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PHYSICAL AND PSYCHOLOGICAL WORKLOAD IN MEN WITH AND WITHOUT LOW BACK PAIN

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ABSTRACT. **Current and retrospective physical and psychological workload was studied in 148 mean, 45–55 years old. The men represented three groups with respect to low back health status: Healthy low back (Group 1, $n = 36$), intermittent low back pain (LBP) (Group 2, $n = 91$) and chronic LBP (Group 3, $n = 21$). The methods used were a selfadministered questionnaire, a rating scale of perceived exertion, and blind expert assessment built on a classification of job titles. Group 1, the back-healthy subjects, had been less exposed to heavy physical work than subjects with intermittent LBP (Group 2) and chronic LBP subjects (Group 3) through their whole working-career and in their present work ($p \leq 0.05$, $p \leq 0.01$). Group 2 tended to be significantly less exposed in their present work than Group 3 ($p \leq 0.06$). Non-neutral working postures were reported more often in Groups 2 and 3 than in Group 1 ($p \leq 0.05$, $p \leq 0.001$). Both groups 2 and 3 perceived present and earlier work to be more strenuous than Group 1, with respect to the low back ($p \leq 0.000$). Subjects in the healthy low-back group had lower values in the qualitative demand index ("too difficult working tasks" and "too great responsibility") than subjects in Groups 2 and 3 ($p \leq 0.01$). This study indicates that more attention should be given to the individual's perception of physical workload.**

Key words: back health, job titles, workload, work postures, qualitative demand, perceived exertion.

INTRODUCTION

In several cross-sectional studies a correlation between heavy physical work and low back pain (LBP) has been demonstrated (2, 10, 18, 20, 21, 26). There are also studies where such a relationship has not been found (3, 7). The contradictory opinions on the importance of physical workload for the etiology of LBP could be due to the fact that it is difficult to assess physical workload. The assessment is mostly derived from questionnaires rather than direct measurements or observations at the work-site (6). The two latter approaches are time-consuming, expensive and inappropriate in retrospective studies. Lately, more interest has been focused on psychological workload, i.e. degree of demands, freedom of action, and social support at work. In several studies, there parameters have shown correlations with reported LBP at work (1, 2, 4). In recent years, the medical model for estimating LBP has been replaced by a biopsychosocial model (30). The results of this latter approach indicates a multifactorial etiology (4, 9, 29).

About 20% of the population never experience LBP (12, 27, 31). An interesting question is whether groups of back-healthy individuals have or have had physical and psychological less straining occupations than individuals with LBP.

The purpose of this study was to evaluate the exposure of lifetime physical workload and perceived psychological strain in back-healthy men versus back-impaired men, 45–55 years old.

MATERIALS AND METHODS

Subjects

In order to find back-healthy and low-back impaired men, two different recruitment procedures were used. One source was a larger manufacturing cable industry with 1100 employees in the Stockholm metropolitan area. The industry represents a wide variety of jobs with predominantly manual work. At the time of the study (1988–1990) all employees were affiliated to an occupational health care center located within the industrial site. A multidisciplinary medical, ergonomic and technical staff was available for workplace evaluation and treatment of the employees.

All men, both white and blue collar employees, 45–55 years old working in the industry on the first of January 1988 were invited by a letter to participate in the study ($n = 147$). One-hundred and twenty-seven men (86%) were included in

the study. Twenty subjects (14%) dropped out of the study for medical reasons ($n = 5$), because employment ended ($n = 4$), or they refused to participate ($n = 11$).

The second source was the outpatient clinic at the Department of Orthopedics, Karolinska Hospital, Stockholm, which represents the same metropolitan area as the above-mentioned industry. All men 45–55 years old consecutively referred to the outpatient clinic for non-specific chronic LBP during 1988 were asked to participate in the study ($n = 21$), and all volunteered.

The material consisted of 148 men ($n = 127 + 21$) divided into three groups based on the following criteria:

Healthy low back (Group 1, n = 36): These subjects never had any LBP or occasionally had a very slight problem, and regarded themselves as having a healthy back. This information was put down on a questionnaire and checked during the clinical examination. They had never been listed as being sick with LBP. This statement was checked with the records of the Social Insurance Office. Data about sick leave periods and diagnosis were collected from 1963–1989 by an independent employee at the Social Insurance Office.

Intermittent LBP (Group 2, n = 91): This group included all men in the age group that did not fulfil the criteria of Groups 1 and 3. They had been free from LBP at least 2 months prior to the evaluation.

Chronic LBP (Group 3, n = 21): These subjects had at least 3 years of non-specific chronic LBP, never surgically treated, and sick-leave for more than 3 months for LBP during the year prior to the evaluation.

Methods

Physical workload for each employee was collected by means of a questionnaire covering 76 items divided into four parts: previous and present occupations, previous and present physical workload, psychological workload, and perceived exertion.

Previous and present occupations included questions about education, military service, present and previous professions and years spent in each job. The following variables were calculated from these questions:

Total number of reported years worked (ALLWORK), number of years worked before 30 years of age (BEFTHY), number of years worked after 30 years of age (AFTTHY), and number of years in present occupation (PRESWORK).

Physical workload questions concerned previous and present work and contained duration in different working postures such as sitting, standing, walking, stooped and twisted postures, frequency of changing posture, possibility of taking breaks during work, frequency and heaviness of lifting and carrying, pulling and pushing, lifting posture, exposure to whole body vibration and sudden uncontrolled movements.

Questions about the duration of different working postures in present work was graded on a four-point scale: "seldom/less than 1 hour a day", "1–3 hours a day", > 3–6 hours a day", "> 6 hours a day". In the analysis, the responses were dichotomized into "not present" (seldom/less than 1 hour) and "present" (the three remaining response alternatives).

The questions concerning the frequency of different events during the working day in present work had a four-point response scale from "almost never", "sometimes", "often" to "almost always". These response alternatives were dichotomized into "not present" (almost never) and "present" (sometimes, often and almost always). Questions about physical workload in previous work were related to present work and had three response alternatives: "less", "the same" and "more".

Table I. *Questions about psychological workload grouped into 5 indices*

Discretion
Possibility to plan your own work?
Early information about future plans in good time?
Opportunities to personal development?
Qualitative demands
Too difficult working tasks?
Too great responsibility?
Quantitative demands
Too much to do at work?
Monotonous work?
Irregular workload?
Social support
Can you talk to supervisors when you have problems at work?
Help from fellow workers when things are piling up?
Understimulation
Your worktasks are too easy?
Too little to do at work?

Reliability of the questionnaire was performed on 20 randomized subjects by the test-retest method. Sixty-one questions had an agreement between test-retest sessions at $\geq 75\%$ and these questions are used in the analysis.

Psychological workload in present work was measured by 12 prevalidated questions (19). Each answer was assigned a value between 1 and 4 ("seldom", "sometimes", "often", "very often"). The 12 questions were grouped into five multi-item indices called "discretion", "qualitative demands", "quantitative demands", "social support", and "understimulation" (Table I). A sixth index was formed out of the qualitative demand index and the discretion index and called "control index".

Perceived physical exertion related to the low back in each occupation for the total working career and in present work was assessed by the subjects. A 0–10 category ratio (CR) scale of perceived exertion was used, where 0 represents no exertion and 10 almost maximal exertion (5). For data analysis, the scale was changed to four categories (1–4) and the following variables were calculated.

TotBacWL = total perceived physical exertion of the low back for all years worked calculated as follows:

$$\text{TotBacWL} = \frac{\Sigma b_x y_x}{Y_{TOT}} \quad (1)$$

where b_x is the scoring category (1–4) for the low back in occupation x, and y_x the number of years in occupation x. The calculations are repeated for second, third etc occupations. Y_{TOT} is the total number of years worked during lifetime for each subject.

PreBacWL = the score (1–4) given for the perceived physical exertion of the low back in present work.

Expert assessment with NYK (Nordic Occupational Classification)

The occupational classification system of the Nordic

countries (NYK) is similar to the International Standard Classification of Occupations (ISCO) (33). In this study, all present and previous job titles for all subjects (Group 1–3) were classified according to the 1983 three digit-level edition of NYK (23). The digits represent occupational area, group, and family (for example: production work, engineering metal work and machinery fitter).

In a work by Vingård (28) these codes were given a score according to the assessed degree of physical workload on four body regions, i.e. neck, low back, knee and hip. The scoring of the NYK codes in Vingård's study (28) were made by four independent medical appraisers, experienced in physical workload assessment. The following four levels were used:

1 = low load, 2 = rather low load, 3 = rather high load, 4 = high load.

A mean of the scoring from the four independent medical appraisers was calculated for each job title and each body region. In this study, only the mean score of physical workload for the low back was used for each job title.

The classification according to job titles was done by one of the authors who was not aware of which group the subjects belonged to.

The following variables were calculated from the scores based on the NYK codes:

ALLEXP = total physical workload exposure derived from following formula:

$$\text{ALLEXP} = \frac{\sum a_x y_x}{Y_{TOT}} \qquad (2)$$

where a_x is the score of jobtitle x, and y is the number of years within job title x. The calculations were repeated for the second, third etc occupation. Y_{TOT} is the total number of years worked during lifetime for each subject.

BTHYEXP = physical workload exposure calculated as above but only for exposure before 30 years of age.

ATHYEXP = physical workload exposure calculated as above but only for exposure after 30 years of age.

PRESEXP = physical workload exposure in present work and only reported with the score.

Statistics

Descriptive statistics (mean, SD) and 95% confidence intervals are given for demographic data, for six psychological indices, for expert assessment variables of physical workload (NYK codes) and for perceived exertion data. Group comparisons were performed with chi-square analysis and *t*-test. The Pearson correlation was used to study linear correlation between certain variables within groups. Significance level was chosen at $p < 0.05$. Trend was determined at $p < 0.10$.

RESULTS

This study is part of a larger investigation where demographic data are collected for all subjects undergoing a clinical and physical evaluation (13, 14, 15). The three study groups were highly similar with respect to age, height, weight and BMI (kg/m^2) (Table II).

The study groups were also similar with respect to the variables concerning number of years worked in different periods during lifetime: total number of years worked (ALLWORK), number of years worked before 30 years of age (BEFTHY), number of years worked after 30 years of age (AFTTHY), and number of years in present work (PRESWORK) (Table II).

There were no statistically significant differences between the groups concerning military service and degree of education. In the whole study population 60% of the men ($n = 89$) were blue collar workers (bc) and 40% ($n = 59$) white collar employees (wi). In the study groups the distribution was the following: Group 1: bc 44%, wi 56%, Group 2: bc 65%, wi 35%, Group 3: bc 67%, wi 33%. These differences are not statistically significant between any of the groups.

The NYK physical workload scores for the three groups are presented in Table III. The mean, SD and 95% confidence intervals are presented for physical workload exposure during all years worked (ALLEXP), workload exposure before 30 years of age (BTHYEXP), after 30 years of age (AFTHYEXP) and during present work (PRESEXP). Group 1

Table II. *Demographic data and number of years worked for Groups 1–3*

There are no significant differences between the study groups.

	Group 1 ($n = 36$)			Group 2 ($n = 91$)			Group 3 ($n = 21$)		
Variable	M	SD	95% CI	M	SD	95% CI	M	SD	95% CI
Age (y)	50	(3)	49–51	50	(3)	49–51	49	(6)	46–51
Height (cm)	177	(6)	175–179	175	(6)	174–177	176	(7)	173–179
Weight (kg)	82	(14)	78–87	81	(13)	78–84	82	(14)	75–88
BMI (kg/cm^2)	26	(4)	25–28	26	(4)	26–27	26	(4)	24–28
ALLWORK (y)	29	(6.4)	28–32	28	(6.4)	24–30	27	(6.4)	24–30
BEFTHY (y)	9	(4.7)	8–11	8	(4.9)	7–9	8	(4.7)	6–10
AFTHY (y)	20	(9.9)	19-21	20	(3.5)	19–21	19	(3.8)	17–21
PRESWORK (y)	13	(9.9)	10–16	10	(7.1)	9–12	12	(9.9)	7–16

Table III. *Expert assessment of physical workload calculated according to the NYK-codes*

ALLEXP = physical workload exposure during all years worked, BTHYEXP = physical workload exposure before thirty years of age, ATHYEXP = physical workload exposure after thirty years of age, PRESEXP = physical workload exposure in present work. Calculated scores of perceived physical exertion on the low back rated according to the Borg-scale .TotBacWl = perceived exertion during all years worked. PreBacWl = perceived exertion in present work.

	Group 1 ($n = 36$)			Group 2 ($n = 91$)			Group 3 ($n = 21$)			Significance		
Variable	M	SD	95% CI	M	SD	95% CI	M	SD	95% CI	1–2	1–3	2–3
ALLEXP	2.0	(0.8)	1.8–2.3	2.4	(0.8)	2.2–2.6	2.7	(0.9)	2.3–3.1	0.032	0.009	> 0.10
BTHYEXP	2.4	(0.9)	2.1–2.7	2.8	(0.9)	2.6–3.0	2.9	(1.0)	2.3–3.4	0.031	0.094	> 0.10
ATHYEXP	2.0	(0.9)	1.7–2.2	2.3	(0.8)	2.1–2.0	2.6	(0.9)	2.2–3.0	0.038	0.016	> 0.10
PRESEXP	1.8	(0.8)	1.5–2.1	2.1	(0.9)	2.0–2.3	2.6	(0.9)	2.2–3.0	0.033	0.002	0.055
TotBacWl	1.7	(0.7)	1.5–1.9	2.5	(0.9)	2.3–2.7	3.4	(0.8)	3.0–3.9	0.000	0.000	0.000
PreBacWl	1.8	(0.9)	1.5–2.1	2.5	(1.1)	2.3–2.8	3.5	(1.0)	3.0–3.9	0.001	0.000	0.001

(healthy subjects) had significantly ($p < 0.03$) less exposure to physical workload during their total working years (ALLEXP) than both Group 2 (intermittent LBP) and Group 3 (chronic LBP). Before 30 years of age (BTHYEXP), Group 1 had significantly ($p = 0.03$) lower physical exposure than Group 2 and tended to have had lower exposure than Group 3 ($p = 0.09$).

For NYK scoring after 30 years of age and present physical workload, Group 1 had significantly lower scores than both Groups 2 ($p < 0.04$) and 3($p < 0.02$). Group 2 tended to be significantly less exposed in present work (PRESEXP) than Group 3 ($p = 0.06$). In Table III the values of the following variables are presented: TotBacWL (perceived physical exertion of the low back during all working years) and PreBacWL (perceived physical exertion of the low back in present work).

Statistically significant differences ($p =< 0.001$) were found between all groups and all ratings. Group 1 rated less perceived physical exertion for both variables than Group 2, which in turn rated less than Group 3.

Table IV displays the correlation coefficients between expert classification according to NYK-codes (ALLEXP and PRESEXP) and perceived physical exertion on the low back, rated according to the Borg-scale (TotWlBac and PresWlBac). There are significant correlations in Group 1 and 2 and in the whole material for both variables. There are no significant correlations in Group 3 for any of the variables.

Statistically significant group differences for questions concerning physical workload in present work are presented in Table V. In Group 3, the following variables were significantly more often present (> 1 h/day) than in Group 1: standing with the trunk stooped and/or twisted, lifting while twisting the trunk and carrying the lifted burden. Group 2 reported significantly more standing (> 1 h/day) with the trunk stooped and twisted than Group 1. In group comparisons, no statistically significant differences were found for sitting, upright standing, walking, exposure to whole body vibration, and motor vehicle driving, frequency of changing posture, lifting, pulling and pushing, and amount of weight lifted.

In Table VI, the results from the psychological questionnaire are presented. Groups 2 and 3 had significantly higher scores in the qualitative demand

Table IV. *The Pearson correlation coefficient (r) between expert assessment according to the NYK-codes and the perceived physical exertion rated by the Borg-scale*

	Group 1		Group 2		Group 3		All	
Variables	r	(n)	r	(n)	r	(n)	r	(n)
TotWlBac/ALLEXP	0.49**	(34)	0.39**	(78)	0.38	(18)	0.46**	(130)
PresWlBac/PRESEXP	0.58**	(34)	0.39**	(83)	0.47	(19)	0.49**	(136)

** $p < 0.01$.

Table V. *Frequencies of responses to questions about working postures with increased load on the low back for Groups 1–3*

	Group 1	Group 2	Group 3	Significance		
Working postures	% (*n*)	% (*n*)	% (*n*)	1–2 chi^2 pval	1–3 chi^2 pval	2–3 chi^2 pval
Standing, stooped	22% (8/36)	38% 33/86	53% (10/19)	– ns	3.93 0.047	– ns
Standing, twisted	11% (4/36)	26% (23/87)	53% (10/19)	– ns	9.21 0.002	– ns
Standing, stooped and twisted	8% (3/36)	28% (25/89)	53% (10/19)	4.79 0.028	11.17 0.000	– ns
Lift and twist	11% (4/35)	28% (25/89)	42% (8/19)	– ns	5.04 0.024	– ns
Lift and carry	20% (7/35)	33% (29/89)	58% (11/19)	– ns	6.34 0.004	– ns

indices than Group 1. There was a statistically significant difference between Groups 1 and 3 and a trend between Groups 2 and 3 in the "control" index, formed from the discretion and qualitative demand indices.

DISCUSSION

In this paper, occurrence of LBP is analysed in relation to physical and psychological workload and perceived physical exertion in three well defined groups of the same age: men with healthy backs (Group 1), men with intermittent LBP (Group 2), and men with chronic LBP (Group 3). The subjects were recruited from two different sources. As the company and the hospital represent the same metropolitan area and as the three study groups are highly similar with respect to height, weight-body composition, leisure activities and socioeconomic status (15) we considered the groups comparable.

Making cumulative measurements of physical workload is not a simple task. Assessment of present work can be made directly on site with the help of EMG, trunk flexion analyzer, forcemeter or indirectly on site observational methods like OWAS, ARBAN, VIRA (17). To measure workload in previous works, other methods must be used.

The NYK-codes have been used by the National Board of Occupational Safety and Health in their registration of work related accidents and illnesses in different occupations (22). The advantage of estimating workload according to job titles is that this method does not rely on difficult assessment in the work-place, is suitable for screening of large populations, and can be made retrospectively. Östlin et al. (33) evaluated the reliability of employee reported job

Table VI. *The results from the answers to the psychological questions grouped into six indices for Groups 1–3*

	Group 1 ($n = 36$)			Group 2 ($n = 91$)			Group 3 ($n = 21$)			Significance		
Index	M	(SD)	95% CI	M	(SD)	95% CI	M	(SD)	95% CI	1–2	1–3	2–3
Discretion	2.9	(0.8)	2.6–3.1	2.7	(0.8)	2.6–2.9	2.7	(0.8)	2.3–3.0	> 0.10	>0.10	>0.10
Qualitative demands	1.4	(0.6)	1.2–1.6	1.8	(0.8)	1.6–1.9	2.0	(0.9)	1.6–2.5	0.009	0 .016	>0.10
Quantitative demands	2.2	(0.5)	2.0–2.3	2.3	(0.6)	2.2–2.5	2.2	(0.5)	1.9–2.4	> 0.10	>0.10	>0.10
Social support	3.0	(0.8)	2.7–3.3	3.0	(0.8)	2.8–3.1	2.8	(0.8)	2.4–3.2	0.10	>0.10	>0.10
Under-stimulation	1.7	(0.7)	1.5–2.0	1.6	(0.5)	1.5–1.7	1.6	(0.7)	1.2–1.9	0.10	>0.10	>0.10
"Control"	2.2	(0.9)	1.9–2.5	2.0	(1.0)	1.7–2.2	1.6	(0.8)	1.2–2.1	>0.10	0.008	0.081

titles over time using census data and found that the correlation was good. Physical workload exposure may take place in, for instance, static, dynamic, and repetitive impact and vibration exposure. The scoring of the NYK codes does not differentiate between these types of exposure. The questionnaire used in the present study complements the estimation of the workload assessed according to job titles. The answers to the questionnaire might indicate that static loading of the trunk (stooped and/or twisted positions) could be a contributing factor responsible for LBP in subjects with intermittent and chronic LBP. This is in accordance with Punnett et al. (25) and by Saraste & Hultman (27) who found that subjects with LBP reported a higher presence of non neutral working positions than controls without LBP.

It has been suggested that subjects with complaints from the musculo-skeletal system may overestimate the exposure or report more than subjects without such symptoms (28). In a study by Wiktorin et al. (32) working subjects with and without complaints from the low back showed equal ability to classify exposure to forward bending position. It is unclear whether subjects who are presently out of work overrate their workload. Our questionnaire also included questions about working positions in all past occupations. However, the reliability was low for these questions and their results were omitted from the analyses.

The distribution of blue-collar workers differed between the groups, although not statistically significantly and it was therefore of interest to compare only the blue-collar workers in the three groups with respect to exposure of physical workload. This comparison revealed that the blue-collar workers in the back-healthy group were less exposed in present and earlier work than the blue-collar workers in the intermittent and chronic LBP groups. This could further indicate the relationship between physical workload and LBP which has been postulated by other authors (2, 8, 18, 26). There were no differences in exposure to physical workload between white collar workers in the three study groups. The subjects with chronic LBP perceived higher physical exertion of the low back than the subjects with intermittent pain. The latter group, in its turn, perceived a higher physical exertion than the back healthy subjects. Discomfort and/or pain may have contributed considerably to the high rating in the chronic LBP group, while the ratings of the group with intermittent pain could not be explained by pain present at evaluation. The correlation between expert classification of physical workload and perceived physical workload is good in the whole material as well as in Groups 1 and 2. Subjects in the chronic LBP group (Group 3) rate their exposure to physical workload higher than the expert classification with the NYK-codes. Correlation between classification of job titles and perceived physical exertion in general was good for different occupations in a large epidemiologic study (24). However, the possible influence of musculo-skeletal problems such as LBP was not analyzed.

Subjects in the intermittent and chronic LBP groups had significantly higher mean values in the qualitative demand index ("too difficult working tasks" and "too great responsibility"). This is in accordance with the findings of Holström (11) who showed that the prevalence rate of low-back healthy construction workers decreased with a higher score on the qualitative demand index.

The control index, formed out of the qualitative demand and discretion indices, was significantly lower for the chronic LBP group than for the healthy back group. The control index was formed after Karasek's model of demand/control mostly used in studies concerning cardiovascular diseases (16). However, in this study, lack of social support in the form of opportunity to talk to the supervisor when problems arise at work and help from fellow workers when needed did not relate to the experience of LBP, which contrasts with the findings of Holmström et al. (11).

An interesting finding in this study is the similar results found by expert classification of physical workload, perceived and rated physical workload by the worker as well as perceived psychological workload. The back-healthy group is less exposed in all these variables, the chronic LBP group most exposed and the intermittent LBP group has exposure values in between the two other groups. The cross-sectional study design does not allow us to decide the temporal order of workload and LBP. Even if the sample size of this study is small it points to the direction of further study on back healthy individuals to better understand individuals with LBP. Perhaps more attention should be given to the individual's perception of physical workload, which was the most significant variable ($p < 0.000$) in this study. That could be done by using the Borg-scale to identify individuals at risk for chronicity.

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