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THE INTERACTION OF THE THERMAL ENVIRONMENT, CLOTHING AND AUXILIARY BODY COOLING IN THE WORKPLACE

A thesis submitted in partial fulfilment of the
requirements for the award of the degree

Masters of Science (Research)
from

University of Wollongong

by

Joanne Nellie Caldwell, BSc.

School of Health Sciences
2008

I, Joanne Nellie Caldwell, declare that this thesis, is submitted in partial fulfilment of the requirements for the award of Masters of Science (Research), in the School of Health Sciences, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

____________________________ Date:______________

Joanne Nellie Caldwell

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Abstract

Extensive research into the physiological impact of wearing thermal protective clothing has been conducted for many years. However, the current literature does not provide a consensus concerning the interaction of heat strain and cognitive function. This project sought to investigate the problems associated with personnel working in uncompensable environmental conditions while wearing Australian Defence Force (ADF) protective clothing. Four separate investigations were conducted. The first was a field based study evaluating the thermal influences of operating a helicopter simulator. The second was a laboratory study evaluating the impact of wearing body armour on physiological and cognitive function. Thirdly, a theoretical evaluation of, the problems associated with performing work in an uncompensable heat stress environment and, the physical characteristics of various coolants and cooling systems were investigated. Finally, a laboratory investigation on the physiological and cognitive consequences of wearing a personal protective ensemble while performing exercise with and without an activated liquid-cooling garment. A significant reduction in flying performance was evident when pilots were heated to a mean skin temperature ($\overline{T}_{sk}$) of $\sim 39°C$ compared to the other two conditions ($\sim 33°C$ and $37°C$, $P < 0.05$), using a water perfusion garment to achieve these target $\overline{T}_{sk}$. However no obvious detriments in cognitive performance were observed for the two laboratory based studies even though subjects were exposed to a significant thermal load, as determined by increases in T_C, $\overline{T}_{sk}$ and f_c ($P < 0.05$). For the final study, where thermal strain was significantly higher in the hot-dry trial without cooling ($P < 0.05$), resulting in a terminal rectal temperature that was $1.6°C$ higher than the thermoneutral condition, the liquid-cooling garment (water temperature $15°C$) successfully prevented all detriments in physiological function observed during the hot-dry trial without cooling. It can therefore be concluded from this investigation that, individuals exposed to extreme environmental conditions while wearing protective ensembles, are at risk of developing increased thermal strain that may lead to heat illness. In terms of cognitive function assessment, this project failed to determine specifically, which areas of cognitive function are in fact adversely affected. However, a reduction in thermal strain can be achieved with the use of an auxiliary cooling device.

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