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Heat-related injuries resulting in hospitalisation in Australian sport

Timothy Robert Driscoll^{a,*}, Raymond Cripps^b, John R. Brotherhood^c

^a School of Public Health, University of Sydney, NSW 2006, Australia

^b Research Centre for Injury Studies, Flinders University, Australia

^c School of Exercise and Sport Science, The University of Sydney, Australia

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Summary The aim of this study was to summarise the extent and characteristics of cases of illness due to environmental heat, significant enough to result in hospitalisation, and arising during sporting activity in Australia. Cases were identified from the hospital separations database compiled by the Australian Institute of Health and Welfare, using the allocated external cause and diagnosis codes and the activity code "While engaged in sports". Hospital separations for the 2 years 2002–2003 and 2003–2004 were used. One hundred and forty eight cases were identified (68% male). Cases were fairly evenly distributed across 10-year age groups starting from age 15 years, apart from fewer cases between 55 and 64 years. Nearly two thirds of the cases occurred in the summer months (December to February inclusive). The most commonly involved individual sports were lawn bowls, cricket, softball, golf, marathon running and walking, and the rate was highest for triathlons, lawn bowls, cricket, and running. Rates for persons aged 65 years or older were more than twice the rates at younger ages. Heat-related disorders are an uncommon cause of significant morbidity in Australians participating in sporting activity. However, particular sports have a relatively high rate of occurrence and these sports would provide an appropriate focus for prevention activity. The availability of a specific code in the International Classification of Diseases and Injuries to cover excessive endogenous production of heat would assist future analyses of the role of thermoregulatory disturbance in leading to morbidity in persons participating in sporting activity.
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Introduction

There are estimated to be nearly 13 million Australians aged 15 years or more involved in

"exercise, physical activity or sport".¹ This is about 80% of the population in this age group. It is not possible to accurately separate activities undertaken for sport from those undertaken for leisure, although for many individual "sports" the context of the activity should be reasonably clear, and the type of activity involved should not differ

* Corresponding author.

E-mail address: timd@health.usyd.edu.au (T.R. Driscoll).

importantly regardless of the primary motivation for the activity.

Heat-related illness associated with sport has been an area of concern for many years. This is particularly the case in hot countries such as Australia, where people can undertake very vigorous physical activity in conditions of high ambient temperature and high humidity. Several disorders considered to be associated with environmental heat stress and exertion have been described: heat stroke, heat exhaustion, heat syncope, heat cramps and heat rash.² Different authors have sometimes used slightly different terms for the conditions, and the patho-physiology underlying the conditions is still debated, especially for heat stroke.³ With regard to exercise and sport, the heat-associated conditions that are likely to be admitted to hospital are heat stroke, collapse with hyperthermia, and severe dehydration. Heat stroke results from gross thermoregulatory failure with deep body temperature $>41^{\circ}\text{C}$, accompanied by central nervous system disturbance. Heat stroke is potentially lethal and may lead to serious injuries in survivors.⁴ Exertion-induced heat exhaustion has been described as collapse during or after exertion with deep body temperature $>38^{\circ}\text{C}$.⁵ It usually involves circulatory instability and in cases with hyperthermia there may also be central nervous system disturbance.⁶ Some authors have suggested that there may be a continuum between exertion-induced heat exhaustion and heat stroke.⁵

Heat-related illness has classically been associated with dehydration related to extreme exercise in high-temperature environments. However, several authors have noted that most significant heat-related illness is primarily related to the rate of physical exertion relative to the fitness of the individual, rather than to the environmental conditions. This explains why heat-related conditions in sport are more common in events of shorter duration, often in athletes of limited experience, and can occur in temperate environments.^{6,7} In these cases, dehydration is not seen as the primary pathophysiological problem, and drinking too much may actually result in significant pathology.⁸ Hyponatraemia may well be due to over-consumption of hypotonic solutions rather than excessive loss of sodium as a result of sweating.⁹

This study was designed to focus on injurious effects of environmental heat on sports participants. Although occasional cases of sports-related heat stroke have been reported in Australia^{4,10,11} and cases of collapse with hyperthermia are a regular occurrence in community running events such as the Sydney City to Surf,⁷ there is not a lot of information available on the incidence of heat-

related disorders associated with sport. Research in this area is complicated by difficulties with definitions and the overlap between 'heat-related' illness to which the environment has made a significant contribution and heat-related illness that is primarily due to endogenous factors. Furthermore, some heat-related cases of collapse may recover spontaneously or with medical care at the sports ground or in the emergency department. Currently these cases are not formally recorded on a widespread basis and are thus lost to enumeration. Therefore, the aim of this study was to summarise the extent and characteristics of cases of illness due to environmental heat, significant enough to result in hospitalisation, and arising during sporting activity in Australia.

Methods

Cases were identified from the hospital separations database compiled by the Australian Institute of Health and Welfare (AIHW).¹² The database records all hospital separations. A separation is "the process by which an episode of care for an admitted patient ceases" and an admission is defined as "Admission is the process whereby the hospital accepts responsibility for the patient care and/or treatment".¹³ This means that a discharge from an emergency department after a prolonged stay may or may not be counted as a separation for the purposes of the database, depending on the administrative approach of the hospital.

Each visit can be categorised in four different ways: external cause, diagnosis, activity, and place. All cases in which an injury contributed to the admission or the stay in hospital are allocated at least one external cause code (E-code). Up to 31 such E-codes can be allocated. Similarly, every case is allocated one or more Diagnosis codes, with up to 31 such codes possible. External cause codes are coded using the Australian Modification of the 10th revision of the of the International Classification of Diseases and Injuries (ICD-10AM).¹⁴ Diagnosis codes also come from ICD-10AM. In addition, each case should be allocated an activity code, which identifies the activity at the time of injury for external cause cases. The activity coding frame includes a code for "While engaged in sports" and a separate code to cover leisure activity ("While engaged in leisure"). Since July 2002, cases with an activity code of "While engaged in sports" can also be allocated a separate code identifying the exact sport involved. These codes can be grouped to combine similar types of sports (e.g. "team ball sports"; "individual athletic activities"). There is

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