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Experimental study on physiological and psychological effects of heat acclimatization in extreme hot environments

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ABSTRACT

Extreme hot environments are prevalent in many industries. Exposed to extreme hot environments, people are at great risk of a variety of heat-related disorders and safety problems. In this paper, a climate chamber was built to simulate the extreme hot environment. The dry bulb temperature in the chamber was 37.0 ± 1.0 °C, the relative humidity was 20–40%, and the black bulb temperature was 41.0 ± 1.0 °C. Eleven healthy male university students were asked to do stair stepping in prescriptive speeds to simulate manual work. The physiological indexes (oral temperature, heart rate, blood pressure and sweating rate) and the psychological effects (comprehensive thermal sensation and fatigue feeling) were measured. The effects of heat acclimatization in extreme hot environments were determined by paired sample *t*-tests. The results demonstrate that the effects of heat acclimatization are significant and the heat acclimatization training can improve adaptability of human body to extreme hot environments.

1. Introduction

Improving worker productivity and maintaining occupational health are major concerns in industry in developing countries [1–3]. Extreme hot environments, in which temperature is above 35 °C for living and above 32 °C for working [4,5], are prevalent in coke oven, iron, steel and glass manufacturing, mining and some military and special facilities [6,7]. Exposed to extreme hot environments, people are at great risk of a variety of heat-related disorders, such as heat rash, heat cramps, heat syncope, heat exhaustion and heat stroke [8]. In addition, mental health, safety problems and decrease/reduction of productivity are also common in extreme hot environments [9,10].

In order to guarantee health and safety, many studies have been conducted on extreme hot environments. Michael and Maria [11], Robert et al. [12] and Pantavou et al. [13] focused on the health effects of exposure to high temperatures and heat waves in summer. Malchaire [14] developed a predicted heat strain model for occupational heat stress assessment. Astrand et al. [15] studied the human responses to heat stress and proposed to adopt the wet bulb-globe temperature (WBGT) to evaluate the hot environment. Hancock and Vasmatzidis [16] studied the physiological limit of workers with heat stress in a hot environment. Nag et al. [17] evaluated the human tolerance limits according to physiological and psychophysical reactions. Hoof [18] investigated the influence of the military field environment, and high temperatures in particular, on sleep, comfort and performance of personnel and equipment, and looked at the benefits of installing air-conditioning systems and future trends in deployable force infrastructure. Piekarski [19], Liu [20], Donoghue et al. [21] and Wyndham [22] surveyed the heat stress in the mine.

Except reducing the environmental heat load, engineering strategies to counter occupational heat stress usually involve heat acclimatization and heat stress management [23]. In most situations, acclimatization can be induced through gradual introduction of the worker to the extreme hot environment. Heat acclimatization is a temporary physiological adaptation that improves tolerance and dissipation of heat [24]. A lot of work has been done in terms of heat acclimatization. Douglas [25] introduced heat acclimatization guidelines for secondary school athletics. Yeargin et al. [26] studied the heat acclimatization for football players using physiological, psychological, fluid balance, anthropometric, and nutritional variables. Qiu et al. [27] compared the effects of heat acclimatization between two training groups. Luo et al. [28] evaluated the effects of exercising method to accelerate body heat acclimatization.

From above literatures, heat acclimatization was usually studied in sports and military affairs. And the study objects were usually

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