

Workplace Design and Health Performance

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Introduction

Sick leave caused by musculoskeletal disorders (MSDs) is staying high, and sick-leave caused by mental stress and depression has been increasing during the latest decade in Sweden according to the National Social Insurance Board, 2004. When introducing an office ergonomic intervention program Amick BC 3rd et al 2003, showed that musculoskeletal symptoms could

be reduced. According to Juul-Kristensen B et al 2004, risk factors for developing shoulder, elbow and back symptoms among computer users could be reduced by interventions such as work pauses, reduction of glare or reflection and screen height.

An early ergonomic work place intervention for employees with MSDs-related absenteeism was evaluated by Arnetz B et al 2003. The intervention group claimed less costs as compared to the reference group.

Psychological factors at work and in private life as risk factors for low back pain are analyzed by Hoogendoorn WE et al 2000. The impact of decision latitude, psychological load and social support at work on musculoskeletal symptoms was described by Johansson JA and Rubenowitz S 1994.

In their review on work organization and leadership, Karasek L and Theorell T 1990, point out "feeling of belonging to the work society" as an essential factor for health. Schnall et al 2000, and Theorell T 2000 show further importance of work organizational factors.

In a Swedish population study, differences between genders and professions were found concerning the influence of work-related physical and psychosocial factors on seeking care for neck or shoulder disorders according to Thornquist EW et al 2001. After a long period of studies about physical factors such as loading and noise, as well as hierarchical status in work organisations, the research focus extends to study the design of work environments at large.

The impact of design and architecture on occupational and patients health was studied by Dilani A 2000 and 2001. However, the impact of ergonomic laboratory research on practical design of work environments is still poorly understood as pointed out by Dekker S and Nyce J 2004. To capture background data for future study designs, it is important to analyze employees' opinions on this issue.

Aim

As a part of a larger study on occupational and individual health of employees at the Swedish Broadcasting Company for Television (SBCT), and with orchestra musicians at the Swedish Broadcasting Company for Radio (SBCR-O), questions on ergonomics and aesthetics were included. The aim was to analyze in a cross-sectional study, in order to determine if the self reported need for ergonomic improvements and lack of aesthetic environment were associated with socio-economic status, health status, occurrence of musculoskeletal symptoms, stress and depression, life-style, professional position, and work environment.

Methods

Study persons

All employees at SBCT in Sweden and SBCR-O in Stockholm who had been employed 12 or more months and were not on long term (> 6 months) leave due to studies, childbirth, working abroad, or sickness were included and asked to answer a questionnaire. Age, professional position according to the company's coding system, and total sick-leave during the year before the study as reported in the company files were recorded.

Questionnaires

The questionnaires were distributed by company mail. (The return envelope was included). The questions on ergonomics and aesthetics were: 1. Do you consider that your workplace ergonomics need to be improved? 2. Do you consider that your workplace aesthetics need

to be improved? The answer alternatives were: yes, definitely; yes, in high degree; yes, in some degree; and no, not at all:

The following groups of variables with pre-validated questions were included: 1. Socio-economics; 2. Health and disease; 3. Professional position; 3. Work environment; and 5. Life style. The occurrence of pain in neck, shoulder, back and other musculoskeletal organs, work stress, depression, and sick-leave were particularly considered.

Variables included in the questionnaires concerning the time period of last 12 months:

- Satisfaction with general life conditions (VAS scale)
- Education level
- Sleeping disturbances
- Intensity of pain (VAS scale) in neck, shoulder, upper and low back, and other musculoskeletal organs
- Frequency of treatment for neck, shoulder, upper back or low back
- Frequency of treatment for stress or depression
- Worry about own recent health
- Sick-leave due to neck, shoulder, upper back or lower back disorders
- Sick-leave due to stress or depression
- Subjectively stated relationship between pain, workload and stress for each of pain locations above
- Occurrence of work related negative stress
- Occurrence of work related problems in general
- Noise at work
- Influence on work (VAS scale)
- Dissatisfaction with work circumstances (VAS scale)
- Frequency of physical training
- Smoking and alcohol intake
- Working hours per week
- Working hours with VDU (Video Display Unit)
- Working hours with VDU in leisure time

Some of the questions are equal to those used by Statistics Sweden (Living Conditions Survey 2003, and Report no 95) in their repeated population studies, or those used in SNQ (Standardised Nordic Questionnaire), Kourinka I et al 1987.

A 4-week test-retest reliability analysis of the other questions in the current study was performed. Thirty-two (32) out of randomly selected 40 persons (80%) participated. All questions showed significant correlation with mean p -value 0.001 ($<0.001-0.007$) and correlation coefficient mean 0.76 (1.00-0.47) by Spearman's non-parametric test.

Statistical methods

Spearman's correlation, Pearson's correlation, univariate analysis of variance, one-way anova, chi-square and logistic regression analyses were used.

Results

2641 fulfilled the inclusion criteria, and 1961 answered, mean 74 (86-70 % in subgroups). The mean age was 48 years (21-67). 43% were females and 67% males. There were no differences in participation between Stockholm, where the headquarters are located, and the rest of the country. Between participants and drop-outs there were no statistically significant differences in age, gender, and education.

The distribution of the answer alternatives on "need for ergonomic improvements" was as follows: yes, definitely 16%; yes, in high degree 18%; yes, in some degree 49%; no, not at all 17%. There was a difference between genders ($p=0.034$). Males found the need more often than females, 85 and 81 %, respectively.

The distribution of the answer alternatives on "need for aesthetic improvements" was as follows: yes, definitely 27%; yes, in high degree 19%; yes, in some degree 36%; no, not at all 17%. There was no statistical difference be-

tween genders ($p=0.083$), but 83 % of males found the need and 79 % of the females.

Education levels and work demands is described in Table 1-2.

Table 1. Education levels.

	n	%
Compulsory school (9 yrs)	94	4,8
Gymnasium or professional education (12 yrs)	391	19,9
More specific professional education	338	17,2
College/University BA (16 yrs)	614	31,3
University MSc	139	7,2
Missing information	385	19,6
Total	1961	100

Table 2. Subjective work demand

	n	%
Psychologically demanding	1404	71,6
Physically demanding	90	4,6
Both psychologically and physically demanding	425	21,6
Missing information	41	2,2
Total	1961	100

There were positive statistically significant correlations between:

- Working hours per week with VDU and neck and shoulder pain ($p=0.003$, $p=0.004$ respectively).
- Subjectively stated relations between shoulder pain and stress ($p=0.008$), shoulder pain and work load ($p=0.001$) as well as neck pain and work load ($p=0.002$).
- Total working hours per week and pain related to workload for neck, shoulder, upper back and low back ($p=0.001$, $p=0.001$, $p=0.004$, $p=0.015$ respectively).
- Working hours with VDU per week and pain related to work load for neck, shoulder and low back ($p=0.002$, $p=0.001$, $p=0.006$ respectively).

There were no statistically significant correlations between working hours per week and any musculoskeletal pain; working hours and pain related to stress; VDU work at leisure time and pain; VDU work at leisure time and pain related to workload and to stress.

Socioeconomy

There were statistically significant differences between the expressed “need for ergonomic improvements” and age, gender, and general life circumstances. Male gender ($p=0.034$), lower age (<46 yrs) ($p<0.001$) and satisfaction with life circumstances were associated with higher reported need for improvements ($p=0.001$). Whereas higher education did not show significant correlation ($p=0.063$). “Need for aesthetic improvements” was significantly correlated only to age ($p<0.001$). Younger persons (< 47 yrs) expressed more than older ones “need for aesthetic improvements” ($p<0.001$). Higher education level showed a similar tendency ($p=0.059$), whereas gender and satisfaction with general life circumstances did not show significant correlation.

Health and disease

According to the company’s sick leave register, 53 % (37 % females and 63 % males) had no sick leave ($p<0.001$). 54 % of females and 42 % of males had 1-183 days sick leave. Older persons, had statistically significant less sick leave than younger ($p=0.016$). The mean satisfaction on general life conditions was 7 on a 0-10 scale. There were statistically significant positive correlations between “need for ergonomic improvements” and all tested variables: the occurrence of musculoskeletal pain (neck, shoulder, upper and low back and other musculoskeletal organs) ($p<0.001$); pain intensity ($p<0.001$); subjectively stated connection of pain (neck, shoulder, upper back, low back and other musculoskeletal organs) to stress ($p<0.001$); subjectively stated connection of pain (neck, shoulder, upper back, low back and other musculoskeletal organs) to work load ($p<0.001$); treatment frequency for

musculoskeletal pain (neck, shoulder and back), ($p<0.001$) and for stress or depression ($p<0.001$); sleeping disturbances ($p<0.001$); worry about own health ($p=0.004$); self reported sick-leave due to neck, shoulder or back pain ($p=0.015$) and to stress or depression ($p=0.021$).

“Need for ergonomic improvements” was strongly correlated to occurrence of pain: $p<0.001$ for each of pain locations. It was most obvious for shoulder and neck pain. For those who reported a definite need for ergonomic improvements, the mean estimated pain on a VAS-scale was 5.2/10 for shoulder and 4.6/10 for neck pain. For those who reported no need for ergonomic improvements, the means were 2.3 and 2.6 respectively. The distribution of the total sum (0-50) of the reported musculoskeletal pain (neck, shoulder, upper back, low back and other musculoskeletal organs) in relation to the stated “need for ergonomic improvements” was as follows: yes, definitely 21.1; yes, in high degree 17.7; yes, in some degree 13.5; no, not at all 10.4.

There were statistically significant positive correlations between “need for aesthetic improvements” and the following variables: the occurrence of musculoskeletal pain (neck, shoulder, upper back, low back and other musculoskeletal organs $p<0.001-0.028$); pain intensity ($p<0.001-0.028$); treatment frequency for musculoskeletal pain (neck, shoulder, upper and low back $p=0.039$); sick-leave due to neck, shoulder, upper or low back pain ($p=0.036$).

“Need for aesthetic improvements” was correlated to the occurrence of pain, $p<0.001- p=0.40$ for each of pain locations. It was most obvious for shoulder and neck and upper back. For those who reported a definite need for aesthetic improvements, the mean estimated pain on a VAS-scale was 4.3/10 for shoulder, 3.6/10 for neck and 2.9/10 for upper back pain. For those who reported no need for aesthetic improvements, the means were 3.4, 3.0 and 2.0 respectively.

The distribution of the total sum (0-50) of the reported musculoskeletal pain (neck, shoulder, back and other musculoskeletal organs) in relation to the stated “need for aesthetic improvements” was as follows: yes, definitely 16.7; yes, in high degree 15.0; yes, in some degree 14.7; no, not at all 13.1. There were no statistically significant correlations between “need for aesthetic improvements” and the following variables: treatment frequency for stress or depression; sleeping disturbances; worry about own health; and sick leave due to stress or depression.

Professional position

There were statistically significant differences between “need for ergonomic improvements” and the groups of professional position

($p < 0.001$). Under Table 3, those who reported the highest “need for ergonomic improvements” were photographers, reporters and program leaders, sound/light/picture technicians, and studio and work room professionals. Those who mostly reported no need at all were high chiefs and IT staff. There were statistically significant differences between “need for aesthetic improvements” and the groups in professional positions ($p < 0.001$). In Table 3, those who reported the highest “need for aesthetic improvements” were: musicians, reporters and program leaders, sound/light/picture technicians, studio and work room professionals, and persons working directly with productions. Those who mostly reported no need at all were high chiefs and IT staff. See Table 3, below:

<i>Profession group according to code</i>	<i>n</i>	<i>% of total</i>	<i>Ergo yes 1 %</i>	<i>Ergo yes 2 %</i>	<i>Ergo some %</i>	<i>Ergo no %</i>	<i>Aest yes 1 %</i>	<i>Aest yes 2 %</i>	<i>Aest some %</i>	<i>Aest no %</i>
1.Administration	320	16,3	12,9	13,2	49,4	24,5	18,2	15,3	39,5	27,1
2. Persons with high chief position	85	4,3	6,0	7,2	41,0	45,8	12,0	12,0	41,0	34,9
3. Chiefs reporting to (2)	70	3,6	10,0	18,6	52,9	18,6	18,6	22,9	40,0	18,6
4. Studio- and work room professionals (e.g. masks, wig-makers, carpenters, painters, costume-makers, tailors and assistants)	77	3,9	16,9	22,5	54,9	5,6	30,6	11,1	36,1	22,2
5. Picture/sound/light technicians	190	9,7	19,7	24,2	49,5	9,7	31,9	21,6	33,5	13,0
6. Photographers	144	7,3	22,6	24,8	43,8	8,8	24,2	15,9	31,8	28,0
7. Persons working directly with productions	373	19,0	18,1	17,9	47	17,0	30,0	20,9	31,7	17,4
8.Reporters, program leaders and editorial workers	507	25,8	19,2	20,4	49,8	10,7	32,7	20,7	33,9	12,6
9. IT staff	35	1,8	11,4	5,7	45,7	37,1	14,3	14,3	42,9	28,6
10. Research and development technicians	79	4,0	5,1	12,7	51,9	30,4	10,3	19,2	51,3	19,2
11.Symphony orchestra	75	3,8	15,1	9,6	63	12,3	40,0	29,3	29,3	1,3
Missing information	6	0,3	0	0	100	0	16,7	66,7	16,7	0

Table 3: Number and % of participants in different professional groups. Distribution of answer alternatives in % for “Need for ergonomic improvements” (n=1917) and “need for aesthetic improvements” (n=1905) in professional groups. Ergo=ergonomic; Aest=aesthetic. Yes, definitely=yes1; Yes, in high degree=yes 2; Yes, in some degree=some; No, not at all=no.

Work environment

There were positive correlations between “need for ergonomic improvements” and occurrence of disturbing noise ($p < 0.001$); stress ($p < 0.001$); problems within work ($p < 0.001$); low influence on own work ($p = 0.006$); dissatisfaction with the work circumstances and general problems in work ($p < 0.001$); subjectively stated connection of musculoskeletal pain to stress and (neck, shoulder, upper back, low back and other musculoskeletal organs) ($p < 0.001 - 0.003$); subjectively stated connection of pain (neck, shoulder, upper back, low back and other musculoskeletal organs) to work load ($p < 0.001$).

There were no statistically significant correlations between “need for ergonomic improvements” and physical or psychological work demands or both physical and psychological demands.

There were positive correlations between “need for aesthetic improvements” and occurrence of disturbing noise ($p = 0.035$); stress ($p < 0.001$); problems within work ($p < 0.001$); dissatisfaction with the work circumstances ($p = 0.003$); musculoskeletal pain related to work load and to stress ($p < 0.001 - 0.003$).

There were no statistically significant correlations between “need for aesthetic improvements” and physical or psychological work demands or both physical and psychological demands, low influence on the work, and general problems in work.

Life style

There were no statistically significant correlations between “need for ergonomic improvements” and high intensity of physical training (> 30 min at least three times per week), smoking or alcohol intake whereas those who were physically active (> 30 min 2 times or less than two times a week) stated a higher need of ergonomic improvements ($p = 0.001$). Those with high intensity of physical training (> 30 min at

least three times per week) had a high need of aesthetic improvements ($p = 0.001$). So did daily smokers ($p = 0.010$).

Logistic regression analyses

In logistic regression analyses concerning age, gender, education level, stress in work, problems in work, sleeping disturbances, smoking and leisure time training (> 30 min at least three times per week) the following correlations were found:

“The need of ergonomic improvements” was positively correlated to lower age, work stress, sleeping disturbances and problems in work ($p < 0.001 - 0.002$), whereas gender, education level, training and smoking were not. “The need of aesthetic improvements” was positively correlated to lower age, work stress, problems in work, training and smoking ($p < 0.001 - 0.023$), whereas gender, education, sleeping disturbances were not.

Discussion

The results in the current study pointed out correlations between the stated need for ergonomic improvements in working life in all the included areas such as: socio-economic and health status, occurrence of musculoskeletal symptoms, stress and depression, professional position, work environment, and life style. Many of the results in the present cross-sectional study were expected. They confirm earlier results about the complexity of work related health concerning musculoskeletal disorders, work load, work stress, influence on own work, and psychosocial factors (rehabilitation outcome included) by Karasek R and Theorell T (Ed) 1990, Johansson JÅ 1995, Basmajian J.(Ed) 1995, Linton SJ 2000, Hoogendoorn WE et al 2000, Feyer et al 2000, Hansson T and Westerholm P (Ed) 2001, Jensen I et al 2001, Evans O et al 2002, , Arnetz B et al 2003, Nachemsson et al report no 145/1 “Neck and Back pain” 2000 and Alexanderson K et al report no 167 “Sickleave” 2003 (www.sbu.se).

The present study analyzes the “need of ergonomic and aesthetic improvements” in a large working population from varying geographic areas and with many professions and working positions, namely: 1. Administration; 2. Persons with high chief position; 3. Chiefs reporting to no 2; 4. Studio- and work room professionals (e.g. masks, wigmakers, carpenters, painters, costume-makers, tailors and assistants); 5. Picture/sound/light technicians; 6. Photographers; 7. Persons working directly with productions; 8. Reporters, program leaders and editorial workers; 9. IT staff; 10. Research and development technicians; 11. Symphony orchestra members.

The fact that the “need of aesthetic improvements” mostly were correlated to the same variables as the “need of ergonomic improvements” puts the focus on the importance of the workplace design in general. These findings correspond well to the descriptions and discussions by Dilani A 2001 and 2002 where he points out the importance of well performed hospital workplaces and care room’s design for workers health and recovering patients. The current study indicates that these conclusions are also valid for other workplaces. Possible cost benefits, including such as less sick leave and higher work effectiveness, could be achieved by ergonomically and aesthetically well designed and well performing work places in addition supported by to wimproved work organization.

Conclusion

A cross-sectional study on eleven different professional groups at radio and television companies (1961 persons) showed a significant correlation between stated needs of both ergonomic and aesthetic improvements in relation to the following factors: socio-economic and health status; professional position; work environment; and life style ($p < 0.001-0.034$). There were more and stronger correlations for ergonomics and health variables than for aesthetics. The need for aesthetic improvements (definitely and in high degree) was 46%; and of ergonomics 34%;

no need at all was 21% and 17 % respectively. High chiefs and IT-staff were those who had the lowest needs.

The correlations of aesthetic and ergonomic needs to lower age, higher education level, work stress, problems in work were mostly the same. I logistic regression analyses proved that the results stayed significant for both aesthetic and ergonomic needs.

The fact that the “need of aesthetic improvements” mostly was correlated to the same variables as the “need of ergonomic improvements” places the focus on the importance of workplace design in general.

These results may indicate that benefits, such as less sick leave and higher work effectiveness, can be achieved through ergonomically and aesthetically well designed work places combined with well designed work performance strategies and procedures.

References

- Alexandersson K (chairman): Prescribed sick leave – causes, consequences and practice. A systematic review. The Swedish Council on Technology Assessment in Health Care, Stockholm, 2003; Report No 167.*
- Amick BC 3rd et al. Effects of office ergonomics intervention on reducing musculoskeletal symptoms. Spine, 28: 2706-11, 2003.*
- Arnetz B et al. Early workplace Intervention for Employees With Musculoskeletal-Related Absenteeism: A Prospective Controlled Intervention Study. Journal of Occupational and Environmental Medicin, 45, 2003.*
- Basmaijan J (Ed). Physical Rehabilitation Outcome Measures. Canadian Physiotherapy Association, Williams & Wilkings, Baltimore 1995 (3rd edition).*

Dekker S. and Nyce J. How can ergonomics influence design? Moving from research findings to future systems. *Ergonomics* 47:1624-39, 2004.

Dilani A. Psychosocially supportive design – Scandinavian health care design. *World Hospital & Health Services*. 37: 20-4, 33, 35, 2001.

Dilani A. Health care buildings as supportive environments. *World Hospital & Health Services*. 36:20-6, 2000.

Evans O. et al. The contribution of gender-role orientation, work factors and home stressors of psychological well-being and sickness absence in male and female dominated occupational groups. *Soc Sci Med* 54:481-492, 2002.

Feyer A.M. et al. The role of physical and psychological factors in occupational low back pain: a prospective cohort study. *Occupational Environ Med* 57: 116-120, 2000.

Hansson T. & Westerholm P. (Editors). *Arbete och besvär i rörelseorganen. En vetenskaplig värdering av frågor om samband. Arbete och hälsa, vetenskaplig skriftserie. ISBN 91-7045-610-0. Arbetslivsinstitutet 2001 (in Swedish).*

Hoogendoorn WE. et al. Systematic review of psychosocial factors at work and private life as risk factors for back pain. *Spine*. 25:2114-25, 2000.

Jensen I et al. A randomised controlled component analyses of a behavioral medicine program for chronic spinal pain: are the effects dependent on gender. *Pain* 91:65-78, 2001.

Juul-Christensen B. et al. Computer users' risk factors for developing shoulder, elbow and back symptoms. *Scand J Work Environmental Health* 30:390-8, 2004.

Johansson J.A. & Rubenowitz S. Risk indicators

in the psychosocial and physical work environments for work-related neck, shoulder and low back symptoms: a study on blue- and white-collar workers in eight companies. *Scand J Rehabil. Med.* 26:131-42, 1994.

Johansson J.A. Psychosocial work factors, physical work load and associated musculoskeletal symptoms among home care workers. *Scand J Psychol* 36:113-129,1995.

Johansson J. A. The impact of decision latitude, psychological load and social support at work on musculoskeletal symptoms. *Eur J Public Health* 5:169-174, 1995.

Linton S.J. A review of psychological risk factors in back and neck pain. *Spine* 26:778-787, 2001.

Kourinka I. Et al. Standardised Nordic Questionnaire for the analyses of musculoskeletal symptoms. *Appl Ergonomics* 18:233-237, 1987.

Karasek R. & Theorell T: *Healthy work. Stress productivity, and the reconstruction of working life.* New York: Basic books , inc; 1990.

Nachemsson A. et al. The Swedish Council on Technology assesment in Health Care. Neck and Back pain. A systematic review. Report no 145/1, 2000.

Schnall P et al. The workplace and cardiovascular disease. In: *occupational Medicine.* Hanley & Belfus, inc.2000.

Statistics Sweden. Living Conditions Survey 2003 (ULF), and Report no 95 2004.

Steenstra IA et al. Cost effectiveness of a multi-stage return to work program for workers on sick-leave due to low back pain, design of a population based controlled trial. *BMC Musculoskelet. Disord.* 4:26, 2003.