

Workload assessment and its influence on a male tile layers working ability

K. Jansen¹, L. Esko² M. Luik², V. Viljasoo², J. Ereline¹, H. Gapeyeva¹, H. Aibast¹ and M. Pääsuke¹

¹Institute of Exercise Biology and Physiotherapy, University of Tartu, 5 Jakobi Street 51014 Tartu, Estonia, e-mail: jansen@ut.ee

²Institute of Technology, Estonian University of Life Sciences, 56 Kreutswaldi Street 51014 Tartu, Estonia, e-mail: pteh@emu.ee

Abstract. The aim of this study was to evaluate tile layers workload at a construction site and its influence to their working ability. The subjects ($n = 8$) were male tile layers (mean \pm SE) age of 36 ± 3.6 years. First the subjects completed a questionnaire and thereafter they performed before and after the working day a test of tile setting on a special wall, where was 3 stages and every stage they must set correctly 14 tiles. In the course of test the electromyographical (EMG) power spectral median frequency (MF) of biceps brachii, trapezius, deltoideus and erector spinae muscles was measured (both sides). The results of questionnaire indicate that the tile layer's most burdened parts of the body were knees, lower back and upper back. Workers complained most about tiredness, skin irritations, discomfort in eyes, knee, leg, lower back and neck/shoulder pain. It is important emphasis that all tile layers were taking tiles from a left side. Objectively estimated muscle fatigue emerged before and after the working day when comparing EMG power spectral MF measured at the beginning and end of the tile setting test. The results indicated that the most burdened muscle was right erector spinae for all 3 stages. In case of physical work, it is advisable to make short breaks every hour, so as to avoid the problems caused by overload. The results of this study can be used by specialists of ergonomics and production managers.

Key words: Electromyography, muscle fatigue, tile layer

INTRODUCTION

The constant use of machinery and power tools, working on elevated work surfaces, manual handling of heavy construction materials, etc. are important contributing factors to make this construction industry as one of the most hazardous industries (Hsiao & Stanevich, 1996). Construction workers have a increased risk for a overload because of their nature of work, also painters (Jansen, 2010) and tile layers (Jensen, 2008; Jensen et al., 2009).

Epidemiological studies indicated that in shoulder joint, various disorders and injuries occur in the first place in case of working with arms elevated above the level of shoulders, as in such a position, the burden on the joint structure increases abruptly (Bjelle et al., 1973; Dan et al., 2001; van Rijn RM et al., 2010).

Tile layers applies tiles on walls, floors, ceilings, and promenade roof decks, measures and marks surfaces to be covered, cuts and shapes tile with tile cutters and biters, spreads plaster base over lath with trowel and levels plaster to specified thickness, using screed. As tile layers have a lot of kneeling work on the knees then they have also increased risk knee disorders (Kivimäeki et al., 1992).

It has been suggested that fatigue affects proprioception and consequently movement accuracy, the effects of which may be counteracted by increased muscle activity (Huysmans et al., 2008).

The aim of this study was to evaluate tile layers changes in neuromuscular fatigue characteristics at a construction site and its influence to their working ability following the working day.

MATERIAL AND METHODS

Subjects

Eight males working as tile layers (mean \pm SE) age of 36 ± 3.6 years participated in this study. The height, body mass and body mass index of the subjects were 178.4 ± 1.5 cm, 79.8 ± 4 kg and 25.02 ± 1.3 kg m⁻², respectively, and their length of employment as tile layer was 6.6 ± 2.3 years. The subjects were participated in this study voluntarily. The questionnaires and the measurements were completed in 2010. Larger facilities were chosen as the site of the measurements. The subjects were familiarized with the essence and the aims of the survey.

Data collection

The measurements were conducted at the beginning and at the end of the working day at the site where the workers were employed. So the subjects did not have to leave the site and the working rhythm was disturbed as little as possible, thus yielding more reliable results. Therefore, a field study was conducted on these building construction workers to indicate the work complexity and workloads in actual field working conditions.

The height and body mass of the subjects were measured at the site with metal anthropometer and electronic scales, respectively. The body mass index (kg m⁻²) of the subjects was also calculated. In the course of the research, subjects completed the questionnaire first. Subjective muscle fatigue sensation in hands, trunk, back and lower limbs was estimated with a psychophysical rating scale (Borg's CR-10 Scale). The scale included numbers from 0 to 10. Perceived exertion was estimated in the following way: 0–2 weak, 3–4 moderate, 5–7 strong, 8–10 extremely strong fatigue. During the tile layer test, the EMG power spectrum MF (Hz) was recorded from deltoideus, trapezius, erector spinae and biceps brachii using 8 channel electromyograph ME 6000 (Mega Electronics, Finland). The data gained were processed with the computer application MegaWin (2007). When processing the data, the following intervals were taken out of the measured segment: from the beginning of the test a 10–20 s interval and from the end of test the last 10 s interval in every 3 stages. The same intervals were taken before and after of the working day. The selection of the muscles depended on the nature of the tile layers exercise. The single-

used surface EMG electrodes (Leonhard Long GmbH) were attached on the subjects by a female assistant who had been instructed correspondingly.

Statistical analysis

Data are expressed as means and standard errors (\pm SE). One-way analysis of variance (ANOVA) was used to test the differences in measured parameters before and after the working day and at the beginning and at the end of the tile setting test. When the significant main effect was found with ANOVA, the Bonferroni post hoc procedure tested for establishing differences among mean values. A level of $P < 0.05$ was selected to indicate statistical significance.

RESULTS AND DISCUSSION

During the tile setting test (Fig. 1), EMG power spectrum median frequency (MF) did not change significantly but there was objectively estimated muscle fatigue when comparing the beginning of the working day and the end of the working day (Fig. 2). The results indicated that the most burdened muscle was right erector spinae for all 3 stages.

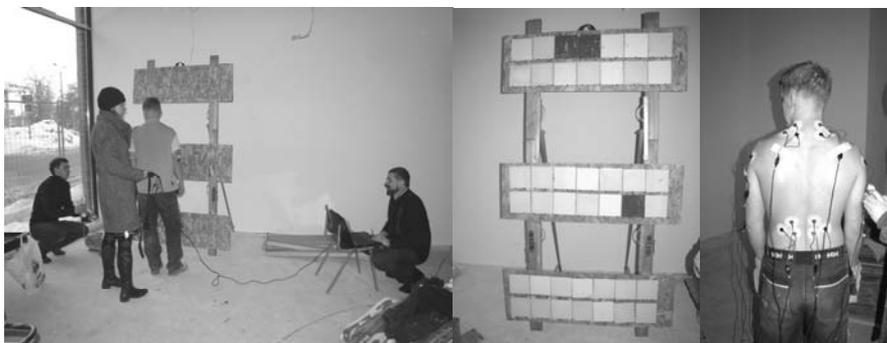


Figure 1. Performing the tile setting test.

As the tilers have paid for how many square meters tiles they set per day, then the daily working hours are quite different. Questionnaire results revealed that there was no difference between length of service and how well they did the study tests.

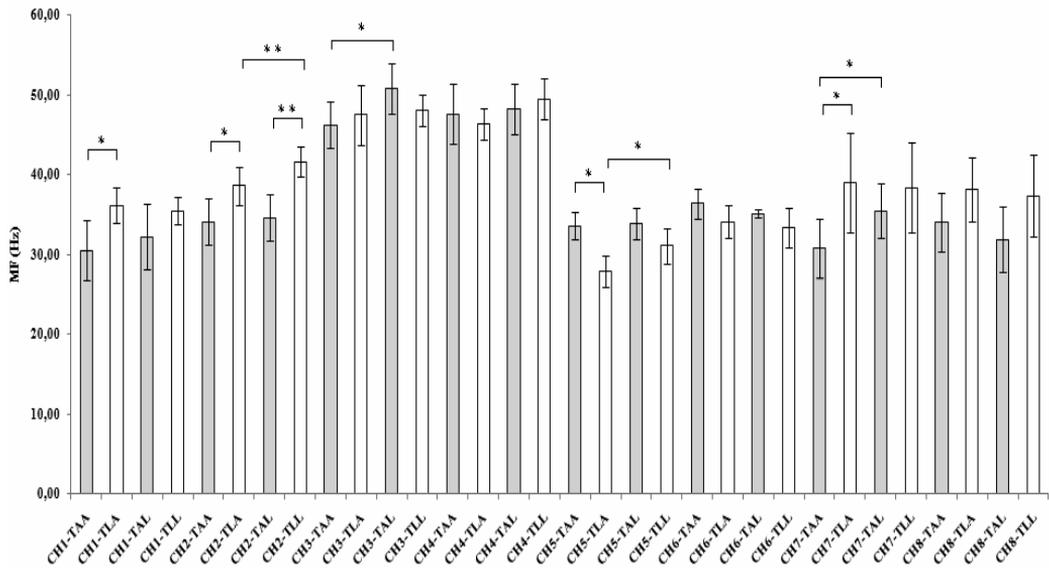
None of the participants were working in shifts, 75% were working regularly in holidays, 62.5% sometimes working overtime, 50% of participants worked also at night. As tilers are one of the last workers on the construction site, then this might be the reason why they should work also in holidays, to do the overtime and night work.

Questionnaire results revealed also that the job needs often continuous concentration, accuracy and good skills. Workers who had a work stress, they complain more often health problems – that's why it is necessary to do the better working plan, so tile layers will have more time to do their work. Also the questionnaire results revealed that none of the participants were instructed about ergonomics. The results revealed that tilers most burdened parts are knees, lower back, upper back and wrist/hand,

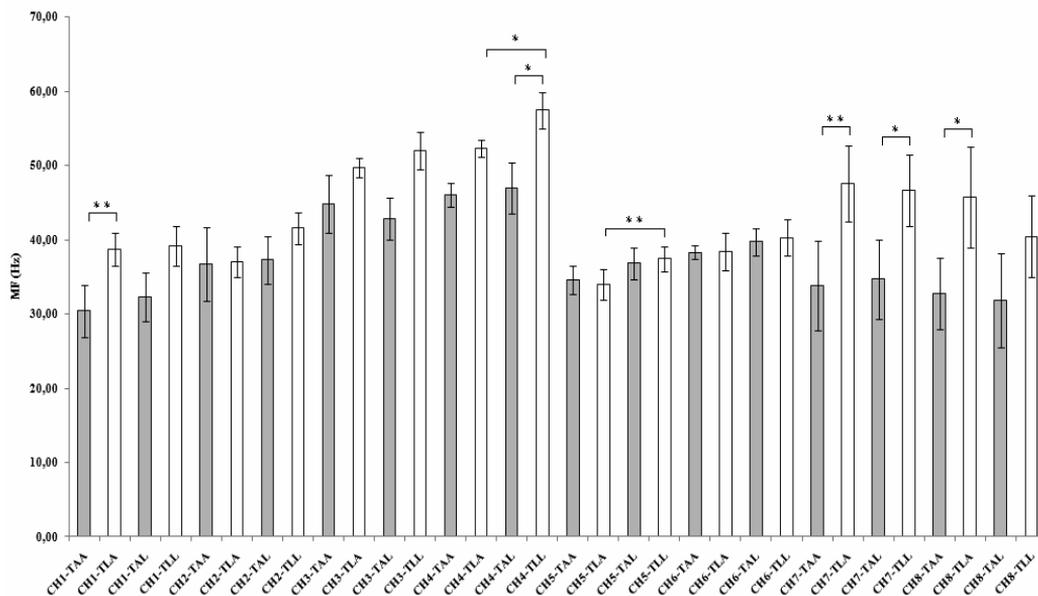
however, there were no significant changes comparing before and after the working day. Knees, lower and upper back greater load is because of that the tile layers should often squat and kneely. William L. Porter (2010) study examines stress transmitted to anatomic landmarks of the knee (patella, combined patella tendon and tibial tubercle) while in static kneeling postures without kneepads and while wearing two kneepads commonly worn in the mining industry. The majority of the pressure was found to be transmitted to the knee via the combined patellar tendon and tibial tubercle rather than through the patella. While the kneepads tested decreased the maximum pressure experienced at the combined patellar tendon and tibial tubercle, peak pressures of greater than 25 psi were still experienced over structures commonly injured in mining (e.g. bursa sac ebursitis/Miner’s Knee). The major conclusion of this study was that novel kneepad designs that redistribute the stresses at the knee across a greater surface area and to other regions of the leg away from key structures of the knee are needed. That’s why it’s necessary that workers use kneepads.

Wrist/hand greater load may because of the nature of tile setting work. Workers oftenly tiling the tiles and because of their work, the wrist has a large move amplitude. In this case it might be useful wearing wrist supports.

A



B



C

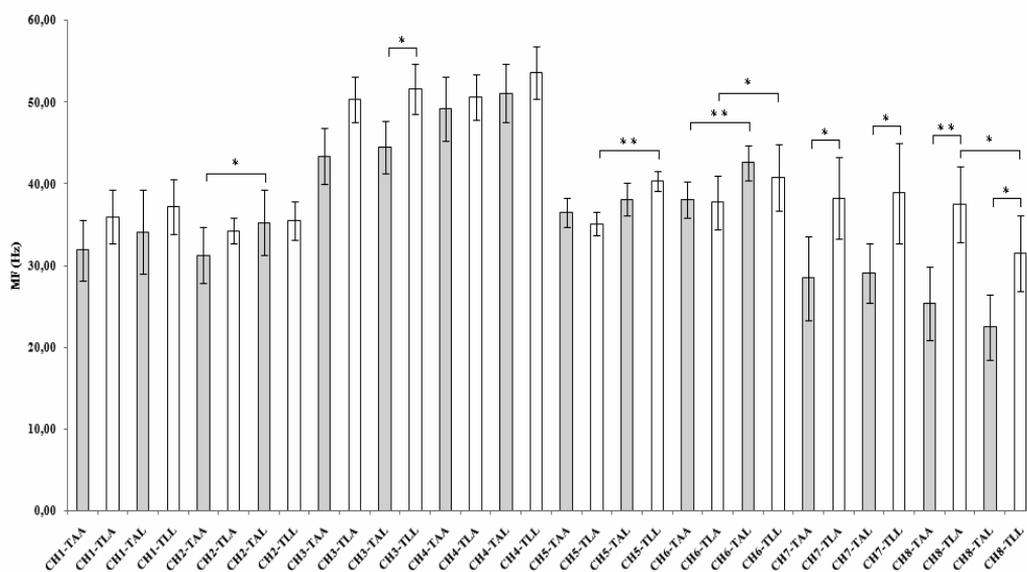


Figure 2. The electromyogram power spectrum median frequency (MF) at stage one (A), two (B) and three (C) (mean \pm SE). * $P < 0.05$; ** $P < 0.01$; CH1 – Biceps (left); CH2 – Biceps (right); CH3 – Deltoidus (left); CH4 – Deltoidus (right); CH5 – Trapezium (left); CH6 – Trapezium (right); CH7 – Erecto spina (left); CH8 – Erecto spina (right); TAA – Before working day at the beginning of the stage; TAL – Before working day at the end of the stage; TLA – After working day at the beginning of the stage; TLL – After working day at the end of the stage.

CONCLUSIONS

Due to the objectively and subjectively estimated muscle fatigue can be related to the fact that at the beginning of the working day, the muscles have not yet reached their working capacity. Proceeding from the data gained with the research, that the tile layers had mostly the shoulder girdle, low back and arms overload, it is recommended that they do stretching exercises before and during the working day. Assumptions of this are the presence of the instructive materials and instructing the worker by a specialist with the necessary training. In case of physical work, it is advisable to make short breaks (5 to 10 minutes) every hour, so as to avoid the problems caused by overload.

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