

## **Distribution of work tasks and associations to pain, fatigue and physical exertion among construction workers**

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**Abstract.** In this paper, results from a mixed-methods study on Musculoskeletal disorders (MSD) in the construction industry will be presented and discussed. The study explores the associations between the distribution of work tasks within work gangs and the workers' perceived fatigue, physical exertion and pain. The analysis is based on questionnaire responses from 519 construction workers and discussed with interviews from 8 construction work gangs. The analysis shows no associations between the studied variables. The qualitative data reflect these results in general. However, important mechanisms of giving harder tasks to younger workers, and taking over tasks for elder colleagues pose important issues to address. Conclusively, reorganizing the distribution of work tasks within the gang with the hope of preventing MSD in the construction industry does not seem the most obvious solution on the grounds of this research.

**Keywords.** Musculoskeletal disorders (MSD), Organization, Work gang, Physical exertion.

### **1. Introduction**

Research on musculoskeletal disorders (MSD) has increased over the last 15 years, and MSD are perceived to be one of the prime health concerns of contemporary western society. The societal interest is in part a result of an ageing work force and the political aspiration to maintain a productive population (Bevan et al 2009; Marmot et al 2010). Observably, the number of people suffering from loss of work ability and eventually ending on disability pension is relatively higher in physically straining jobs (Andersen et al 2007; Pension Denmark 2013). Work in the construction industry is characterized by high levels of physical strain and workers have a high prevalence of pain experiences, why this area of work has come to particular interest. In the present paper we present results that are part of a larger research effort that investigates structural, organizational and cultural aspects of work, relating to physical strain as a risk factor for developing MSD (Andersen et al 2007; Andersen et al 2012) and experiences of pain as an indicator of developing MSD.

#### *1.1 Organization of work and work conditions*

One traditional principle for the organization of work in the construction industry is the work gang. Work gangs, is a form of organization, which dates back to at least the 19<sup>th</sup> century (Nørregaard 1943). In the work gang, workers typically organize the distribution of work tasks among themselves, with the foreman<sup>8</sup> as a central figure. Irrespective

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<sup>8</sup> In Danish known in some professions as *sjakbajs*

construction profession (e.g. brick layer, concrete worker, carpenter), work contains a number of tasks that requires manual handling. Hence, construction workers need to use muscle power to get the work done. In combination with professional knowledge, skills and the use of technical aids, the use of muscle power needs to be coordinated between the work gang's members in order to complete a building task.

Obviously, works tasks differ in complexity and some work tasks require more muscle power than others. Thus, in different construction professions there will be different ergonomic recommendations for working positions and the use of assistive technical devices (e.g. manually mounting a heavy window or measuring and cutting a drywall plate). In addition the workers' acceptance and tolerance for physically straining work varies but it seems that pain and physical exertion is considered an unavoidable part of the construction work. (Ajslev et al 2013).

In this paper we explore whether the distribution of work tasks in the gang is associated with physical exertion, fatigue and pain. In addition, we contrast and discuss the quantitative results with the worker's own descriptions of practices of the negotiation and distribution of work tasks as described in the case study. This mixed methods approach provides the opportunity of learning something from the context behind the numbers. As such, this paper serves to enlighten a discussion of the work gang as an appropriate forum for the organization of work. Particularly, as regards the distribution of tasks within the work gang. This will also yield information on the possibilities for reducing MSD by changing the distribution of work tasks.

## 2. Methods

The paper draws upon empirical perspectives from a survey comprising 519 (response rate 81%) construction workers in 2013 as well as a case study entailing 32 construction workers from 8 work gangs conducted in 2012-2013. In the case study short observations and semi-structured interviews were employed<sup>9</sup>. As all respondents did not answer all questions in the pen and paper questionnaire, the number of valid cases in the statistical analysis varies from 478 to 497.

### 2.1 Explanatory variables

*Distribution of work tasks.* Distribution of work tasks was assessed with 3 questions that were phrased as statements. The statements were responded to on a scale indicating the degree of agreement, ranging from 0 = not at all to 10 = yes, completely. The questions/statements read Q1: "*The members of your work gang contribute equally to completing work tasks?*", Q2: "*The distribution of physically exerting work tasks are evenly distributed among the members in the work gang?*", Q3: "*The distribution of work tasks is fixed within the work gang?*". The scores were trichotomized into 3-levels: Low (0-3), Medium (4-6) and (high 7-10).

### 2.2 Outcome variables

*Pain frequency* was assessed with one question "*how often do you feel bodily pain (including arms, hands, knees, shoulder, back, etc.)?*". Response options were: 1= every day, 2=several times a week, 3= a few times a month, 4=a few times a year at maximum, 5=never. The scores were trichotomized into 3-levels: High (1every day/several times a week), Medium (a few times a month), and Low ( a few times a year/never).

*Fatigue* was assessed by the question "*How fatigued are you after a typical work day?*".

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<sup>9</sup> In this paper we limit the use of the qualitative study to a discussion in regard to length limit

The response options were: 1=Not fatigued, 2=A little fatigued, 3=Some-what fatigued, 4=Fatigued, 5=Completely Exhausted. In the questionnaire these were asked in relation to the six body regions (i) the body in general, (ii) in the back, (iii) neck/shoulder, (iv) arms/wrists (v) legs, and (vi) in the head. In the present study, only the general body score was used as an outcome score where higher scores indicated a greater degree of fatigue (range 1 to 5)

*Physical exertion* was measured with the BorgCR10 scale (Borg 1982; 1998). The question read: “*In general, how physically exerting do you perceive your current work to be*”. The CR10-response scale contained 16 steps; 0 – not at all, 0.3, 0.5 - extremely weak, 1- very weak, 1.5, 2-weak, 2.5, 3-moderate, 4-somewhat strong, 5strong, 6, 7-very strong, 8, 9, 10-extremely strong and 11-maximal exertion.

### 3. Results and integration with case study

There were no statistically significant associations between either of the questions about distribution of work, and pain, fatigue or physical exertion (Table 1 and 2).

*Table I – Distribution of work tasks and associations across pain groups.*

Distribution of work tasks within the work gang	To a low degree	To a medium degree	To a high degree	Chi-square test
	n	n	n	p-value
<i>Equal contribution of members for solving the work tasks (n=497)</i>	44 (8.9%)	109 (21.9%)	344 (69.2%)	
<i>Pain</i>				
High (Every day/Several times a week)	24 (55.8%)	67 (62.6%)	177(52.8%)	0.394
Medium (beskrivning)	12(27.9)	29(27.1%)	101(30.1%)	
Low (beskrivning)	7(16.3%)	11(10.3%)	57(17.0%)	
<i>Even distribution of physically exerting work tasks (n=496)</i>	44 (8.9%)	127 (25.6%)	325 (65.5%)	
<i>Pain</i>				
High (Every day/Several times a week)	23 (53.5%)	82 (65.1%)	161 (51.3%)	0.110
Medium (a few times a month)	14(32.6%)	30(23.8%)	97(30.9%)	
Low (a few times a year/never)	6(14.0%)	14(11.1%)	56(17.8)	
<i>Fixed work tasks within the work gang (n=498)</i>	106 (21.3%)	129 (25.9%)	263 (52.8%)	
<i>Pain</i>				
High (Every day/Several times a week)	55 (53.9%)	74 (58.7%)	138 (53.7%)	0.364
Medium (a few times a month)	27(26.5%)	39(31%)	76(29.6%)	
Low (a few times a year/never)	20(19.6%)	13(10.3%)	43(16.7%)	

Supplementary, age-adjusted analyses showed a small but statistically significant association between “*medium degree of even distribution of physically exerting work tasks*” (i.e. question 2) and level of fatigue ( $F [2, 477] = 3.11, p = 0.045, PES = 0.013$ ). Workers reporting a medium degree of even distribution of work reported a 0.187 point higher mean score on fatigue than workers reporting a high degree of even distribution of physically exerting work tasks.

**Table II – Fatigue and physical exertion scores across distribution of work task groups**

Distribution of work tasks within the work gang	To a low degree		To a medium degree		To a high degree		Univariate ANOVA F-test p-value
	Mean	SD	Mean	SD	Mean	SD	
<i>Equal contribution of members for solving the work tasks</i>							
<i>Fatigue</i>	3.07	0.95	3.06	0.74	2.99	0,76	0.668
<i>Physical exertion</i>	6,12	2,79	5.9	1.97	5.85	2,22	0.764
<i>Even distribution of physically exerting work tasks</i>							
<i>Fatigue</i>	3.09	0.94	3.13	0,72	3.05	0,77	0.054
<i>Physical exertion</i>	6,52	2,45	5.95	2.02	5,73	2,25	0.078
<i>Fixed work tasks within the work gang</i>							
<i>Fatigue</i>	3,0	0,80	3,01	0,78	3,02	0,77	0.985
<i>Physical exertion</i>	5.95	2,1	5,65	2,2	5,93	2,28	0.472

#### 4. Discussion and Conclusions

The results from the questionnaire study seem to indicate that there is no systematic variation in the data that can be ascribed to variations in the distribution of work within the work gangs as here assessed with three questions.

As reflected in Q3, some 50 % of the workers reported a high degree of fixed tasks. Generally there was also a consensus that there was an equal distribution of work when solving ordinary work tasks (Q1) as well as physically exerting work tasks (Q2). Less than 10 % of the workers perceived a low degree of even distribution of work tasks. Interestingly, the workers that perceived and reported the highest degree of even distribution of work, reported similar degrees of pain, fatigue and physical exertion.

The qualitative case study indicated that the distribution of work tasks was determined mainly by considerations for the productivity and by the character of work. Following these logics, it was of importance that work was put into system so that the gang members could perform the same tasks as much as possible: *"It's about putting everything into system, so that one can do the same task all day, otherwise it isn't feasible[...] you know, we swap once in a while, but not all the time, it just doesn't work"* (Hugger, carpenter foreman). The general tendency in the qualitative study is that workers see a meaning in this way of organizing work, and also the low degree of uneven task distribution is reflected from the interview material.

What is however interesting, is that workers describe that a particular distribution of physically exerting tasks can take place in relation to younger workers and apprentices who tend to get the harder tasks more often than others. At the same time some workers describe that a distribution of physically exerting work tasks, can take place when workers take upon themselves tasks that other – often elder – workers cannot handle because of physical impairments. This knowledge from the qualitative study is hard to read from the quantitative empirical material, but is very important to be aware of. As both a tendency towards handing the younger members of the gangs the harder tasks, and taking over harder tasks for elder colleagues could be a risk for increasing pain in the longer run.

There were no significant associations between distribution of work tasks on the three variables measured in this investigation, and the perceived physical exertion, fatigue or reported frequency of pain among the construction workers. When adjusted for age, there

seem to be a small association between a medium degree of evenly distributed physically exerting work tasks, and a higher level of fatigue. Also a higher percentage of workers in the same group report experiencing pain every day or several times a week. This association is not significant however. It is worth putting some effort into investigating this relation between pain frequency and distribution of physically exerting tasks, and also putting some attention to the mechanisms of giving younger workers harder tasks, and taking over for elder colleagues. But action on these grounds cannot be seen as conclusive.

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