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Approach to the evaluation of the thermal work environment in the greenhouse-construction industry of SE Spain

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ABSTRACT

The aim of the present work was to evaluate the thermal environment of workers in the greenhouse-construction industry in SE Spain. For this, the heat stress of these workers was evaluated by the WBGT index, on developing quadratic equations of the maximum and minimum of this index according to the time of day. High correlation coefficients and good distributions of residuals were found. This evaluation revealed a high or very high risk of heat stress during the months of June to September over a large part of the work day, especially from 9:00 to 18:00 h (GTM). For this, work-rest regimes are proposed in order to control this risk. Finally, the application of the ESI index has been validated for determining the heat stress in greenhouse-construction workers in SE Spain.

1. Introduction

Spain has one of the highest accident rates in the European Union (EU), where the construction industry represents 27.3% of the labour accidents; of these 34.6% are serious, while 33.9% are mortal [1–3]. Some 74% of construction involves buildings, where 35.2% of the mortal accidents occur and 43% of all accidents [4].

In Spain, accidents from heat stress cause deaths in the construction sector due to the bad organization and prevention on the job. For the period 1990–2000, the greatest number of accidents in the construction industry were from overexertion (20.9%), followed by blows from materials and tools (20.5%), and falls from one level to another (10.7%), while exposure to high temperatures accounted for 0.1% [3]. However, if only the fatal accidents are analysed, falls from heights are the most significant (33.8%), followed by blows or being run over by a vehicle (15.9%), while exposure to high temperature reaches 0.2%. However, not only do such deaths occur in this sector, but also, as indicated by Armendáriz [5], heat stress occurs in jobs that require or generate a great quantity of heat, such as in the iron and steel industry, glass, and ovens in general, and in activities requiring strenuous physical exertion, as in agriculture and construction. Critical states of heat stress can provoke irritability, increased aggressiveness, distraction, errors, discomfort from sweating and trembling, accelerated or slowed pulse rate, etc., with negative repercussions on health and, in extreme situations, death [6–9].

In agreement with Chad and Brown [10], environmental heat considerably influences cardiovascular and thermoregulatory systems of workers undertaking heavy as well as light tasks. Therefore, Maiti [11], evaluating the work load in the construction industry of India, recorded values both of physical load as well as heat stress that exceeded the limit values recommended by health guidelines. In these circumstances, the construction workers felt that their effectiveness in their job was determined not only by the physical load of the work, but also by the impact of the physical environment, so that a greater environmental load diminished work efficiency while augmenting the potential for accidents. Kähkönen et al. [12] found similar results on determining the heat stress for several production sections, including construction in Tanzania. In this sense, Fundación MAPFRE [13] reported that in work environments with high temperatures, the attention and state of awareness of the workers diminished, altering job effectiveness and worker safety. Kroemer and Grandjean [14] found a correlation between work performance and higher environmental temperatures at work, while Miller and Bates [9] showed the deleterious effects of high air temperature on workers in the open air who did not receive adequate water. Thus, all workers active during the warm months should undergo a regime of work and rest in order for the body to maintain adequate temperature balance and hydration [9,15,16]. In addition, Zhao et al. [17] mentioned that workers in warm and humid environments tended to store heat in the body and to suffer an electrolyte imbalances, for which they could suffer a heat stroke

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