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PSYCHOSOCIAL WORK ENVIRONMENT IN RELATION TO CHANGES IN SELECTED BIOCHEMICAL PARAMETERS IN DISTRICT NURSES

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Sixty-four female district nurses between the ages of 25 and 60 in the greater Stockholm area were subjects in a longitudinal study of psychosocial work environment and biochemical serum parameters. Each participant filled out questionnaires and had blood drawn on four different occasions at three-month intervals during one year. The rating on the fourth occasion showed psychosocial work environment to have deteriorated – social climate and authority over decisions were significantly inferior to those on previous occasions. These changes were accompanied by small but significant elevations of serum cholesterol, calcium and triglycerides. Another pattern was also observed which was probably due to increased health habit awareness – a progressive decrease in glycated haemoglobin and gamma glutamyl transferase. No significant interactions were observed with age or smoking habits – old and young subjects did not differ in their change patterns over time, nor did smokers in respect to non-smokers.

Key terms: calcium, cholesterol, gamma glutamyl transferase, glycated haemoglobin, health parameters, triglycerides.

For most people work is an important part of life and everyday living. Work plays a central role in the individual's overall health condition and feeling of happiness. The impact of work on the lives and welfare of people on and off the job and the high cost of dissatisfied workers to industry and society have become research topics of major interest (1, 2). Emphasis has been placed on the right of all people to meaningful, healthy and stimulating jobs (3, 4).

Only recently it has been recognized that long-term stress can seriously affect human health. It may lead to heart disease, irritable bowel syndrome and mental illness (4, 5). Health professionals permanently face stressful situations during their working life. It is therefore important that they be aware of the nature of stress in life and at work and of its relations to illness (6–8).

The women in the »caring« profession of physicians and registered nurses as compared to the general population have been reported to be at higher risk of suicide (8–10). On the other hand registered nurses do not appear to face elevated risk of developing coronary

heart disease as do other working women, like subordinated auxiliary and enrolled nurses (11). This may be due to the fact that registered nurses have a better opportunity to influence their work conditions than auxiliary and enrolled nurses.

Usually operating in people' s homes district nurses have a special responsibility for the health and welfare of other people. Because of their central role in primary health care it was considered worth relating the descriptions of their psychosocial work conditions to health parameters (12). District nurses have greater responsibility and authority over decisions than most other registered nurses. The nature of their work, which implies responsibility for life and death, calls for special emotional involvement (12–14).

District nurses are likely to report psychosocial work conditions and emotional climate accurately. It is a group that is sensitive to changes in authority over decisions. Such changes have been discussed and instituted in Sweden on a large scale in primary health care so they were likely to be experienced during the study period (12).

The present study was designed to test three hypotheses:

– Changes in psychosocial work conditions on a group level go along with changes in biochemical parameters.

– Subjectively perceived psychosocial work conditions correlate with biochemical parameters.

– District nurses are particularly sensitive to information about health and more than others are likely to be influenced by repeated measurements of health parameters. Accordingly, during the repeated observations we also noted changes in health parameters caused by increased health awareness. For instance, by measuring serum liver enzymes and reporting pathological levels to the individual district nurses we made some of them reduce alcohol consumption and dietary intake (15).

Thus, in the present longitudinal study two types of changes in biochemical parameters may be expected to take place: those induced by stress and those due to health habits. By analysing the change patterns it is possible to draw conclusions about the relative contribution of each mechanism.

The aim of the present study was to describe the associations between the psychosocial work environment and the changes perceived in the environment on the one hand and biochemical and health parameters on the other.

SUBJECTS AND METHODS

The subjects eligible for the study were female district nurses in the county of Stockholm. A stratified sample of 64 district nurses aged between 25 and 60 years was selected from employment lists. One district nurse among the selected refused to participate. The youngest age category below 30 years of age (29.7±0.9) numbered 11 district nurses. In the 40–45 (43.2±1.9) age group there were 32 randomly selected district nurses and in the 55–60 (57.7±1.6) group 20 district nurses were selected. The total mean age of 63 subjects was 45.4±9.9 years.

The study followed a longitudinal design: each district nurse was asked to participate four times during a year. This afforded the opportunity of studying changes in selected parameters.

Measurements were taken for each district nurse and each variable about every third month during the year. Accordingly, there were three or four measurements depending on how often the district nurse came to be examined. For the psychosocial questionnaire occasional observations are missing. All blood tests were performed four times for each

subject. The participation rate in the psychosocial part of the study was 98 per cent at the first test and 92 per cent at the fourth test.

On the four measurement occasions during the study year, blood samples were taken at the district nurse's outpatients clinic. The sampling took place between 7:00 and 9:00 a.m. after overnight fasting. All samples were drawn by the principal investigator who was a registered nurse and deep-frozen within three hours. Immediately after blood sampling a short physical examination was carried out by the principal investigator. The subjects had their height and weight recorded with light clothing on. The body mass index was calculated according to equation: BMI= weight(kg)/height(m)^2 and overweight was defined by values exceeding 24 for women (16).

Blood samples were taken for the assessment of calcium, gamma glutamyl transferase, cholesterol, triglycerides and glycated haemoglobin. Serum cholesterol (reference interval: <6.7 mmol/L) was analysed by means of an oxidase method (17) in relation to cardiovascular risk (18). It is known to be influenced by diet (19) and to a small degree also by long-lasting stress (18–20). Serum gamma glutamyl transferase (GT) (reference interval for women: 0.13–0.58 μkat/L) (21) concentration tends to be elevated in subjects who consume excessive amounts of alcohol but also in other conditions that affect liver function e.g. abuse of certain drugs such as salicylates. Serum triglycerides (reference interval: <2.3 mmol/L) were measured by means of an enzymatic method (22). They are reported to be influenced by stress (19, 20, 23) and also by diet (16). Serum calcium (reference interval: 2.20–2.60 mmol/L) (24) was measured because there is evidence that the parathyroid hormone is influenced by psychological factors and that this is reflected in changes in calcium concentration. Blood glycated haemoglobin (HbA_1C) (reference interval: 4.4–6.2%) (25) increases in subjects with a long-lasting elevation of blood glucose concentration. The levels are sensitive to stress (26), but this component is primarily used in health care to monitor the treatment of diabetes. Short-term changes in blood glucose concentration are likely to have minor effects on HbA_1C.

Health habits including the smoking habit were recorded by means of a special health questionnaire.

For psychosocial variables a self-administered questionnaire was used which comprised several groups of questions. The measures of psychological job demands, intellectual discretion and authority over decisions were initially introduced by *Karasek* (27) on the basis of factor analysis of the American Quality of Employment Survey in 1977. A Swedish modification of Karasek's short questionnaire was administered to the subjects in this study (28, 29).

According to the initial hypothesis formulated by Karasek the influence on health of excessive job demands is amplified by the concomitant lack of intellectual discretion and/or authority over decisions. To test this hypothesis we calculated ratios between psychological demands and each one of these two »control« dimensions. The ratios were labelled strain 1 (demands divided by intellectual discretion) and strain 2 (demands divided by authority over decisions). The demand dimension was constructed from five questions concerning psychological work demands. Each question had four response categories ranging from 1 – no, practically never to 4 – yes, often. A total score accordingly ranged from 5 to 20. Intellectual discretion was constructed in an analogous way, with four questions regarding possibilities to learn new things and to experience creativity at work, resulting in a total score ranging from 4 to 16. The dimension authority over decisions, finally, was constructed from two questions concerning the possibility of one's influence over how to do something and what to do. The total score ranged from 2 to 8. Social climate was described by means of an index labelled »positive factors« (11). The index consisted of six questions (pleasant

atmosphere, cohesiveness, work mates supportive, understanding offered on a bad day, agreement with superiors and satisfaction with colleagues and subordinates). Those were scored from 1 (not true) to 4 (altogether true). The total score ranged from 4 to 24.

The first survey took place in February and March, the second in May and June, the third from mid-August to mid-October and the fourth from mid-November until the end of January next year.

Statistical methods used were those described by *Siegel and Castellan* (30) and *Löfgren* (31). Conventional comparisons of group means were made for all variables studied. ANOVA for repeated means was used to examine whether there were significant changes between test occasions. A series of ANOVA analyses using age and smoking subgroups aimed at investigating possible interaction of smoking habits and age with changes in biochemical parameters. A series of multiple regression analyses were performed using the physiological variables as depending and the psychosocial ones as explaining variables. Analyses were always made for the first and fourth tests and for the difference between the tests.

RESULTS

Table 1 shows the results of one-way analyses of variance. Analysis of the psychosocial work environment characteristics shows that authority over decisions and positive factors as well as the ratio between demands and authority over decisions varied greatly between the tests. Accordingly, at the fourth test the psychosocial work environment deteriorated – the possibilities to influence decisions were fewer, the psychosocial climate was poorer and the ratio between demands and authority over decisions turned out to be less favourable.

Table 2 shows the results of one-way analyses of the biomedical and health parameters, and body mass index. Gamma GT and HbA_1C levels significantly decreased during the study period. Decrease in HbA_1C was continuous whereas that of gamma GT was most

Table 1

Means and standard deviations of psychosocial work environment indices

Index between tests	Test 1	Test 2	Test 3	Test 4	Df	F–test	P
Demand index	11.84±2.46	12.14±2.13	11.73±2.32	12.09±2.13	3/165	1.11	0.35
Intellectual discretion index	12.34±1.44	12.07±1.28	12.23±1.55	12.36±1.12	3/165	0.74	0.53
Authority decision index	6.84±1.20	6.63±0.98	6.63±1.05	6.34±1.18	3/165	3.46	0.02
Positive factors index	19.70±3.16	19.86±2.85	19.86±2.47	18.95±3.35	3/165	2.85	0.04
Demand / Intellect. discret. index	0.97±0.22	1.01±0.18	0.97±0.22	0.99±0.19	3/165	1.20	0.31
Demand / Authority decision. index	1.80±0.51	1.87±0.42	1.81±0.44	1.96±0.47	3/165	3.01	0.03

Table 2

Means and standard deviations of biochemical parameters and body mass index

	Test 1	Test 2	Test 3	Test 4	Df	F-test	P
Calcium mmol/L	2.35±0.14	2.31±0.11	2.35±0.11	2.40±0.12	3/180	6.34	0.0004
Hba_1 C, percent	5.79±0.62	5.75±0.63	5.46±0.52	5.23±0.41	3/174	19.72	0.0001
Cholesterol, mmol/L	5.71±1.21	5.57±1.24	5.63±1.43	5.97±1.23	3/180	2.67	0.0491
Triglycerides,*							
10 log(10x)	0.92	0.96	0.95	1.02	3/180	9.64	0.0001
Antilog mean mmol/L	0.84	0.90	0.89	1.11			
Antilog range ± ISD	0.60–1.15	0.66–1.24	0.62–1.28	0.72–1.32			
Gamma GT,*							
10 log(10x)	0.52	0.38	0.33	0.38	3/177	9.35	0.0001
Antilog mean μkat/L	0.33	0.24	0.21	0.23			
Antilog range ± ISD	0.11–0.55	0.12–0.47	0.11–0.42	0.13–0.44			
Body mass index**	23.13±2.86	22.83±2.85	22.90±2.86	22.80±2.74	3/183	0.95	0.42

*Logarithms of measured values were used in the statistical analyses.
**Body mass index [(BMI = weight(kg)/height $(m)^2$]

Table 3

Significant multiple regression results of changes in biochemical parameters

	Test 1	Test 4	Tests 1–4
Gamma GT*10 log(10x) μkat/L* **			
Age		P=0.02**	
Demand/Authority decisions index		P=0.03**	
Hba_1C/ percent			
Age	P=0.004 (+)		P=0.005 (+)
Years in nursing	P=0.001 (+)		P=0.02 (+)
Cholesterol mmol/L			
Years in nursing	P=0.04 (+)		
Intellectual discretions index	P=0.03 (+)		
Demand index		P=0.03 (+)	
Triglycerides*10 log(10x)mmol/L* **			
Positive climate	P=0.04 (+)		

** The higher the index value the higher the concentration.
*** Logarithms of measured values were used in the statistical analyses.

Non-stepwise multiple regression with each one of gamma GT*10 log(10x), Hb A_1C, cholesterol, triglycerides*10 log(10x) and calcium as dependent variables and age, smoking habits (yes/no), psychological demands, intellectual discretion, authority over decisions, psychosocial climate, years in nursing and years in district nursing as explaining variables. The table displays significantly explaining factors and the corresponding level of statistical significance indicates a positive relationship – the higher the index the higher the concentration.

pronounced from the first to the second test. There were no changes in serum triglycerides and calcium levels between the first three tests but a sharp increase was observed at the fourth test. A similar pattern was noticed for serum cholesterol. The body mass index did not show any major changes between the tests.

Two-way analyses of variance demonstrated strong effects of age on all biochemical parameters except gamma GT. No statistically significant interactions were observed between the test results and age. Accordingly, the subjects in the three age groups did not differ with regard to the way in which the biochemical parameters changed over time. Analysis for smoking/non-smoking allowed to conclude that there were no statistically significant interactions between smoking habits and test, i.e. smokers varied across tests in the same way as non-smokers.

Table 3 shows the results of multiple regression analyses i.e. beta coefficients and corresponding significance levels for the associations between each one of the variables: age, number of years in a caring occupation, number of years as district nurse, smoking habits (yes/no) and the psychosocial work environment variables described above as explaining factors and each one of the biochemical factors (test 1, test 4 and the difference between tests 4 and 1) as dependent variables. Only the results that indicated significant associations with work conditions ($P<0.05$) are presented.

Body mass index, calcium and HbA_1C showed no significant associations with the psychosocial work environment variables. Gamma GT was correlated in the fourth test with the ratio between demand and authority over decisions – the higher the ratio the higher the gamma GT level. No such observations were made in the first test.

Cholesterol was correlated with intellectual discretion in the first test – the lower the intellectual discretion level the higher the cholesterol and with demand in the fourth test – the higher the demand the higher the cholesterol. Triglycerides were correlated with positive factors in the first test – the better the psychosocial climate the higher the triglycerides level. No such associations were observed in the fourth test. Neither the difference in psychosocial work environment variables between the fourth and the first tests nor age and number of years in nursing and district nursing could explain any of the biochemical differences between the first and the fourth tests.

DISCUSSION

This study has shown that the significant changes observed in repeated measurements of psychosocial work environment parameters during the year of study were associated with a number of significant changes in the biochemical parameters.

Compared to the results from a previous study (15) the changes in the serum concentration of liver enzymes in the present sample were pronounced compared to those observed in other occupations. In a small sample of female physicians included in the previous study, however, the effects were similar.

The observed changes in gamma GT and HbA_1C, were consistent with increased awareness of health habits. After each test the district nurse received written information regarding all the blood tests. It is therefore likely that the health awareness effect was stronger in this health care occupation than in the general population.

Triglycerides, calcium and cholesterol concentrations were increased in the fourth test. This could have been caused by deterioration in psychosocial work environment. Thus,

in the fourth test the district nurses reported that authority over decisions and psychosocial climate had greatly deteriorated. At the same time the demands were reportedly higher although this difference was not statistically significant. Thus the changes in lipid levels and calcium may have been consequences of psychosocial stress.

It was not possible to predict changes in the biochemical parameters from the first to the fourth test on the basis of changes in psychosocial work environment over the same period. This failure may indicate that although the relationship between psychosocial and biochemical changes was valid on a group level the individuals that reported changes in work problems did not necessarily demonstrate biochemical changes. A feasible explanation in the present study may lie in the anxiety which was prevalent in the district health care system in the Stockholm region during the study period because of a prospect of dramatic organizational changes (12). This for instance may have accounted for the decrease in authority over decisions in the studied group on the occasion of the fourth test.

Another expected observation was the association between a high cholesterol concentration and a low level of intellectual discretion. This could be interpreted to be the effect of chronic stress on lipoprotein metabolism (16, 22). Marked elevations of serum cholesterol have been observed in connection with unemployment in a recently published longitudinal study of the effects of unemployment in Swedish workers (32).

An observation which was unexpected and bore no relationship to current theories was the association between a good psychosocial climate and a high triglycerides concentration.

Two of our hypotheses were supported by the results of the study. Changes in psychosocial work environment went along with changes in certain stress parameters and we also observed changes that could have been due to increased awareness. This pattern was distinct from the stress pattern.

REFERENCES

1. *Sutherland VJ, Cooper CL.* Understanding Stress. London: Chapman and Hall 1990.
2. *Hingley P, Cooper C.* Stress and the nurse manager. London: John Wiley 1986.
3. *Weisman CS, Alexander CS, Chase GA.* Job satisfaction among hospital nurses: a longitudinal study. Health Services Research 1980;15:341–64.
4. *Karasek RA, Theorell T.* Healthy work. New York: Basic Books 1990.
5. *Theorell T.* Psychosocial factors in relation to the onset of myocardial infarction and to some metabolic variables – pilot study. Doctoral dissertation. Stockholm. Karolinska Institute 1971.
6. *Haynes SG, Feinleib M, Kannel W.* The relationship of psychological factors to coronary heart disease in the Framingham study. Am J Epidemiol 1980;111:37–58.
7. *Baglioni AJ, Carry L. Copper, Hingley P.* Job stress, mental health and job satisfaction among UK senior nurses. Stress in the Community. Stress Medicine. New York: John Wiley 1990:6;9–20.
8. *Heim E.* Job stressors and coping in health professions. Psychother Psychosom 1991;55:90–9.
9. *Arnetz BB, Horte LG, Hedberg A, Theorell T, Allander E, Malker H.* Suicide patterns among physicians related to other academics as well to the general population. Acta Psychiatr Scand 1987;75:139–43.
10. *Stefansson C-G.* Occupation and suicide in Sweden. In: Work Environment Commission. Occupations exposed to particular health risks Appendix F. IMM-report 1990;1:1–17. (In Swedish)
11. *Alfredsson L, Hammar N.* Occupation and myocardial infarction. A description based upon the population in five counties. In: Work Environment Commission. Occupations exposed to particular health risks Appendix F. IMM-report 1990;1:1–32. (In Swedish)
12. *Dončević Š, Theorell T.* The psychosocial work environment of district nurses in Sweden. Work and Stress 1988;2:341–51.

13. *Kubler-Ross E.* Death: how dare we face you? In: Howel JG ed. Modern Perspectives in the Psychiatry of Old Age. New York: Brunner Mazel 1975.
14. *Maslach C.* Burnout – the cost of caring. New Jersey: Prentice Hall 1982.
15. *Theorell T, Ahlberg–Hulten G, Berggren T, Perski A, Sigala F, Svensson J, Wallian BM.* Work environment, personal habits and risk of cardiovascular illness. National Institute for Psychosocial Factors and Health. Stockholm. Stress Research Reports 1987;195.
16. *Bjorvell H, Rossner S, Stunkard A.* Obesity, weight loss and dietary restraint. Int J Eating Disorders 1986;5:727–34.
17. *Trinder P.* Determination of glucose in blood using glucose oxidase with an alternative oxygen acceptor. Ann Clin Biochem 1969;6:24–7.
18. *Dimsdale JF, Herd JA.* Variability of plasma lipids response to emotional arousal. Psychosom Med 1982;68:470–6.
19. *McCann BS, Russell Warnick G, Knopp RH.* Changes in plasma lipids and dietary intake accompanying shifts in perceived workload and stress. Psychosom Med 1990;52:97–108.
20. *Levi L.* Stress and distress in response to psychosocial stimuli. Doctoral dissertation. Stockholm. Karolinska Institute. Acta Med Scand 1972;191:1–157.
21. *IFCC* Methods for the measurement of catalytic concentration of enzymes. IV IFCC Method for gammaglutamyltransferase. J Clin Chem Clin Biochem 1983;21:683.
22. *Wahlefeld AW.* Triglycerides, determination after enzymatic hydrolysis. In: Bergmeyer HU, ed. Methods of enzymatic analysis, 2nd ed. New York: Chemie Weinheim and Academic Press, Inc. 1974:1831.
23. *Siegrist J, Matschinger M, Cremer P, Seidel D.* Atherogenic risk in men suffering from occupational stress. Atherosclerosis 1988;69:211–8.
24. *Sarkar BCR, Chauhan UPS.* A new method for determining micro quantities of calcium in biological materials. Ann Biochem 1967;20:155–66.
25. *Jeppson JO, Jerntrop P, Sundqvist G, Englund H, Nylund V.* Measurement of hemoglobin A1C by a new liquid chromatographic method: Methodology, clinical utility and relation to glucose tolerance evaluated. Clin Chem 1986;32:18–67.
26. *Arnetz B.* Psychophysiological effect of social understimulation in old age. Doctoral dissertation. Karolinska Institute, Stockholm 1983;1–168.
27. *Karasek RA.* Job demands, job decision latitude and mental strain: Implications for job redesign. Adm Sci QU 1979;24:285–307.
28. *Karasek RA, Baker D, Marxer F, Ahlbom A, Theorell T.* Job decision latitude, job demands, and cardiovascular disease: A prospective study of Swedish men. Am J Public Health 1981;71:694–705.
29. *Theorell T, Ahlberg-Hulten G, Sigala F, Perski A, Soderholm M, Kallner A, Eneroth P.* A psychological and biomedical comparison between men in sex contrasting service occupations. Work and Stress 1990;4:51–63.
30. *Siegel S, Castellan NJ Jr.* Nonparametric statistics. New York: McGraw-Hill, 1988.
31. *Lofgren H.* Statistical data analysis with StatView and McIntosh Lund. Studentlitteratur 1989. (In Swedish)
32. *Mattiasson I, Lindgärde F, Nilsson JÅ, Theorell T.* Threat of unemployment and cardiovascular risk factors: longitudinal study of quality of sleep and serum cholesterol concentrations in men threatened with redundancy. Br Med J 1990:301;461–6.

Sažetak

PSIHOLOŠKI I SOCIJALNI ASPEKTI RADNE SREDINE I BIOKEMIJSKI PARAMETRI U MEDICINSKIH SESTARA

Longitudinalno istraživanje odnosa psihološko-socijalnih aspekata radne sredine i biokemijskih parametara provedeno je među područnim patronažnim medicinskim sestrama u širem gradskom području Stockholma. Ispitanice su bile 64 patronažne medicinske sestre starosti između 25 i 60 godina, koje su četiri puta u razmacima od tri mjeseca tijekom jedne godine popunile upitnike i dale uzorke krvi. Prema njihovim ocjenama pri četvrtom ispitivanju psihološko-socijalni aspekti radne sredine pogoršali su se – društvena klima i odgovornost pri odlučivanju bile su značajno nepovoljnije nego

li pri prethodnim ispitivanjima. Promjene u radnoj sredini bile su popraćene malim ali značajnim porastom koncentracije kolesterola, kalcija i triglicerida u serumu. Primijećeno je i progresivno smanjenje glikoliziranog hemoglobina i gama glutamil transferaze do kojeg je vjerojatno došlo zahvaljujući povećanoj svjesnosti ispitanica o zdravstvenim navikama. Nisu primijećene interakcije između ovih biokemijskih parametera i dobi i navike pušenja – u promjenama registriranima tijekom istraživanja nije bilo razlika između starijih i mladih ispitanica kao ni između pušačica i nepušačica.

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Ključne riječi: gama glutamil transferaza, glikolizirani hemoglobin, kalcij, kolesterol, trigliceridi, zdravstveni parametri.