job strain. The average change in the job strain ratio from the worst to the best occasion was 0.23 with a standard deviation of 0.016 and a range of 0.05 to 0.83. The highest levels were recorded for the waiters, who claimed the highest demand levels and also occupied a low position on the decision latitude scale. The next highest levels were determined for the baggage handlers, who reported a very low level of intellectual skill. The third highest position was held by the air traffic controllers, who claimed relatively high demands and a relatively poor authority over decisions. The most dramatic differences were found in the groups with the highest average scores — waiters and baggage handlers.

Variables

The sleep disturbance index was derived from a questionnaire introduced by Åkerstedt (1, 2). It has questions dealing with difficulties in falling asleep, difficulties in staying asleep, and feelings of tiredness. Each item was scored from zero to three, and the items were added for the total score. In this sample the total scores ranged from 0 to 23. The standard error of the mean varied from 0.59 to 0.65. The distribution was close to normal.

Adrenocortical (cortisol) and hypophyseal (prolactin) responses

Blood was drawn in the morning before the workday started for the determination of the adrenocortical and hypophyseal responses. For the waiters it was difficult to keep the time of the blood sampling constant. For the other groups the blood sampling varied by no more than 1 h on the blood sampling occasions for one and the same individual. The average sampling hour of all the groups but the waiters was comparable. Three of the waiters had their blood samples taken in the middle of the day, and in these cases the difference in sampling time between the occasions was larger than for the other workers. Due to the known circadian variation of cortisol (23) these differences may have introduced a random error for this group. No systematic

Table 2. Average job strain scores of the six occupational groups on the occasions when the questionnaires were filled out, the occasions being classified according to their degree of strain.

Degree of strain	Job strain scores					
	Symphony orchestra musicians (N = 11)	Air traffic controllers (N = 16)	Physicians (N = 17)	Baggage handlers (N = 7)	Waiters (N = 10)	Airplane mechanics (N = 12)
Highest	0.96	0.98	0.86	1.04	1.10	0.81
Next highest	0.85	0.89	0.80	0.92	0.93	0.74
Next lowest	0.82	0.83	0.73	0.85	0.84	0.68
Lowest	0.74	0.76	0.68	0.77	0.73	0.61

bias, however, has been introduced for the waiters with regard to variations between occasions, but, since the average sampling time was somewhat later than in the other groups, the mean cortisol level of the waiters may have been somewhat underestimated.

Blood was drawn from the subject without previous rest in the supine position. Registered nurses performed all the blood sampling, which took place at the work site or in close vicinity to it before work started in the morning.

The plasma cortisol and plasma prolactin concentrations were determined by means of methods of the Diagnostic Products Corporation, Los Angeles, California (cortisol NO predilution 125 l double antibody radioimmunoassay and double antibody prolactin — NHS, respectively).

Adrenomedullary responses

Blood pressure was measured by the subjects themselves by means of self-triggered equipment, Cardiocare 2000. The agreement with conventional blood pressure measurement performed on the same occasion by trained personnel had proved to be excellent for systolic blood pressure — interrater reliability coefficient 0.95 for patients at a hypertension clinic and 0.85 for a sample of healthy subjects unaccustomed to blood pressure measurements. The corresponding coefficients for diastolic blood pressure were not quite as good, ie, 0.79 and 0.73, respectively. Blood pressure was measured without the subjects' having rested and with them in the sitting position. The instruments were calibrated at regular intervals. On each measurement occasion a conventional measurement was performed at the start of the workday in order to detect technical problems in the equipment. The subjects were instructed to measure their blood pressure as close to once an hour as possible. Average blood pressure was computed for the work period and for a period of leisure time. At least three measurements were required for the computation of average blood pressure at work or during leisure time. On the average seven measurements at work and six measurements during leisure time constituted the individual means presented. There was no difference in the average number of recordings per individual between the four occasions.

It is important to emphasize that the reported job strain did not show any variation in relation to the first to fourth measurement and also no seasonal variation. Thus the first to fourth measurements were randomly distributed across the job strain ratio.

Modifying factors

Family history of hypertension was hypothesized to influence both the level of blood pressure and the blood pressure reactions to job strain. One question was used, namely, "Has anyone in your family (parent or siblings) had high blood pressure before the age of

60?" Subjects who responded to this question with "yes" were operationally defined as having a positive family history of hypertension. Depressive tendency was explored by means of a diary which the subjects filled out every time they measured their blood pressure. Subjects who reported feeling rather or very sad or depressed at least once were operationally defined as having a depressive tendency.

Statistical methods

For each dependent variable an analysis of variance was performed for repeated observations. Furthermore a two-tailed paired t-test was used to determine whether the difference between the occasion with the highest and the lowest strain was significant. The results of the total sample, the men only, those with a positive family history of hypertension, and those with a depressive tendency were subjected to these tests. Unpaired two-tailed t-tests were used to determine whether, on the occasion with the most strain, those with a family history of hypertension and those with a depressive tendency differed significantly from the other subjects with regard to the dependent variables. The results of the total sample, those of the men only, those of persons with a depressive tendency, and those of persons with a positive family history of hypertension were also analyzed with these tests. For all the dependent variables a two-way analysis of variance was used to test the interaction between job strain and family history of hypertension and depressive tendency. This test was also applied to the results of the total sample, those of the men only, those of the persons with a positive family history of hypertension, and those of the persons with a depressive tendency. Finally, we used the two-way analysis of variance to test the interaction between occupation and job strain for each of the dependent variables for the total sample only.

The statistical tests for the two endocrinological variables were performed only for the men. The results were subjected to a logarithmic transformation since the distributions of both variables were markedly skewed.

Stepwise regression analyses were used to explore factors of relevance for physiological change (from least to worst strain).

Results

Sleep disturbance

Table 3 shows the average scores of sleep disturbance on the four assessment occasions.

The statistical analyses showed increasing sleep disturbance from the lowest to the highest degree of job strain of the total group ($P=0.03$, analysis of variance). The difference between the average sleep disturbance scores on the most and least strainful occasions was highly significant for the total group ($P=$

Table 3. Average scores of sleep disturbance in relation to the degree of strain on the four assessment occasions.

Degree of strain	Sleep disturbance scores			
	Total sample (N = 71)	Men only (N = 50)	Persons with a positive family history of hypertension (N = 20)	Persons with a depressive tendency (N = 20)
Highest	11.6	11.7	11.0	13.6
Next highest	11.0	10.2	10.8	13.9
Next lowest	11.0	10.5	10.5	13.1
Lowest	10.4	9.9	9.6	13.1

Table 4. Average plasma cortisol concentration in relation to the degree of job strain on the four assessment occasions (men only). Statistics have been based upon log (n) concentrations. The means presented in the table were subsequently derived from anitlog (n) computations.

Degree of strain	Plasma cortisol (mmol/l)		
	All men (N = 50)	Men with a positive family history of hypertension (N = 15)	Men with a depressive tendency (N = 9)
Highest	437	369	404
Next highest	451	408	416
Next lowest	469	437	420
Lowest	420	400	408

Table 5. Average plasma prolactin concentration in relation to the degree of job strain on the four assessment occasions (men only). Statistics have been based upon log (n) concentrations. The means presented in the table were subsequently derived from anitlog (n) computations.

Degree of strain	Plasma prolactin (ng/l)		
	All men (N = 46)	Men with a positive family history of hypertension (N = 15)	Men with a depressive tendency (N = 8)
Highest	4.30	3.66	6.34
Next highest	3.25	3.49	2.69
Next lowest	3.52	3.96	2.20
Lowest	3.52	4.99	1.89

Table 6. Average systolic blood pressure (mm Hg^a) at work in relation to the degree of job strain on the four assessment occasions.

Degree of strain	Systolic blood pressure (mm Hg ^a)			
	Total sample (N = 58)	Men only (N = 40)	Persons with a positive family history of hypertension (N = 18)	Persons with a depressive tendency (N = 14)
Highest	129	133	132	130
Next highest	126	130	130	125
Next lowest	126	131	127	124
Lowest	125	129	126	125

^a 1 mm Hg = 0.13 kPa.

0.001, paired two-tailed t-test) and significant for the group with a positive family history of hypertension ($P = 0.03$). Among those with a positive family history of hypertension there was a significant two-way interaction between depressive tendency and job strain ($P = 0.02$, two-way analysis of variance). Among those without a depressive tendency there was a significant increase in the sleep disturbance scores with increasing job strain. Those with a depressive tendency tended to have high scores regardless of the degree of job strain.

Endocrinologic changes

Table 4 shows the mean concentrations of plasma cortisol on the four assessment occasions. Neither all of the men together nor their subgroups showed any changes in the average concentration with increasing job strain. Men with a positive family history of hypertension ($N = 15$) had a significantly lower concentration than the other men ($N = 35$) on the occasion with the highest degree of job strain ($P = 0.04$, unpaired two-tailed t-test).

Table 5 shows the average concentrations of prolactin on the four assessment occasions. The numbers of subjects in the table differ from those in table 4 because the cortisol assays were made before the prolactin assays. Occasionally the blood samples were too small or lost. Since all four analyses were required for inclusion in the present analysis, several subjects were lost.

The only analysis that was statistically significant in the case of prolactin was the two-way interaction between job strain and depressive tendency for the total sample ($P = 0.05$, two-way analysis of variance). Another indication of the same tendency was the finding that the eight men with a depressive tendency had a much more pronounced average difference in the prolactin concentration between the occasion with the highest and the lowest job strain score than the other subjects ($P = 0.03$, unpaired two-tailed t-test). Thus, while the group with a depressive tendency did not differ from the others with regard to the average level of prolactin plasma, it had a much larger fluctuation in prolactin level, and this fluctuation was clearly associated with job strain — lower than the average level when job strain was low and higher than the average level when job strain was high.

Blood pressure

Table 6 shows the mean systolic blood pressure during workhours on the four assessment occasions. The systolic blood pressure increased with increasing job strain in the total group ($P = 0.02$, one-way analysis variance). The differences between the occasion with the highest and lowest degree of job strain were significant for the total sample ($P = 0.03$), the men ($P = 0.05$), and the subjects with a positive family history of hypertension ($P = 0.02$). The diastolic blood pressure

at work, as well as the systolic and diastolic blood pressure during leisure time, showed no relationship to job strain in this longitudinal study.

For systolic blood pressure during workhours, finally, a linear regression was calculated for each subject with each of the following variables as independent variables: the demand/decision latitude ratio, demand, and decision latitude. Systolic blood pressure at work constituted the dependent variable in these analyses. For each subject a regression coefficient was computed which showed the degree of change in the systolic blood pressure for each unit of change in the dependent variable. For all the three pairs of variables, a mean regression coefficient and the standard error of the mean were calculated. Finally, whether this mean was significantly different from zero was determined, and, on the average, there was no significant relationship.

The analyses of linear regression showed that a change in one average standard deviation of the job strain ratio corresponded to a change of 2 mm Hg (0.27 kPa) in systolic blood pressure during the workhours ($P=0.03$). The effect of demand as a single factor was more significant ($P=0.01$) than the effect of decision latitude as a single factor (not significant) although the effect of both were in the expected direction — the more the increase in demand and the more the decrease in decision latitude, the higher the blood pressure.

Multiple predictors of physiological change

A stepwise multiple regression analysis using family history of hypertension, age, depressive tendency, difference (highest/lowest) in job strain, and change (highest/lowest) in sleep disturbance as explaining variables and change (highest/lowest) in the cortisol concentration as the dependent variable revealed that change in sleep disturbance was the only variable that had any statistically significant explanatory power. The less the increase in sleep disturbance, the greater the increase in morning plasma cortisol. The percentage of explained variance was 11. The corresponding analysis for prolactin showed that depressive tendency and a positive family history of hypertension were the only factors that had any statistically significant importance as independent variables. The explained variance was 8 % for depressive tendency and 9 % for family history of hypertension. Men with a depressive tendency and a lack of family history of hypertension had greater differences in their prolactin concentration than the other men did.

The corresponding analyses using the same explanatory variables but systolic and diastolic blood pressure as dependent variables showed that a positive family history of hypertension was the only variable that independently predicted blood pressure change.

Occupation

A two-way analysis of variance for the interaction between occupation and job strain was performed for

the two questionnaire outcome measures and for the three physiological outcome variables. For systolic blood pressure at work a significant interaction between occupation and job strain was observed ($P=0.01$ for the total sample and $P=0.05$ for the men only, two-way analysis of variance). The waiters had a much greater increase in blood pressure with increasing job strain than the other groups did. The mean systolic blood pressure at work for the waiters on the occasion with the lowest degree of job strain was 120.1 mm Hg (16.01 kPa), whereas on the occasion with the highest degree of job strain the corresponding mean was 131.6 mm Hg (17.55 kPa). Blood pressure was the only outcome variable that showed a statistically significant interaction between job strain and occupation. Prolactin was the only outcome variable that showed a statistically significant difference between the occupational groups (main effect for occupation in the two-way analysis of variance $P=0.0004$). This analysis, as well as the corresponding one for plasma cortisol, was made only for the men. The physicians had the lowest average concentration, and the waiters and mechanics had the highest. We found no differences with regard to the cortisol concentrations of the occupational groups.

However, an analysis based on the same study but utilizing all male participants in the study, even those who participated only one, two, or three times, showed a statistically significant difference between the occupational groups ($P=0.001$, one-way analysis of variance). In this case the male physicians had the highest cortisol levels (25). Thus the physicians in the present study tended to have high cortisol and low prolactin levels.

Discussion

The study has been based upon a relatively small sample and needs to be replicated in larger groups. A large number of statistical tests have been performed for the subgroups, and there is a risk that some of the associations may have occurred by chance. Nevertheless many of the results follow biological patterns that have been described previously.

As far as we know, this is the first study that has analyzed the physiological effects of job strain systematically with a longitudinal perspective according to the terminology suggested by Karasek (12). We have utilized the spontaneous fluctuations that may occur in job strain during the course of a year. The job strain ratio (demand divided by latitude) was calculated from a slight modification of the original questionnaire that was based upon a factor analysis of the Quality of Employment Survey in the United States in 1977. The ratio did not depend on season and did not change systematically from the first to the second or from the second to the third or from the third to the fourth measurement. It showed considerable variation over the course of a year, and thus a study of the

physiological effects of these changes was considered appropriate. The questionnaire for measuring sleep disturbance has been used in several previous studies. Self-triggered measurement of blood pressure has been considered sufficiently accurate — at least the systolic one — and has been judged as more interesting than blood pressure at rest as a physiological indicator of strain. Cortisol has been widely recognized as one of the most sensitive indicators of distressed feelings in situations which require adaptation (20). According to Henry et al (9), defeat and loss of control are central components in cortisol responses to a threat. Cortisol and the corticosteroids in general are assumed to be of importance in the pathogenesis of hypertension (29). Prolactin is less established as a stress hormone, but we know from previous research that it may be either elevated or depressed in stressful situations, and it has been shown to be very sensitive to fluctuations in mood (19). In a previous study by our group, we were able to show that a program which activated an early grief process in relatives of cancer patients induced marked elevations in plasma cortisol during the terminal phase of the illness. During earlier phases the activation program was associated with a tendency towards decreased prolactin levels. After the death of the patients the relatives reported less mental exhaustion and less sleep disturbance than a group of relatives of cancer patients selected in the same way but not exposed to the activating program (7).

The two modifying factors tendency to become depressed and family history of hypertension have been extensively studied in the literature. A tendency to become depressed has been associated with a number of psychosomatic diseases, including cancer. In the present study a somewhat unusual method was used, namely, diaries. It has been stated that diaries give an immediate and closer picture of mood than other kinds of questionnaires (17). A family history of hypertension is considered to be one of the major risk factors for hypertension (5). Hypertensive subjects may have a tendency to underreport symptoms, as has been pointed out by Tibblin et al (28). They also may have alexithymic tendencies which could result in a major disturbance in reporting both symptoms and environmental conditions (27). A recent study has shown that subjects with a positive family history of hypertension but without hypertension are more alexithymic and they react with more blood pressure elevation to stressors than other persons (11). In the present study it was hypothesized that subjects with a positive family history of hypertension would have a tendency to underreport subjective symptoms.

The group studied in our investigation could not be said to be representative of the working population in Sweden. The dropout frequency was considerable, and only groups offering various kinds of services were included. However, a substantial variation between the studied groups was found with regard to job strain.

Since the conclusions in the study are based upon longitudinal observations, there is no *a priori* reason to believe that any important bias would have arisen due to the dropout rate. It could be, however, since the dropout frequency was greater in the groups belonging to lower socioeconomic strata and since the association between change in job strain and blood pressure change was stronger in these groups, that an underestimation of the strength of the association may have occurred.

Of the studied subjects, two men (one symphony orchestra musician and one air traffic controller) were on moderate doses of betablocking medication, and one baggage handler and one female waiter were on small doses of diuretics. No other medication relevant to blood pressure regulation or the studied hormones was taken by the participants. All medication was kept on a constant level during the study period. Therefore medication is unlikely to explain any of the findings. No significant changes in smoking habits or in the blood concentration of the liver enzyme gamma glutamyl transferase (whose elevation may be an indicator of excessive alcohol consumption) were observed. Thus changes in tobacco and alcohol consumption are also not likely to explain the findings.

The findings may be summarized in the following way: When demands increased in relation to decision latitude, there were marked changes in sleep disturbance and in systolic blood pressure during the workhours. There was no change in the plasma cortisol or prolactin levels, but among those who reported a depressive tendency the prolactin levels showed wide fluctuations ranging from low levels when the job strain levels were low to high levels when the job strain levels were high. These findings are consistent with our hypotheses and with findings in cross-sectional studies. Thus Karasek, in a Swedish population study (12), found that feelings of exhaustion were much more common among workers who reported high demands and low decision latitude than among other workers. Johnson (in an unpublished report to the Swedish Work Environment Fund in 1985) and Nyrén (22) have shown that functional gastrointestinal symptoms are associated with job strain. Our own group has previously shown that systolic blood pressure during workhours is higher among those 28-year-old men who had had high blood pressure at the age of 18 years and who then worked in occupations with strain than in other 28-year-old men (26). That finding is consistent with the observation in the present study that most of the blood pressure change was accounted for by those who had a positive family history of hypertension. Pieper et al (paper under preparation) found that, in several population studies in the United States, systolic blood pressure measured in the conventional way was higher in occupations with strain than in other occupations even when several potential confounders had been taken into account. The findings regarding prolactin are not directly comparable to those of other studies,

but they are consistent with the observation that prolactin has a role in conditions of stress and depression, particularly in situations characterized by disturbances in social interaction. Of course these findings were based on the results of the male participants only, and therefore they cannot be generalized to women. Ely (6) showed that animals which go through a social crisis situation have different prolactin responses depending on whether they become defeated or dominate. "Dominants" show low prolactin levels while "sub-dominant" and "defeated" animals respond with marked elevations of prolactin levels. Despite the fact that such findings are not directly applicable to humans, they do make our findings of wide plasma prolactin variations in the subgroup with a "depressive tendency" biologically plausible.

According to the theory formulated by Henry & Stephens (8), Lundberg & Frankenhauser (20), and Karasek et al (14), cortisol levels should have increased when demands successively increased in relation to decision latitude. In this study there was no such increase in the morning cortisol levels. The levels in the men with a positive family history of hypertension even turned out to be lower than expected during the worst period of job strain. This occurrence could be a sign of a masked depression inducing a disturbed circadian pattern with low levels in the morning (but possibly also high levels during later hours in the day). Studies of circadian variations would be needed in order to elucidate this point (24). This explanation seems unlikely, however, since the group with a positive family history of hypertension tended to report less sleep disturbance than the other workers. Another possible explanation could be that the subjects in the group with a positive family history of hypertension were simply not aware of any distressing responses in themselves — they may have felt less "defeated" than the other workers. It is interesting to note that, in the present study, the physicians tended to have high morning plasma cortisol levels. This phenomenon may indicate that physicians encounter many emotionally upsetting situations which could threaten their possibilities to control. Of considerable interest was the observation that those who had had the most increase in cortisol levels during the worst period of job strain were the ones who had the least change in sleep disturbance and no family history of hypertension. This result may be consistent with our observation in the study of relatives of cancer patients; according to that study relatives in a group receiving active attention that started an early grief process had marked elevations of plasma cortisol during the illness but also decreased sleep disturbances after the death of the patients. Thus marked cortisol responses in a stressful situation may be beneficial from some points of view.

Depressive tendency was associated with markedly increased reports of sleep disturbance. A positive family history of hypertension showed some tendency to be associated with decreased sleep disturbance. Both

of these observations are consistent with our hypotheses. Furthermore, the effects of job strain were different in different groups of the population. Most of the effect on blood pressure was accounted for by those who had a positive family history of hypertension, and in the group with a depressive tendency sleep disturbance was unaffected by job strain — in this group the level of reported sleep disturbance was always high. Furthermore, it was only in the groups of men *with* a depressive tendency and *without* a family history of hypertension that an association between plasma prolactin and job strain was observed.

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