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Effect of elevation change on work fatigue and physiological symptoms for high-rise building construction workers

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Abstract

This study investigates the environmental variables encountered by high-rise building construction workers as well as self-reported work fatigue and physiological responses among workers at a construction site. The objective of this study is to investigate the effect of elevation change on the prevalence rates of subjective fatigue symptoms and physiological responses, such as calf circumference, blood pressure, heart rate, critical flicker fusion (CFF) and strength, among workers. The measurement of environmental variables showed that wind velocity, temperature and level of ultraviolet light increase at successively increasing elevations. Based on the prevalence rates of post-shift subjective fatigue symptoms, all high-rise building construction workers are categorized as physically-demanding type. The post-shift prevalence rates of subjective fatigue symptoms and heart rate among high-rise building construction workers were found to increase at successively increasing elevations. The results of strength tests showed strength after work was greater than that before work. This indicated work load or elevation change cannot well explain this unexpected change and psychological factors may be involved. Thus, strength test is not a reliable indicator of work fatigue. Significant difference was found in the measurements of CFF value (ascending test) and calf circumference of both legs at various floor heights. This suggested that elevation change will affect workers' visual sensitivity when working at higher floors.

Keywords: Work fatigue; Physiological symptoms; High-rise building construction

1. Introduction

For decades, high-rise building construction workers have worked in one of the highest-risk workplaces in Taiwan. To protect these workers, the Taiwanese government has promulgated and revised numerous relevant guidelines to ensure adequate protections and rest for these workers (CLA, 1997a). However, more than 150

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high-rise building construction workers are killed in workplaces annually, representing one-fourth of the work-related death toll in Taiwan (CLA, 1997b).

A study has shown that physiological responses differed between high-elevation and ground-level workers. For example, when heart rates were compared among workers on bridge construction sites, the hearts of those working at higher elevations were found to beat 10–20 beats/min faster than for ground-level workers (Mao et al., 2000). Some easy ground-level tasks become more difficult when performing at high-elevation workplaces (Steven and Mohamed, 1979). Since concern with falling is the major source of stress for high-elevation workers, it is essential to investigate the causes of falling accidents at high-elevation operations.

Mao et al. (2000), in a report on the work fatigue and physiological responses among high-elevation workers, concluded that claims of subjective fatigue symptoms among high-elevation workers were significantly less than those among ground-level workers, such as workers in heat stress workplaces and VDT operators. However, self-reported rates of "unsteady footsteps", "waist pain" and "dyspnea" among high-elevation workers were found to be considerably higher than in ground-level workers. Differences were also found between the two groups in the measurements of balance function, calf circumference and response time. Additionally, high-elevation workers might encounter some difficulties in physiological adjustment when performing heavy duties or delicate tasks. The effects of extreme weather conditions, such as thermal or cold stress, strong winds, on the work performance and safety of high-rise building construction workers is greater than those of ground-level workers.

Eyes are an important organ in the human body. The potential scope that visual sense can reach exceeds that of any other sense, and this scope increases further when standing at high-elevation. Since our senses are one of the key mechanisms for signaling the advent of danger, instinctive responses, such as fear, panic and shivering, increase with the perceived danger. If these instinctive responses occur in high-elevation workers, their judgment capacity may be reduced, and their risk of falling increased if no adequate protective measures are provided. Some studies on physiological responses among high-elevation workers, such as workers at power tower, pillar and bridge construction sites are contained in the literature (Miura et al., 1993). However, limited information is available in this regard for Taiwanese workers, especially information on the effect of elevation change.

The construction industry, which employs high-rise building construction workers, contributes the bulk of the work-related deaths in Taiwan. A key difference between the construction industry and other industries is that it is common for several subcontractors to undertake a construction project, resulting in ineffective and inconsistent management. Furthermore, construction projects generally require many skilled workers with various specialties during different work periods. Therefore, it is very common for high-rise building construction workers to either work only on short contracts or only to work at a particular construction site for a limited period. Unfamiliarity with the workplace further enhances the risk of injury for high-rise building construction workers.

Currently, many unsolved questions remain regarding the effects of elevation change on high-rise building construction workers. This study was undertaken to investigate physiological and psychological fatigue among high-rise building construction workers working on different floor heights. Both questionnaires and physiological measurements were carried out in this study. Workplace environmental variables were also monitored to evaluate the effects of environmental disturbances. With the data obtained, the effect of elevation change on work fatigue and physiological symptoms of workers can be clarified.

2. Methods and equipments

2.1. Subjects

All subjects were high-rise building construction workers on a typical construction site at which approximately 80 workers were present. The subjects include riggers, steel fixers, form workers, electrician–plumbers, concreters and miscellaneous workers. Various measurements were conducted on the workers as the construction of the sixth floor began (24 m in height), and the measurements were continued until the completion of the entire 10-floor building. The duration for completing one floor is about 30 working days. Approximately 65