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Pain perception of overweight forestry workers: A retrospective study on effects of an occupational training program

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Abstract. Objective: Forestry work is associated with intensive musculoskeletal stress. Physical exercise reduces musculoskeletal pain, especially for people with overweight. The aim of this study is to investigate the effects of a training intervention on the pain perception of overweight forestry workers. Methods: The intervention group (IG), split in an overweight (BMI (body mass index) ≥ 26 kg/m^2) and a normal weight (BMI < 26 kg/m^2) sample, did an occupational training intervention. The control group (CG) did no specific training program. The Nordic Questionnaire was used for ascertaining the perception of musculoskeletal pain. Results: The IG with overweight referenced a lower pain perception compared to the CG in all seven body regions. The differences in shoulder (p = 0.01, τ = 0.22) and lower back (p = 0.04, τ = 0.18) were significant. No differences could be found in the two groups with a BMI < 26 kg/m^2. Conclusion: The results indicate that a specific training intervention has positive effects on the perception of pain for the workers with overweight.

Key words: musculoskeletal pain, shoulder, lower back, exercise, repetitive physical workload, body mass index.

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Introduction

The occupation of forestry work is characterized by great physical stress, especially on the musculoskeletal system. In Germany, forestry work is one of three occupations showing the highest illness rate due to musculoskeletal diseases (Meyer *et al.*, 2013). The specific risk factors for pain perception were identified in a study with a sample of 3,000 workers of a Finnish forest company (Miranda *et al.*, 2001). These employees worked with the trunk flexed forward, twisting movements of the trunk, their hands above the shoulders, and a repetitive working manner (Miranda *et al.*, 2001). Especially the position of a permanently flexed core for harvesting timber produces muscular imbalances after years of work. These imbalances often cause functional limitations in the spine (Beyer *et al.*, 2009). Additionally, hand-arm vibrations can be considered another risk factor. Repetitive movements in a high frequency produce shoulder pain as well as movement limitations in the upper limbs (Bovenzi *et al.*, 1991; van der Windt *et al.*, 2000; Miranda *et al.*, 2001).

The body mass index (BMI) seems to be another risk factor for musculoskeletal pain. There are different studies which show the positive association between overweight or obesity and musculoskeletal disorders in different populations and occupations re-

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spectively (Marcus, 2002; Webb *et al.*, 2003; Heuch *et al.*, 2010; Wright *et al.*, 2010; Caberlon *et al.*, 2013). Haukka *et al.* (2012) e.g. investigated in a study with kitchen workers that obesity increases the prevalence of musculoskeletal pain compared to non-obese workers. Nilsen *et al.* (2011) examined that obese people run a 20% increased risk of chronic pain in the shoulders as well as in the lower back. One study identified a higher body weight as a risk factor for musculoskeletal pain in employees of a forest company (Viikari-Juntura *et al.*, 2001). The risk of getting neck pain was 1.4–1.5 times greater in overweight subjects compared to employees with a BMI < 26 kg/m^2. However, the sample was recruited from within the company and no information given about the percentage of forest workers.

Physical activity plays an important role in the prevention of musculoskeletal pain. It is proven that strength and stabilization exercises reduce back pain (Hauggaard & Persson, 2007; Mayer *et al.*, 2008; Caberlon *et al.*, 2013) especially low back pain (Hayden *et al.*, 2005). We were able to prove that a specific training program has a positive effect on pain perception in forestry workers independent from the BMI (Rudolph *et al.*, 2016). Also the inverse connection between physical activity and overweight, obesity respectively is well documented (Lee *et al.*, 1999; Howe *et al.*, 2011; Abate, 2014). Only one study was to be found that describes the role of physical activity in connection to the BMI and low back pain (LBP). Here, in a sample of 6.796 adults it was shown that physical activity with the target of reducing back pain had a greater effect in overweight and obese subjects compared to the normal weight group (Smuck *et al.*, 2014). The effect of a specific work-related training intervention for an overweight occupational group is not yet investigated. The aim of this study is to examine if overweight forestry workers have a higher benefit from an occupational training program than forestry workers with normal weight due to reduced musculoskeletal pain perception.

Material and Methods

The study was realized in a retrospective cross-sectional design. At first the personal data were collected (age, number of work years, sex, height, and weight). In addition, there were three questions about the volume, the intensity, and the duration of physical activities (in addition to the occupational activity). The pain perception was determined through the Nordic Questionnaire (Kuorinka *et al.*, 1987).

The intervention group (IG) was recruited from 500 forestry workers in Lower Saxony, Germany who pursued a training intervention specifically designed to compensate physical stress patterns of hard forestry work. The IG composed a stratified cluster sampling. A compulsory requirement was an 80% training participation, i.e. the subjects had to fulfill 91 out of 114 training sessions in the intervention-period of three years. The control group (CG) was a random sample of forestry workers from a forestry company in another federal state.

The sample included 221 subjects that were separated in one IG (n = 126) and one CG (n = 95). IG and CG were furthermore split in two groups in correlation with their BMI. The BMI was calculated by means of dividing the body weight (kg) by the body size (m^2) (World Health Organization, 2000). We created two groups in order to the BMI. According to Viikari-Juntura *et al.* (2001) subjects with a BMI < 26 kg/m^2 were put into the normal weight group. The overweight group had a BMI ≥ 26 kg/m^2.

With regard to the personal data, no statistically relevant differences could be identified between IG and CG. There was also no significant difference to be found when additional physical activities were pursued (see Table 1). No additional activity means being active not more than once a week during the intervention period.

Table 1. Personal data of the IG (intervention group) and CG (control group) in correlation to the BMI (body mass index) (Mean ± SD). No significant differences in the intergroup comparison were found.

	BMI < 26				BMI ≥ 26			
	IG		CG		IG		CG	
N	46		22		66		59	
Male	100%		100%		97%		98%	
No activity	41%		40%		61%		46%	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age	37.6	15.5	40.3	15.6	46.5	8.9	46.0	12.2
Work years	19.6	14.7	22.2	16.0	28.4	9.0	28.9	11.7

Fit im Forst – work-related training intervention for forestry workers

The IG consisted of forestry workers from a forest company in Lower Saxony. The company has 24 forest offices spread out in the state. The IG participated in a training intervention specifically created as a compensation strategy for the physical requirements in forest work. At the beginning, the work-related factors were analyzed through a qualitative video recording. It also included testing the motor skills and other psychosocial parameters. The results were taken in order to define a work-specific profile. Considering this work profile a specific training intervention was designed and implemented. The program provided one 90-minute training session once a week in a sports center in the proximity of each of the 24 forest offices over a period of three years. Approximately 20 forestry workers per group participated in the program. Each group was equipped with two professional coaches (a physical therapist and a trainer). The training sessions focused on exercises for core stability in order to prevent and/or restore lower back pain and exercises for stabilizing the shoulders (Rudolph, 2013).

Questionnaire and Statistical Methods

A modified version of the Nordic Questionnaire was used to determine the pain perception in the anatomical areas of the neck, shoulders, upper back, lower back, hips, knees, ankles/feet (Kuorinka *et al.*, 1987). The questionnaire regards the musculoskeletal pain in the last 12 month (e.g. "Did you have pain or ache at some time during the last 12 months?"). The original version had five categories for each question (0 days; 1–7 days; 8–30 days; > 30 days, but not daily; daily). The questionnaire was modified to the version used by Miranda *et al.* (2001) and Viikari-Juntura *et al.* (2001). The categories 0 and 1 as well as 4 and 5 were combined so that we had a three-category variable (0–7 days = healthy; 8–30 days = mild pain; > 30 days = severe pain).

The questionnaire was evaluated statistically and the significance level was set at 5%. Dependence among variables was measured with the Kendall's rank correlation coefficient (τ). In the statistical analysis, the four groups out of the whole (overweight IG, overweight CG, normal weight IG and normal weight CG) sample were compared to each other.

Results

Comparing the overweight subjects from the IG and the CG, there is a lower pain perception in each body region. In the regions shoulder ($p = 0.01$, $\tau = 0.22$) and lower back ($p = 0.04$, $\tau = 0.18$) the differences of pain perception are significant (Table 2).

Table 2. Pain perception in the different anatomical regions. Represented are the differences between the overweight intervention group (IG) compared to the overweight control group (CG) as well as the IG and CG with normal weight. The table shows the p-value plus the Kendall's tau coefficient (τ) ($*p < 0.05$ = significant; $**p < 0.01$ = highly significant).

Pain Perception	IG *vs.* CG			
	BMI ≥ 26 (overweight)		BMI < 26 (normal weight)	
	p	τ	*p*	τ
Neck	0.15	0.12	0.85	0.02
Shoulder	0.01**	0.22	0.39	0.10
Upper back	0.10	0.14	0.74	0.04
Lower back	0.04*	0.18	0.99	0.00
Hips	0.14	0.13	0.52	0.08
Knees	0.05	0.17	0.30	0.11
Feet/Ankles	0.92	0.01	0.46	0.08

With respect to the two normal weight groups, no significant differences in pain perception in any anatomical body region between IG and CG can be found. There are also no statistically significant differences comparing the normal weight IG and the overweight IG. Considering the normal weight and the overweight CG, there is a significantly higher pain perception in the shoulder region ($p = 0.04$, $\tau = 0.21$) and feet/ankles ($p = 0.03$, $\tau = 0.19$) in the overweight group with a moderate effect.

Figures 1 and 2 show the period of pain perception in the shoulders and lower back in the four groups. With regard to the shoulders, the normal weight IG indicated less pain perception. While 18 % out of the overweight IG perceived shoulder pain on more than 30 days in the last 12 months, the percentage of the overweight CG is 40% and the normal weight CG 23% (Figure 1).

Considering the lower back, more than 50% out of the overweight IG as well as the normal weight IG and CG indicated a pain perception less than eight days. 24% out of the overweight IG and almost twice as much out of the overweight CG (45%) had pain on more than 30 days during the previous year.

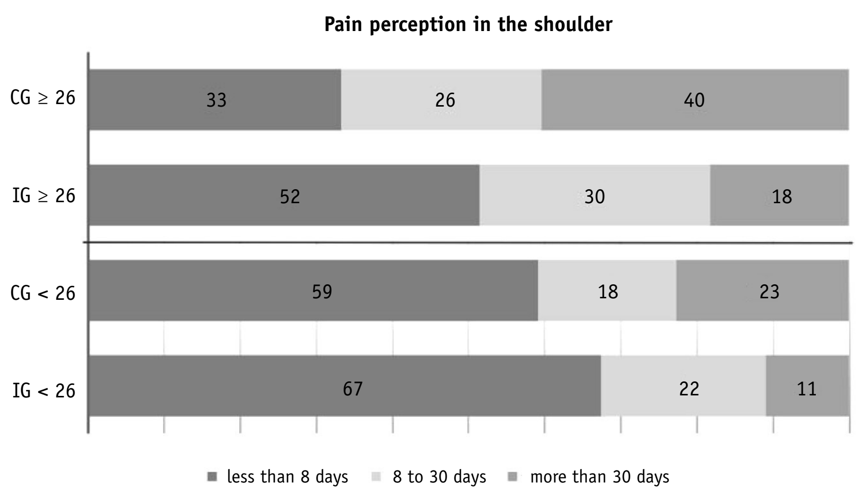

Figure 1. Days of perceived pain in three categories from less than 8 days to more than 30 days in the anatomical region of the shoulders. (CG ≥ 26 = overweight control group; IG ≥ 26 = overweight intervention group; CG < 26 = normal weight control group; IG < 26 = normal weight intervention group.)

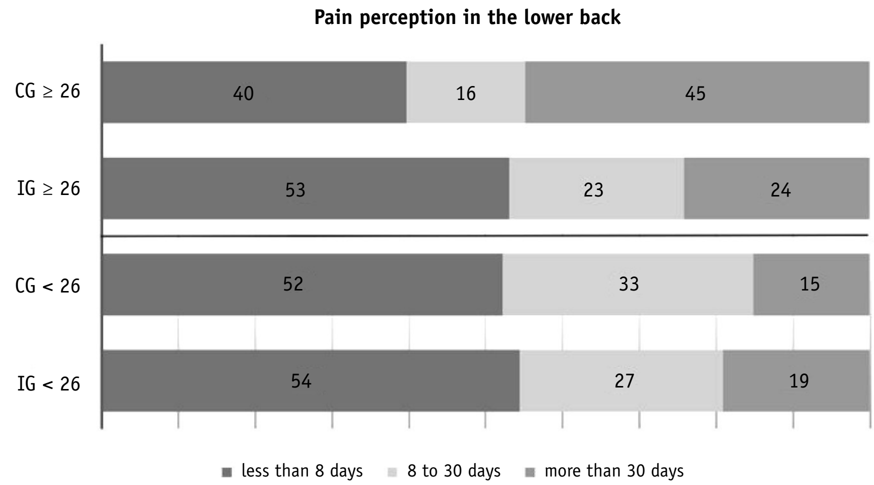

Figure 2. The days of perceived pain in three categories from less than 8 days to more than 30 days in the anatomical region of the lower back. (CG ≥ 26 = overweight control group; IG ≥ 26 = overweight intervention group; CG < 26 = normal weight control group; IG < 26 = normal weight (intervention group.)

Discussion

The physical stress patterns in forestry work as described above as well as overweight can be risk factors for musculoskeletal pain. Especially the shoulders and the lower back play an important role in forestry work. These regions are heavily stressed by carrying the motor saw and/or working with the trunk flexed forward while harvesting timber. As the training intervention focused on exercises for the shoulders and core stability (Rudolph, 2013), the decrease in pain perception can be considered a direct result of the training program, even though the effect size is small. Other existing studies also show positive training effects on musculoskeletal pain especially in overweight subjects (Abate, 2014). That means the results from the overweight sample confirm the existing positive effects of training interventions based on work-specific requirements (Curwin *et al*., 2013; Habibi & Soury, 2015).

No differences can be found comparing the normal weight IG to the normal weight CG. This means that, here, only the overweight group was able to get a benefit from the program. These results accord with Smuck *et al*. (2014) who showed that sedentary and moderate activities have a more robust influence on LBP in overweight and obese subjects compared to normal weight subjects. However, they were measuring physical activity by using an accelerometer and the sample was not recruited on the basis of a specific occupation.

There is also a difference with regard to the period of pain perception comparing the overweight IG and CG. In the anatomical regions shoulders and lower back the perceived pain values on more than 30 days were almost doubled in the CG. Regarding pain perception on less than eight days, there was also a difference in the shoulder and lower back region in favor of the CG. The results indicate that the training program has had a positive effect on the pain perception in general as well as on the days of perceived pain.

The use of the Nordic Questionnaire was positive in our study. Its reliability and validity have been verified before (Kuorinka *et al*., 1987) and it is, therefore, regularly used in health scientific research.

We used in our sample the body mass index to categorize the weight groups. Other studies show an increasing evidence that the cut-off values of the BMI are not valid for some populations (Luke et al., 1997; Deurenberg & Deurenberg-Yap, 2001). It is also shown that the amount of body fat, rather than the amount of excess weight determines the health risks (Deurenberg *et al*., 1998), i.e. musculoskeletal complaints. Although we did not measure the percentage of body fat, it would be interesting to investigate the correlation between physical activities, pain perception, and the percentage of body fat in forestry workers.

Conclusions

Forestry work as well as the BMI can be considered as risk factors for musculoskeletal pain (Miranda *et al*., 2001; Viikari-Juntura *et al*., 2001; Nilsen *et al*., 2011). We have been proven that a specific training program can reduce the pain perception in overweight forestry worker, especially in the shoulders and the lower back. These results are supported by findings in other studies that indicate the positive effects of training interventions by focusing on work-specific requirements as well as of sedentary and moderate activities on LBP in overweight subjects (Curwin *et al*., 2013; Abate, 2014; Smuck *et al*., 2014; Habibi & Soury, 2015). Further research should investigate the effects of a training intervention regarding the amount of body fat instead of bodyweight. Other studies show that this is a better predictor for health risks like musculoskeletal pain (Deurenberg *et al*., 1998). Nevertheless, these findings should guide the public health sector and timber industry in establishing training interventions for overweight forestry worker with a focus on strength and stabilization exercise.

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