

## PHYSICAL STRENGTH AND ENDURANCE IN RELATION TO PERCEIVED PSYCHOSOCIAL WORK ENVIRONMENT, SLEEP DISTURBANCE AND COPING STRATEGIES IN MEN

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**ABSTRACT.** The study explored relationships between subjective descriptions of psychosocial work situation, sleep disturbance and coping patterns at work on the one hand and performance during a test of physical strength and perceived effort during a muscular endurance test on the other. The physical strength of the shoulders flexors was measured. The subjective degree of effort was rated 60 and 90 seconds after the beginning of a test of isometric endurance of the neck extensor muscles. Four samples with numbers of about 80 subjects each were studied, first of all one sample of men and one of women from the general working population and secondly a sample of “super male” workers (furniture removers) and a sample of “service oriented female” workers (medical secretaries). The findings indicated that there is a relationship among men between self-reported coping strategies at work and results in the physical tests. Thus, in the random sample of men, individuals who described open coping patterns were found to perceive more effort after one minute and also after one minute and a half of the physical endurance test and were also found to be physically stronger than other individuals. Those who described themselves as less supported socially than other men reported more subjective effort and tended to be physically stronger than other individuals. Among furniture removers, those who described that they had a high degree of covert coping tended to report a higher degree of subjective effort after one minute. Among men in both groups, a high degree of sleep disturbance tended to be associated with more perceived effort during the endurance test. The work environment variables showed no consistent and statistically significant associations with the outcome variables.

In conclusion the study has shown that in men sleep

disturbance, social support and self reported coping patterns are related to physical strength/endurance tests results (different coping patterns in men and “super males”, respectively) but that other self-reported psychosocial work environment characteristics are not.

*Key words:* muscular strength, muscular endurance, rated perceived exertion, effort, psychosocial job stress, gender, coping strategy, sleep disturbance.

### INTRODUCTION

Recently, many scientific publications have dealt with the psychosocial work environment. It has been shown that high psychological demands, poor decision latitude and poor social support at work, either as separate variables or in combination, are associated with cardiovascular disease (1, 6), blood pressure regulation during working hours (2, 3, 4) and symptoms from the locomotor system (5–9). There has been a scientific discussion about the role of individual characteristics in these relationships. For instance, in the discussion on work environment and risk of cardiovascular disease the question has been raised whether the association between job strain (the combination of high demands and low decision latitude) and risk of myocardial infarction development could be due to selection mechanisms—with “coronary prone” persons selecting themselves for high strain jobs. Two empirical studies have refuted this possibility (1, 10), suggesting, on the contrary, that the “coronary prone” selection process may even attenuate the association between job strain and cardiovascular risk. With regard to the locomotor system, the importance of the relationship between

individual characteristics and perceived work environment to the relationship between work environment and illness symptoms is largely unknown. In this case, physical strength and perceived exertion during muscular endurance may be of importance. Persons who feel that they have to make great efforts during physically strenuous work may perceive their work situation as more psychologically demanding than do their work mates. Very few previous studies have illuminated this question, although it has been shown in health care personnel (11) that perceived psychological and physical demands are to a great extent independent of one another. At the same time, however, there are also weak albeit significant correlations between them.

No significant correlation was found among randomly selected women or men between rated high exertion during isometric endurance testing of the neck extensors and reported neck disorder during one year before the test (12).

It should be emphasized that the interrelationship between perceived physical and psychological demand levels may largely be "culturally" determined—in physically demanding jobs, for instance, physical demands may be an important part of psychological demands.

The present study was designed to test the relationships between results in physical strength/endurance tests—a static shoulder strength test and a static endurance test of neck muscles performed in the laboratory on the one hand, and perceived psychosocial work environment, sleep disturbance and self-reported coping strategies at work on the other. In order to illuminate these interrelationships, four different contrasting study groups were selected.

## MATERIALS AND METHODS

### *Study groups*

This study is part of the MUSIC study. In that study there are four study groups, all of them selected from the greater Stockholm area: randomly selected working men (96 participants, participation rate 66%), *Random men*; randomly selected working women (90 participants, participation rate 64%), *Random women*; furniture removers, all men (83 participants, participation rate 71%); and medical secretaries, all women (89 participants, participation rate 86%).

All participants were between 20 and 64 years old. The stratified selection was made in such a way that the groups would be comparable with regard to age. The selection as well as some characteristics of drop-outs have been published elsewhere (13).

### *Methods*

The shoulder strength test was a procedure designed to test the maximal isometric flexion (upward-forward) strength in the shoulder muscles. The measurements were performed with the person sitting on an adjustable chair with a position standardized for the recording of maximal isometric strength (Nm) in the shoulder flexor muscles with the upper limb horizontal. Furniture removers were shown to have 9–13% more strength than random men, and women had 43–56% of the strength of men (14). The subjective degree of efforts was rated on a standardized scale (0–14) after 60 and 90 seconds (s), respectively, during an isometric endurance test of the cervical spine extensors (15, 16). The isometric endurance test of the cervical spine extensors was performed with the person sitting in a special test chair with the thoraco-lumbar spine vertical and with the cervical spine kept flexed 45° in a standardized way. The load on the head (helmet and extra weight) was 50 N, the same for men and women. The test was performed during a maximum of 3 minutes and the persons rated the perceived effort of the neck muscles every 30 s on the standardized 0–14 scale (17). These measures of efforts after 60 s and 90 s were used in the subsequent statistical analyses.

All the psychosocial variables were described by means of a self-administered questionnaire. Psychological demands (five items), intellectual discretion (four items) and authority over decisions (two items) were measured by means of a self-administered questionnaire which is a modification (18) after Karasek (19) who had based his original questions on demands and control on American Quality of Employment Surveys (20). Questions about social support at work (six items) have been introduced in a study by Theorell et al. (21). Questions on sleep disturbance (10 items) are based on a Swedish questionnaire introduced by Åkerstedt and co-workers (22). The questions about coping strategies are based upon a questionnaire used in an American epidemiological study (23) and deal with the individual's way of coping with an imagined situation at work: "The boss or some work mate treats you in an unfair way. What do you do in this situation?" The questionnaire gives a number of four-graded possible response categories. Factor analysis has shown that two general patterns are common, namely open (eight items) and covert coping (eight items), respectively (24). Psychometric properties have been presented elsewhere (25).

All the dimensions used have acceptable Cronbach alpha coefficients ranging from 0.7 to 0.9 in the randomly selected groups—with one exception, namely intellectual discretion for men, with a Cronbach alpha coefficient of 0.5. Cronbach alpha coefficients cannot be calculated for authority over decisions because of the small number of items, but the correlations between the items were acceptable (0.6). The Cronbach alpha coefficients were in general acceptable for the medical secretaries as well, with values between 0.7 and 0.9 for all dimensions except covert coping (0.6) and intellectual discretion (0.4). For furniture removers the Cronbach alpha coefficients were between 0.7 and 0.8 for all dimensions except intellectual discretion (0.4). The correlations between the two items in the authority over decisions index were low for the two separate occupational groups—0.5 for medical secretaries and 0.3 for furniture removers.

### *Statistics*

All calculations were made separately for the four different study samples. First of all, all pairs of explaining/dependent

Table I. Product-moment correlations between explaining and dependent variables, male samples

	Psychol. demand	Intell. discr.	Author. decision	Social support	Sleep disturb.	Open coping	Covert coping
Furniture removers ( $n = 78-83$ )							
Subj. effort 60 s	0.14	-0.10	-0.19+	-0.01	<u>0.22</u>	0.12	0.19+
Subj. effort 90 s	0.20+	-0.10	-0.15	0.00	<u>0.23</u>	0.15	0.16
Obj. strength	0.21+	0.09	-0.02	0.01	0.11	0.09	0.08
Random men ( $n = 83-94$ )							
Subj. effort 60 s	0.00	0.01	-0.06	<u>-0.25</u>	0.18+	<u>0.27</u>	0.09
Subj. effort 90 s	-0.02	0.01	-0.04	<u>-0.25</u>	0.19+	<u>0.27</u>	0.15
Obj. strength	-0.08	-0.05	-0.10	-0.20+	0.00	<u>0.22</u>	-0.10

Relationships that are underlined are statistically significant ( $p = 0.05$ ). + after a correlation indicates a statistically significant tendency ( $p = 0.10$ ). For women no statistically significant relationships were found.

variables were subjected to a calculation of (Pearson) product moment correlation coefficients since all the studied variables were normally or close to normally distributed. Secondly, a series of multiple linear regression analyses was performed. The aim of these calculations was to explore the independent relationships between physical effort after one minute on the one hand and social support at work and sleep disturbance as well as open and covert coping on the other, after adjusting for age, physical strength and psychological demands.

## RESULTS

Table I shows the product moment correlations between different study variables in the four different groups.

In *furniture removers*, a high degree of sleep disturbance was correlated with a high degree of subjective effort during the isometric endurance test of the cervical spine extensors, after 60 s as well as 90 s of effort. In multiple regression including the potential confounders age, physical strength and psychological demands, the correlation between sleep disturbance and subjective effort after one minute was significantly reduced (parameter estimate = 0.58 with standard error 0.31,  $p = 0.07$ ).

For *random men*, there was a significant and consistent relationship between degrees of open coping and effort both after one minute and after 90 s and also a significant relationship between objective strength and open coping—the stronger the man and the more effort he was reporting the more open coping. The relationship between open coping and subjective effort during the muscular endurance test after one minute remained significant in multiple regression (parameter estimate = 0.38 with standard error 0.15,  $p = 0.02$ ). Poor social support at work was significantly associated with a high degree of subject effort both after one minute and after one minute and

a half. The relationship between poor social support and high effort after one minute remained significant (parameter estimate = -0.06 with standard error 0.02,  $p = 0.02$ ) also in multiple regression.

No consistent significant findings were obtained in the female groups.

## DISCUSSION

The groups studied in the present examination represent men and women in the general working population (random samples) as well as two groups with special conditions, namely heavy physical demands (furniture removers) in a "macho" occupation and a subordinated service (medical secretaries) in a typically female occupation. The attrition rates were higher in the random groups (one third of the selected study population) than in the special groups. It is unlikely that the attrition could have a decisive effect on the correlation patterns observed, although it should be borne in mind in the interpretation of results.

The physical strength test of the shoulder flexor was carried out in accordance with a widely accepted procedure. The isometric endurance test of the cervical spine extensors is a new test (16). The subjective effort rated during the test could represent both the motivation and energy of the subject when performing the test, but also feelings of frustration if he/she believes that he/she was performing poorly. This test is likely to have affected the groups differently. It is probably of special relevance to furniture removers since they have become accustomed to physical efforts of this kind in their daily routine work. For random men it may represent an unusual test of their male capacity. Indeed, a high degree of open coping was

clearly correlated with both perceived effort and objective strength in random men but not in furniture removers. For women, the physical stress test may lack relevance altogether. This could to some extent explain the absence of significant relationships in the female groups.

The psychosocial variables in most instances showed good or acceptable internal homogeneity. It should be pointed out, however, that in the two special groups intellectual discretion and authority over decisions did not function satisfactorily from this point of view. This may lead to underestimation of possible true associations.

The statistical procedures began by simple calculation of product-moment correlation coefficients for all explaining versus outcome variables in the test. The psychosocial measurements are based upon relatively vague concepts. This will always lead to increased random error in the measurements. In consequence, the estimations of common variance will be underestimations. Thus, although some of the observed significant correlations are small it is likely that they represent underestimations of the true relationships. Seven out of 84 statistical tests were significant on the 0.05-level. Four of these could have been random associations. However, the observed relationships did constitute a meaningful pattern of associations. They also seem to be understandable psychophysiologically. Therefore, it is unlikely that they represent random phenomena only. Since some of the relationships may have been confounded by age, physical strength/endurance and psychological demands, a series of multiple regression analyses was performed. The tests for the most part confirmed the simple correlation analyses.

Open coping is reported more frequently in men than in women (24). Furthermore it should be pointed out that correlations between coping and perceived work environment are different in men and women. In the present study random women reported more covert coping (25) when they had high levels of psychological demands and when they received little support at work, whereas these relationships were not significant for men.

Fairly consistent findings were obtained for sleep disturbance in men. Both in random men and in furniture removers, a high sleep disturbance score was associated or tended to be associated with more subjective effort. Lack of sleep is associated with increased catecholamine excretion, and it is possible

that this lowers the threshold for feeling subjective effort (26).

One of the most important questions in the present study was whether physical strength or subjective effort during physical endurance testing would be associated with the subjects' perception of their own work situation. In particular, it could have been anticipated that male furniture removers would show such associations. The only finding was that psychological demands tended to be positively correlated with physical strength in furniture removers. One interpretation of this finding could be that the physically strongest furniture removers obtain more work than others. However, the multiple regression analysis confirmed that this finding was statistically weak and that accordingly the association, if at all significant, has very little significance, quantitatively. Apart from this, no relationships were found between self-reported psychological demands and decision latitude characteristics and physical stress test results. The non-significant findings regarding the self-reported demand-control description are of importance since it has been suspected that these self-reports may be confounded by physical strain factors.

Social support at work was clearly associated with physical test results in the random sample of working men. Hence, random working men who feel support from work mates report significantly less effort and tends to be physically stronger than other men. These results indicate that self reported social support may to some extent be confounded by physical strain factors. The female groups were studied with the same methods, but no significant associations were found and they are not reported here.

## REFERENCES

1. Karasek, R. A. & Theorell, T.: *Healthy Work*. Basic Books, New York, 1990.
2. Schnall, P. L., Schwartz, J. E., Landsbergis, P. A., Warren, K. & Pickering, T. G.: Relation between job strain, alcohol, and ambulatory blood pressure. *Hypertension* 19: 488-494, 1992.
3. Theorell, T., de Faire, U., Johnson, J., Hall, E., Perski, A. & Stewart, W.: Job strain and ambulatory blood pressure profiles. *Scand J Work Environ Health* 17: 380-385, 1991.
4. Theorell, T., Ahlberg-Hultén, G., Jodko, M., Sigala, F., Söderholm, M. & de la Torre, B.: Influence of job strain and emotion on blood pressure levels in female hospital personnel during work hours. *Scand J Work Environ Health* 19: 264-269, 1993.
5. Bongers, P. M., de Winter, C. R., Kompier, M. A. J. &

- Hildebrandt, V. H.: Psychosocial factors at work and musculoskeletal disease. *Scand J Work Environ Health* 19: 297–312, 1993.
6. Theorell, T., Perski, A., Orth-Gomér, K., Hamsten, A. & de Faire, U.: The effects of the strain of returning to work on the risk of cardiac death after a first myocardial infarction before age 45. *Int J Cardiol* 30: 61–67, 1991.
  7. Theorell, T., Nordemar, R., Michélsen, H. & the Stockholm Music I Study Group. Pain thresholds during standardized psychological stress in relation to perceived psychosocial work situation. *J Psychosom Res* 37: 299–305, 1993.
  8. Toomingas, A., Theorell, T., Michélsen, H. & Nordemar R.: Associations between perceived psychosocial job factors and prevalence of musculoskeletal disorder in the neck and shoulder. International scientific conference on prevention of work-related musculoskeletal disorder PREMUS, Sweden, May 12–14, 1992, Stockholm: Arbetsarkyddverket. 8: 289–290 (Arbete och hälsa: no 17), 1992.
  9. Holmström, E. B., Lindell, J. & Moritz, U.: Low back and neck/shoulder pain in construction workers: Occupational workload and psychosocial risk factors. *Spine* 17: 672–677, 1992.
  10. Landsbergis, P., Schnell, P. L., Deitz, D., Friedman, R. & Pickering, T.: The patterning of psychological attributes and distress by "job strain" and social support in a sample of working men. *J Behav Med* 15: 379–405, 1992.
  11. Josephson, M., Wigaeus, Hjelm, E. & the UPP-study group: The association between perceived physiological and psychological job strain among female nursing personnel. *In* Book of abstracts of the international scientific conference on prevention of work-related musculoskeletal disorder PREMUS, Sweden, May 12–14, 1992. Stockholm (Eds. M. Hagberg & A. Kilbom) Arbetsarkyddverket. 11: 142–144 (Arbete och hälsa: no 17), 1992.
  12. Schüldt, K., Ekholm, J., Toomingas, A., Harms-Ringdahl, K., Köster, M. & the Stockholm MUSIC I Study Group: Samband mellan uthållighet/ansträngning i nackextensorer och uppgivna besvär i nacken. I: Stockholmsundersökningen 1. Utvärdering av metoder för att mäta hälsa och exponeringar i epidemiologiska studier av rörelseorganens sjukdomar (Eds. M. Hagberg & att C. Hogstedt), 275–282, MUSIC Books, Stockholm, 1993.
  13. Alfredsson, L., Hagberg, M. Hogstedt, C., Fellenius, E., Köster, M., Johansson, K. & the Stockholm MUSIC I Study Group: *In* Stockholmsundersökningen 1 (Eds. M. Hagberg & C. Hogstedt). pp. 328–333, MUSIC Books, Stockholm 1991.
  14. Lannersten, L., Harms-Ringdahl, K., Schüldt, K., Ekholm, J. & the Stockholm MUSIC I Study Group: Isometric strength in the flexors, abductors and external rotators of the shoulder. *Clin Biomech* 8: 235–242, 1993.
  15. Harms-Ringdahl, K., Schüldt, K., Ekholm, J., Lannersten, L., Kosek, E. & the Stockholm MUSIC I Study Group: *In* Stockholmsundersökningen 1. (Eds. M. Hagberg & C. Hogstedt) MUSIC Books, Stockholm, 1991.
  16. Ekholm, J. Schüldt, K., Harms-Ringdahl, K., Lannersten, L., Kosek, E. & the Stockholm MUSIC I Study Group: Normative data of muscular endurance in cervical spine extensors, shoulder flexors and wrist extensors—data from a randomly selected population. Abstract, Eighth Meeting of the European Society of Biomechanics, pp. 289–290, Rome, Italy, 1992.
  17. Borg, G.: Psychophysical scaling with applications in physical work and the perception of exertion. *Scand J Work Environ Health* 16 (Suppl. 1): 55–58, 1990.
  18. Theorell, T., Perski, A., Åkerstedt, T., Sigala, F., Ahlberg-Hultén, G., Svensson, J. & Encroth, P.: Changes in job strain in relation to changes in physiological state. *Scand J Work Environ Health* 14: 189–196, 1988.
  19. Karasek, R.A.: Job demands, job decision latitude, and mental strain: implications for job redesign. *Admin Sci Q* 24: 285–307, 1979.
  20. Quinn, R. P. & Staines, G. L.: The 1977 Quality of Employment Survey: Descriptive statistics with comparison data from the 1969–70 and the 1972–73 surveys. Survey Research Center, Institute for Social Research, University of Michigan, 1977.
  21. Theorell, T., Ahlberg-Hultén, G., Sigala, F., Söderholm, M., Kallner, A. & Encroth, P.: Psychosocial and biomedical comparison between men in six contrasting service occupations. *Work and Stress* 4: 51–63, 1990.
  22. Åkerstedt, T. & Torsvall, L.: Experimental changes in shift schedules—their effects on well-being. *Ergonomics* 21: 849–856, 1978.
  23. Harburg, E., Erfurt, J., Havenstein, L.S., Chape, C., Schull, W.J. & Schoch, M.A.: Socio-ecological stress, suppressed hostility, skin color and black-white blood pressure. *Detroit. Psychosom Med* 35: 276–286, 1973.
  24. Theorell, T., Michélsen, H., Nordemar, R. and the Stockholm MUSIC I Study Group: *In* Stockholmsundersökningen 1. (Eds. M. Hagberg & C. Hogstedt) MUSIC Books, Stockholm, 1991.
  25. Theorell, T., Michélsen, H., Nordemar, R. and the Stockholm MUSIC I Study Group: *In* Stockholmsundersökningen 1 (Eds. M. Hagberg & C. Hogstedt) MUSIC Books, Stockholm, 1993.
  26. Theorell, T. & Åkerstedt, T.: Day and night work: changes in cholesterol, uric acid, glucose and potassium in serum and in circadian patterns of urinary catecholamine excretion. *Acta Med Scand* 200: 47–57, 1976.

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