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Editorial

Australian community sport extreme heat policies: Limitations and opportunities for improvement

The importance of sport in Australian culture is evidenced by 79% of the population aged ≥15 years participating in sport or physical activity one or more times per week.[1] Another defining feature of Australia however is its hot climate. Notably, 2013 was the hottest year on record in Australia and the risk of experiencing extreme heatwaves in summer has increased two-fold in the past few decades.[2] While fatal heat-related injury during sport is mercifully rare, many cases of heat-related illness during sport and physical activity have been documented.[3] Recent examples include reports of heat exhaustion in nine children during the 2016 Triathlon Championships in Penrith (NSW).[4] Moreover, the incidence rate of heat-related health problems at sporting events is likely underreported due to confounding coding and diagnostic issues, especially in the hospital setting.[3] In view of these concerns, many Australian sporting organisations have developed extreme heat policies that stratify the risk of heat illness based on environmental conditions and recommend procedures for cooling participants. The aims of this *editorial* are to summarise the Sports Medicine Australia (SMA)[5] heat policy and a representative sample of existing heat policies issued at the community level by the six most popular club sports in Australia (according to the 2016 AusPlay survey);[1] and discuss the limitations of these existing policies while highlighting opportunities for improvement through future research.

1. Sports Medicine Australia heat policy

The current SMA extreme heat policy,[5] established in 2005 and outlined in Table 1, is arguably the most influential extreme heat policy in Australia. For example, four out of the six representative sport heat policies listed in Table 2 refer to the SMA policy to either set environmental thresholds for activity or provide recommendations surrounding the prevention of heat illness. The guidelines were one of the first forms of heat protection for exercising Australians and the strength of the policy is the ease of access and interpretation for the wider community, especially within the scope of technology at the time of conception.

A primary opportunity for improvement of the policy is the current disparity between a linear stepwise risk stratification approach and the physiological strain typically elicited by prevailing environmental conditions. For example, according to the International Organisation for Standardisation (ISO) heat stress standard for occupational environments,[6,7] conditions constituting the upper boundary of the 'moderate' risk category in the SMA guidelines (30 °C ambient temperature [T_a] and 60% relative humidity (RH)) are similarly stressful as those determined as 'extreme' (≥36 °C T_a and >30%RH). The environmental heat stress imposed by a given T_a and humidity can be simply expressed using a single value, e.g. a "heat index".[8] Fig. 1 illustrates the various combinations of T_a and relative humidity that the heat index equivalent of the 'extreme' SMA threshold (36 °C, 30%RH) represents, and a large portion of the 'high' zone and approximately one-third of the 'moderate' zone of the SMA policy exceeds the same level of environmental heat stress defined as 'extreme'.

Another limitation of the existing policy is that it does not seem to fully account for very hot (>40 °C T_a) but dry (<15%RH) conditions that often occur across a typical Australian summer. Evidence of the necessity to address this limitation include the 2017 heatwave across New South Wales, which reached conditions of 46 °C T_a in the shade with 14%RH at 4pm on the 11th of February in Penrith. Under such a scenario, the traditional SMA policy would have advised the continuation of play whereas a number of sporting organizations independently chose to cancel competition.[9] This decision was advisable as while sweat would evaporate freely with such low ambient humidity, skin surface heat loss would still be limited by the physiological capacity to secrete sweat.[10]

The evidence proposed by the SMA policy regarding acclimatisation may also need reviewing in light of recent research findings. A natural heat acclimatisation is suggested to develop across the course of an Australian summer, which subsequently reduces the risk of heat illness. However, Australian household air conditioning ownership has substantially increased during the preceding decades[11] and therefore a significant physiological adaptation to the heat may not occur over a summer season due to an inadequate level of exposure.[12]

2. Heat policies of the six most popular club sports in Australia

Association football (soccer), golf, Australian football, netball, tennis, and cricket are the six leading club sports in Australia by combined adult and children participation.[1] Ambient temperature and Wet Bulb Globe Temperature (WBGT) remain the two most common environmental measures for defining risk stratification among the extreme heat policies issued to community participants within these sports (Table 2). The argument for using T_a

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Table 1
The Sports Medicine Australia (SMA) extreme heat policy environmental threshold guidelines.

Guidelines based on ambient temperature and relative humidity			
Ambient temperature	Relative humidity	Risk of heat illness	Recommended management for sports activities
15–20 °C		Low	Heat illness can occur in running Caution over-motivation
21–25 °C	Exceeds 70%	Low-moderate	Increase vigilance Caution over-motivation
26–30 °C	Exceeds 60%	Moderate-high	Moderate early pre-season training Reduce intensity and duration of play/training Take more breaks
31–35 °C	Exceeds 50%	High-very high	Uncomfortable for most people Limit intensity, take more breaks Limit duration to less than 60 min
≥36 °C	Exceeds 30%	Extreme	Very stressful for most people Postpone to cooler conditions (or cooler part of the day) or cancel

Guidelines based on wet bulb globe temperature (WBGT)		
WBGT	Risk of heat illness	Recommended management for sports activities
<20 °C	Low	Heat illness can occur in distance running Caution over-motivation
21–25 °C	Moderate-high	Increase vigilance Caution over-motivation Moderate early pre-season training Take more breaks
26–29 °C	High-very high	Limit intensity, take more breaks Limit duration to less than 60 min per session
≥30 °C	Extreme	Consider postponement to a cooler part of the day or cancellation (allow swimming)

Table 2
Representative sample of extreme heat policies for community-based sporting competitions in the six most popular club sports in Australia.

Sport	Organisation	Adult threshold	Children threshold	Activity change	Activity modification notes
AFL	South Australian Amateur Football League	40 °C T_a 38 °C T_a	n/a n/a	Cancelled Game modifications	 -Rescheduling -Additional in-play cooling breaks
Association football (soccer)	Football New South Wales	37 °C T_a 32 °C T_a	32 °C T_a n/a	Cancelled or postponed Game modifications	 -Additional in-play cooling breaks
Cricket	South Australian Cricket Association	37 °C T_a	34 °C T_a	Game modifications or cancelled	-Additional in-play cooling breaks -Rescheduling
Golf	Golf Australia	36 °C T_a and 25%RH[A]	n/a	Cancelled or postponed	-As per SMA recommendations
Netball	Netball New South Wales	SMA guidelines using WBGT	SMA guidelines using T_a and RH	Game modifications, cancelled, or postponed	-Reduced playing time -Longer break intervals -Provision for extra water -Use of a fan -Rescheduling
Tennis	Tennis Australia	34 °C WBGT 30 °C WBGT 38 °C T_a	34 °C WBGT 30 °C WBGT 36 °C T_a	Cancelled Game modifications Cancelled	 -Reduced scoring format -Extra break between 2nd and 3rd sets

AFL: Australian Football League; *SMA*: Sports Medicine Australia; T_a: ambient temperature; *RH*: relative humidity; *n/a*: not available.
[A] Slightly modified version of SMA guidelines.

presumably relates to the ease at which it can be understood and accessed by the wider community. However, using only T_a in isolation neglects several critical environmental factors that contribute towards human heat stress; i.e. ambient humidity, solar radiation, and wind. Alternatively, WBGT, which when properly implemented also utilises direct measures of humidity and thermal radiation as well as indirect measures of wind speed, has been a popular indicator of environmental heat stress at the professional sports level and often in occupational environments. However, in order to perform at set of measures in situ to derive a valid WBGT assessment, a specific high quality device is required and can potentially cost >AUD$1,000, which likely deters many community-based clubs. Estimated WBGT is freely available based on air temperature (measured in the shade) and ambient humidity reports by the Australian Bureau of Meteorology.[13] However, it is important to recognise that this is not a true outdoor WBGT value and is calculated based on an assumed moderate sun exposure and light winds.[13] Limitations of the WBGT index, even when measured completely in the sun, include an underestimation of the true environmental strain during times of high humidity or low air movement.[14]

Cricket Australia presently recommends that extreme heat policies for clubs, schools, and associations be formulated through consultation with the respective state or territory chapter of SMA. For example, the *South Australian Cricket Association* considers 'excessively hot weather' to be 37 °C T_a for adults, at which point coordinators can approve additional drinks breaks or cancellation of matches. However, as of 2016 humidity levels were not included within the environmental threshold. Given that the thermal and cardiovascular strain of a given participant exercising at a fixed metabolic rate and wearing the same clothing would be markedly different between at 37 °C with 10% compared to 50% RH, the inclusion of humidity in future heat stress risk evaluations for cricket would be advisable. *Tennis Australia*'s nationwide community guidelines for adults (≥17 years) set cancellation thresholds using both WBGT (34 °C) or T_a (38 °C). Tennis organisations that do not have the potential to measure WBGT must rely on the guide-

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