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Editorial

Heat-induced labor loss and growing global concerns in a warmer world

Outdoor laborers, especially those who engage in physically demanding work that exposes them to hot environments, are at an increased risk of heat-related illness associated with climate change. Exposure to heat for prolonged periods can cause an increase in heat strain and, in severe cases, death. Heat-related illnesses are usually preventable and exist along a continuum from less severe signs and symptoms, such as muscle cramps to heat exhaustion, and heat stroke. In addition to the health and safety risks associated with occupational heat exposure, new concerns have emerged in the past decade.

In 2013, it was reported that environmental heat stress had reduced labor capacity to 90% in peak months over the past few decades[1]. In addition, based on Representative Concentration Pathways (RCP) scenarios, if RCP 8.5 were applied (the worst-case scenario), labor capacity would be reduced by 80% in 2050, and by 40% in 2200. While the possibility of global warming affecting laborers' health and economic conditions has been a concern since the beginning of the 21st century[2], the estimates clearly indicate that the global increase in temperatures has induced labor loss and reduces labor productivity. Recent studies have also shown that newly predicted and ongoing climate warming may increase the risk of labor and productivity losses in several countries in Southwest Asia, South Asia, and Africa[3] as well as gross domestic product loss in China[4]. Labor capacity was estimated using the wet-bulb globe temperature (WBGT) and the threshold limit values (TLVs) of environmental heat stress for industrial laborers[5]. In the TLVs of occupational heat, the limit for body core temperature is set at 38ºC to prevent adverse health effects. When the WBGT increases in workplace, the TLVs declining in proportion with work intensity (metabolic demands). Accordingly, working time and intensity are limited by an increase in temperature.

Simultaneously, labor force demographics are rapidly changing and the unprecedented aging of populations and workforces in most developed and many developing countries has significant implications for employees, human resource management, organizations, and society[6]. Elderly individuals are more vulnerable to heat stress, which is associated with altered thermoregulatory function in hot environmental conditions[7]. Reduced sweating response and cutaneous vasodilation impair heat loss, which induces elevation of the body core temperature, leads to higher levels of cardiovascular strain, and increases the risk of heat-related illness during exposure to a hot environment. Guidelines for the TLVs have had to be revisited to protect the aging workforce[8]. Although the renewed TLVs have not yet been released, working time and operations in hot environmental conditions will most probably be restricted for older laborers. There have been several reported adaptation strategies in heat occupations[9], such as heat acclimation, cooling garments, and physical fitness. If these adaptations help to prevent the elevation of the body core temperature, the relationship between the WBGT and the TLVs could shift upward to prevent labor capacity from decreasing. However, since it would increase the burden on laborers to adopt heat acclimation strategies or to try to enhance the physical fitness, especially older laborers, the development of new effective cooling garments or techniques will be required in the near future. In addition, wearable physiological monitoring devices to assess heat strain during working hours may be applied to older laborers and heat-vulnerable subgroups (e.g., individuals with chronic diseases), since wearable devices that monitor body core temperature have become progressively more advanced[10, 11].

Another concern which has been raised over the past decade relates to heat-related kidney injury. Agricultural laborers in Central America[12] and equatorial regions[13] suffer from an epidemic of chronic kidney disease of non-traditional origin. Furthermore, a recent United States study reported that laborers in diverse industries, including those working in indoor facilities, were being hospitalized for heat-related acute kidney injuries[14]. These injuries are assessed utilizing kidney injury markers or via specific crite-

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ria for increased serum creatinine and/or decreased urine output[15]. Laboratory-controlled studies have shown that increases in markers of kidney injury following physical labor in a hot environment is exacerbated by longer working periods, the extent of body core temperature elevation, and dehydration[15]. Although the mechanisms underlying these injuries have not been fully investigated, it was recently reported that heat acclimation in mice improved kidney tubular damage and subsequent fibrosis caused by heat stress[16]. Further research is needed to evaluate the effectiveness of heat acclimation on preventing the progression of heat-related kidney injury.

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Ken TOKIZAWA
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