The evaluation of team lifting on physical work demands and workload in ironworkers

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Abstract. Lifting and carrying heavy loads occur frequently among ironworkers and result in high prevalence and incidence rates of low back complaints, injuries and work-disability. From a health perspective, little information is available on the effect of team lifting on work demands and workload. Therefore, the objective of this study was to compare the effects of team lifting of maximally 50 kg by two ironworkers (T50) with team lifting of maximally 100 kg by four ironworkers (T100). This study combined a field and laboratory study with the following outcome measures: duration and frequency of tasks and activities, energetic workload, perceived discomfort and maximal compression forces (Fc peak) on the low back. The physical work demands and workload of an individual iron worker during manual handling of rebar materials of 100 kg with four workers did not differ from the manual handling of rebar materials of 50 kg with two workers, with the exception of low back discomfort and Fc peak. The biomechanical workload of the low back exceeded for both T50 and T100 the NIOSH threshold limit of 3400N. Therefore, mechanical transport or other effective design solutions should be considered to reduce the biomechanical workload of the low back and the accompanying health risks among iron workers.

Keywords: Team lifting, Physical work demands, Workload, Prevention, Construction work.

1. Introduction

Lifting and carrying heavy loads occur frequently among ironworkers [1] and is associated with high prevalence and incidence rates of low back complaints, injuries and work-disability [2]. The Dutch labour inspectorate allows manual handling of rebar materials up to maximally 50 kg with two ironworkers (T50) with team lifting of maximally 100 kg by four ironworkers (T100). This study combined a field and laboratory study with the following outcome measures: duration and frequency of tasks and activities, energetic workload, perceived discomfort and maximal compression forces (Fc peak) on the low back. The physical work demands and workload of an individual iron worker during manual handling of rebar materials of 100 kg with four workers did not differ from the manual handling of rebar materials of 50 kg with two workers, with the exception of low back discomfort and Fc peak. The biomechanical workload of the low back exceeded for both T50 and T100 the NIOSH threshold limit of 3400N. Therefore, mechanical transport or other effective design solutions should be considered to reduce the biomechanical workload of the low back and the accompanying health risks among iron workers.

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2. Method

A within-subjects (n=10) controlled field study during full working days and an experimental laboratory study (n=12) were performed to compare the effects of team lifting of maximally 50 kg by two persons (T50) with team lifting of maximally 100 kg by four persons (T100).

2.1. Field study

In the field study, the following outcomes were determined: duration and frequency of tasks and activities, energetic workload and perceived body region discomfort. The task demands were measured by means of systematic observations using the PalmTRAC system [3]. The energetic workload was determined through the percentage heart rate reserve (%HRR). Perceived body region discomfort was measured using visual analogue scales.

In total, ten experienced ironworkers participated in the study: mean (SD) age, height, weight and years of work experience were 38 (7) years, 180 (9) cm, 81 (13) kg and 17 (9) years, respectively.

2.2. Laboratory study

Maximum peak lumbar compression force (Fc peak) was calculated [4, 5] using a 3D dynamic biomechanical model and anthropometric, kinematic and ground-reaction force data of fourteen lifting and carrying conditions in a laboratory setting divided over two methods of team lifting [6, this proceedings]:

1. lifting and carrying a 50-kg load, two iron bars, in a team with one other ironworker (two-worker manual handling),
2. lifting and carrying a 100-kg load, an iron lattice, in a team with three other ironworkers (four-worker manual handling, e.g. see Fig. 1).

In total, twelve experienced ironworkers participated in the laboratory study: mean (SD) age, height, weight and years of work experience were 31 (8) years, 180 (8) cm, 80 (13) kg and 11 (9) years, respectively. Five of them also participated in the field study.

2.3. Statistics

Differences in mean duration and frequency of tasks and activities, energetic workload, local discomfort and Fc peak between T50 and T100 were tested with ANOVA for repeated measures. All tests were carried out using SPSS (Statistical Product and Service Solutions 16.0). A significant difference was defined as p < 0.05.

3. Results

Total work time, duration of tasks, duration of lifting and carrying, and energetic workload did not significantly differ between T50 and T100.

Low back discomfort at the end of the workday was significantly higher for the condition of T100 (VAS score 24 (SD 23)) compared to T50 (VAS score 8 (SD 12)) on a scale from 0-100 (p=0.016).

In the laboratory, compared to the T50 lifting conditions, the T100 lifting conditions resulted in a lower Fc peak during the lifting tasks but in a higher Fc peak during carrying tasks.

For T50 and T100, the average maximal lumbar compression forces during lifting from floor level were 5286N (SD 831) and 4768N (SD 941), respectively. The average maximal lumbar compression forces during carrying while stepping over a 46 cm obstacle were 7471N (SD 993) and 7860N (SD 833), respectively.
4. Discussion

The physical work demands and workload of an individual iron worker during manual handling of rebar materials of 100 kg with a total of four workers did not differ from the manual handling of rebar materials of 50 kg with a total of two workers, with the exception of perceived low back discomfort and Fe peak.

The biomechanical workload of the low back exceeded for both T50 and T100 the NIOSH threshold limit of 3400N [7] during lifting as well as during carrying loads over obstacles.

Implementation of preventive measures like mechanical transport or other effective design solutions should be considered to reduce the biomechanical workload of the low back and the accompanying health risks among iron workers.

References