

Association between Heat Stress and Occupational Injury among Thai Workers: Findings of the Thai Cohort Study

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Abstract: Global warming will increase heat stress at home and at work. Few studies have addressed the health consequences in tropical low and middle income settings such as Thailand. We report on the association between heat stress and workplace injury among workers enrolled in the large national Thai Cohort Study in 2005 (N=58,495). We used logistic regression to relate heat stress and occupational injury separately for males and females, adjusting for covariate effects of age, income, education, alcohol, smoking, Body Mass Index, job location, job type, sleeping hours, existing illness, and having to work very fast. Nearly 20% of workers experienced occupational heat stress which strongly and significantly associated with occupational injury (adjusted OR 2.12, 95% CI 1.87–2.42 for males and 1.89, 95% CI 1.64–2.18 for females). This study provides evidence connecting heat stress and occupational injury in tropical Thailand and also identifies several factors that increase heat exposure. The findings will be useful for policy makers to consider work-related heat stress problems in tropical Thailand and to develop an occupational health and safety program which is urgently needed given the looming threat of global warming.

Key words: Heat stress, Climate change, Occupational injury, Workers, Thai Cohort Study

Introduction

As global warming proceeds, concern is growing regarding the direct effect of heat stress on human health in many countries¹. Recently, studies of heat stress have drawn attention to adverse health effects among workers. The international program “High Occupational Tempera-

ture: Health and Productivity Suppression” (HOTHAPS)² has focused on effects of heat exposure on working people and extended its research to many areas, especially tropical developing countries^{3–9}.

In low and middle income tropical countries where heat stress is a problem, rapid urbanization and the cash economy may cause workers to do heavy labour for long periods of time under hot and humid conditions, especially those who have low socioeconomic status¹⁰. As a result, these workers are exposed to excessive heat and are at risk of heat-related illness and increased occupational injury¹¹.

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Possible consequences of excessive heat stress include an increase in the likelihood of occupational injury due to fainting, confusion, poor concentration, and psychological distress, resulting in reduced protection and unsafe working conditions. A relationship between heat stress and injury occurrence has been reported several times over the last 35 yr¹¹⁻¹⁴). However these studies were conducted in developed non-tropical countries; this leaves unanswered questions about the effect of heat stress on occupational injury in tropical developing countries where temperatures and humidity are already high. In the future, occupational injury risk in all countries could increase as a result of global warming.

Recent reviews have highlighted global warming and health impacts in tropical areas^{2, 15}). In Thailand, hot and humid conditions, especially during the hot season (March to June), can be detrimental to population health. The average temperature in Thailand has already increased 0.74°C over the last century¹⁶). Increasing heat stress is anticipated as Thailand urbanizes, because of the urban heat island effect and progressive global warming¹⁷).

A recent study of workplace occupational heat stress in Thailand by Langkulsen *et al.*¹⁸) revealed a very serious problem that they classified as “extreme caution” or “danger” in a wide array of work settings. Other studies found that occupational heat stress in Thailand can lead to increased risks of kidney disease and psychological distress^{7, 9}). So heat stress is already a public health concern in Thailand and current warming trends are expected to exacerbate the problem due to further increases in air temperatures¹⁹). However, information on occupational injury related to heat stress in Thailand is still quite limited. As high humidity and hot weather is routine in Thailand, studies on occupational injury almost always overlook heat stress as a contributing factor.

Occupational injury is an important health issue for workers in Thailand²⁰). Occupational injury and disease data are recorded primarily through the Workmen’s Compensation Fund (WCF) in order to provide cash benefits and medical care to insured workers who suffer workplace injury²¹). In 2008, more than 176,000 cases of occupational injury were reported; 613 cases were fatal and over 45,700 cases reported more than three days absence from work. However, these injury records cover only formal employment which accounts for approximately a third of the Thai workforce²²). The reports do not capture events at informal work settings, including agricultural work in which heat-related injury is of particular concern due to physically demanding tasks in hot and humid weather²³).

To address the knowledge gap regarding work injury in Thailand, we used the baseline data of a large national adult cohort to examine the epidemiological association between heat stress and injury in the Thai workplace. We identify potential risk factors for heat stress at work. This study will be useful for policy makers considering occupational health and safety program. Such programs are needed to mitigate effects of heat stress at work and prepare for global warming.

Methods

Data and study population

The data derive from the baseline measurements of a large national Thai Cohort Study (TCS) that began in 2005 with distance-learning students enrolled at Sukhothai Thammathirat Open University (STOU). This study investigates the health-risk transition now underway among the Thai population and started with a 20-page mailout health questionnaire; details on overall methodology have been reported elsewhere²⁴). Overall, 87,134 students aged 15 to 87 yr responded from all areas of Thailand. They represented the adult Thai population well for geographic distribution, income, age and social status²⁴).

The baseline data included information on health status and on a wide array of socioeconomic characteristics and health behaviours. As well, heat stress at work and occupational injury were recorded. The heat stress and the occupational injury questions were in different sections of the questionnaire so answers on these issues were independent of each other. The distribution and frequency of risk factors associated with non-traffic injuries by locations have been reported in two recent studies using baseline TCS data^{25, 26}).

The analysis was restricted to cohort members who reported engaging in paid-work in 2005 (N=62,076). We then excluded 3,581 workers (6%) who did not respond to one or more questions relating to covariates that were potential confounders of heat stress-injury effects (see below). The final analysis group included 58,495 workers (Fig. 1).

Measures of heat stress

The information on individual experiences of heat stress in 2005 was derived from the question: “During the last 12 months, how often did you experience high temperatures which make you uncomfortable?”; respondents answered on a four point scale (“often”, “sometimes”, “rarely”, and “never”). For the main analysis of occupational injury, we

