

Competing in the heat: Summary of the physiological testing conducted at the Australian Open Wildcard Playoff 2003

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Introduction

When playing tennis in cool conditions, the heat produced as a by-product of exercise is dissipated from the body through various mechanisms, thereby keeping the body temperature at safe levels¹

However, when playing tennis in hot/humid conditions, the body is less effective at releasing heat, leading to a rise in core body temperature. Increases in core temperature has been suggested as the main underlying factor causing fatigue during play in the heat².

More seriously, it is well documented that prolonged exercise without satisfactory fluid intake increases the risk of heat illness³.

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Introduction

Professional tennis players are subject to a wide variety of environmental conditions including heat and humidity. However it is not known how the tennis players' body responds in hot and humid conditions, particularly under competitive conditions. Studies investigating this question (and more general physical responses to tennis) have used simulated conditions^{1,4} rather than true competition.

The Australian Open has a heat policy whereby the Referee (in conjunction with the Medical Officer) may suspend play when the temperature reaches 35 °C and WBGT index of 28⁵.

In this study we measured the core temperature and hydration status of professional tennis players during the Australian summer in tournament competition.

Methods

Players who attended the Australian Open Training Camp and entered in the Australian Open Wildcard Playoff Tournament were invited to participate in the study, approved by the Ethics Committee, Deakin University

Subjects who responded were asked to read and sign a plain language statement and written consent form and complete a pre-test medical questionnaire (approved by Deakin University). Subjects were told that they could leave the testing at any time with no consequence.

Variables measured included:

- Core body temperature;
- Hydration status;
- Body weight (pre and post match)
- On-court temperature and Wet Bulb Globe Temperature (WBGT) Index;

Core Temperature measurement

Players swallowed a temperature sensor (HiQ Inc, Fig. 1) to monitor internal body temperature during each match.

Internal temperature was measured during change of ends by wireless telemetry (Fig. 2).

A new tablet was taken each day by players progressing through the tournament.



Fig 1. Ingestible temperature sensor



Fig 2. Taking measurement of core body temperature

Hydration status measurement

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Hydration status was measured via urine analysis, and measurement of body weight.

Subjects were given a plastic sterile urine collection bottle and asked to provide a sample each morning when they awake. Subjects were also asked to provide a sample the following day of their last match.

Urine samples were measured at Alfred Hospital Pathology Services and on-site.

Subjects were also weighed pre and post match for changes in body weight associated with sweat loss.

Temperature and WBGT Index

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Measurement of on-court conditions was conducted using an environmental measurement instrument (Kestrel Instruments).

Conditions recorded include

- Ambient temperature
- Relative humidity
- Wind speed
- Wet Bulb Index



Fig 3. Environmental conditions measurement instrument

Results – Temperature and WBGT Index

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	Day 1	Day 2	Day 3	Day 4
Temp. (°C)	38.5	23.4	26.5	20.7
Range (°C)	34.2 – 43.1	22.2 – 26.1	23.3 – 28.1	19.0- 23.9
WBGT Index	23.0	19.4	19.1	17.4
Range	21.7 – 26.2	19.0 – 20.0	16.5 – 20.4	15.9 – 18.8

Table 1. Daily mean and range ambient temperature and WBGT

Table 1 illustrates the daily mean/range ambient temperature (red) and mean/range WBGT index.

Day 1 recorded a mean ambient temperature of 38.5 °C, otherwise play was conducted under recorded temperatures less than 35°C and WBGT Index of 28.

Results – Core Temperature

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Figures 4-7 (below and next page) illustrate the time course changes in core temperature in all subjects.

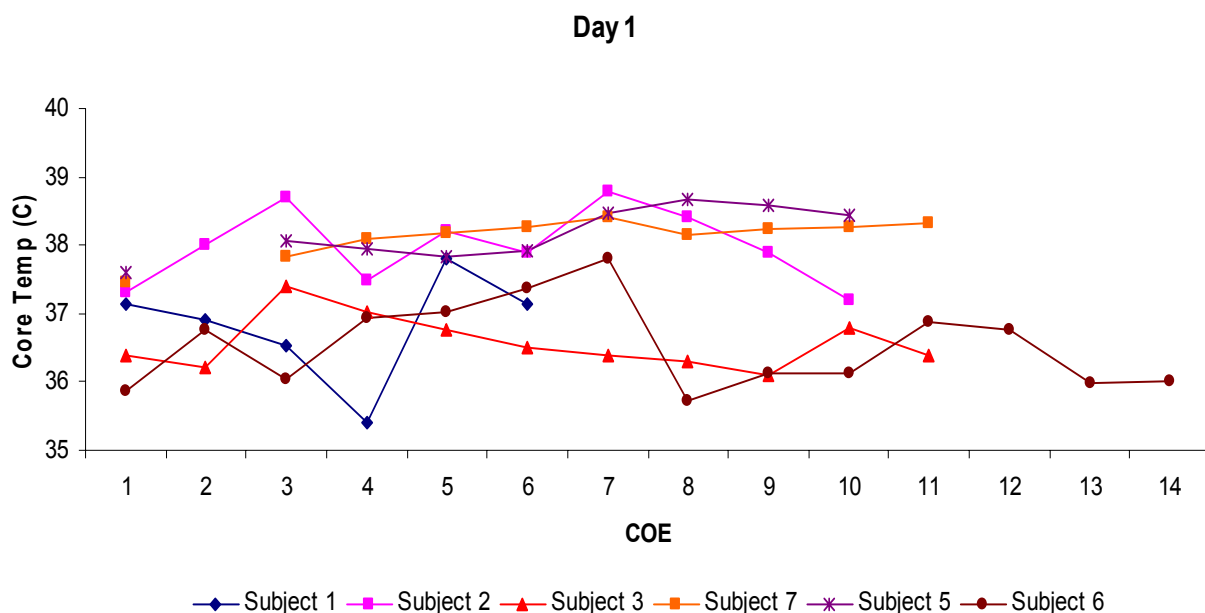


Fig 4. Day one results

Results – Core Temperature

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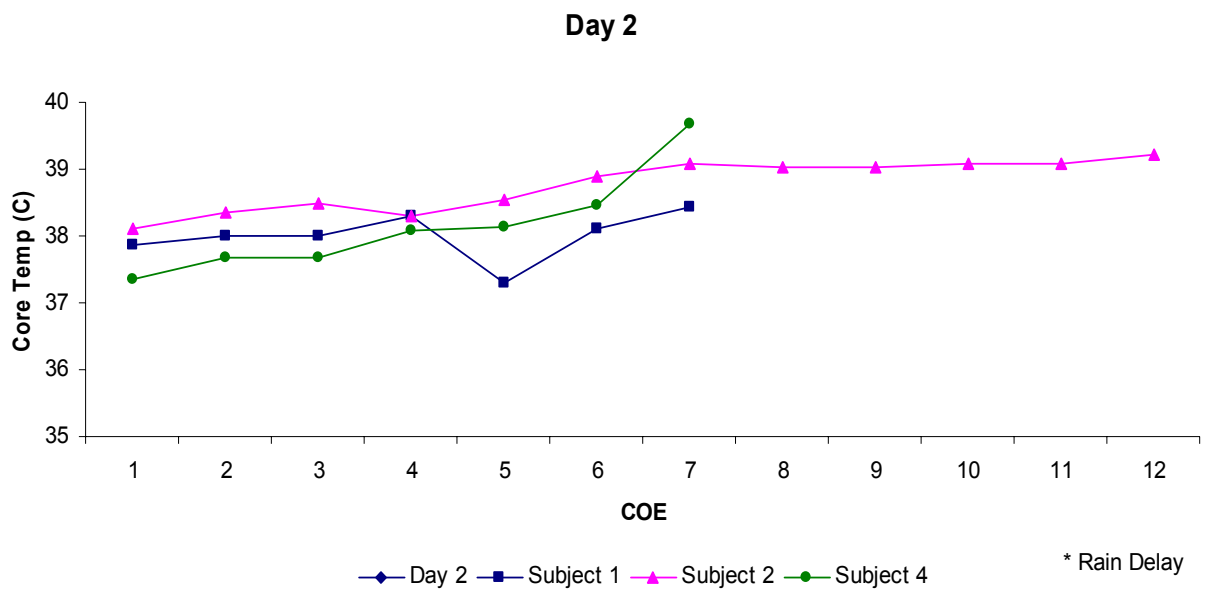


Fig 5. Day two results

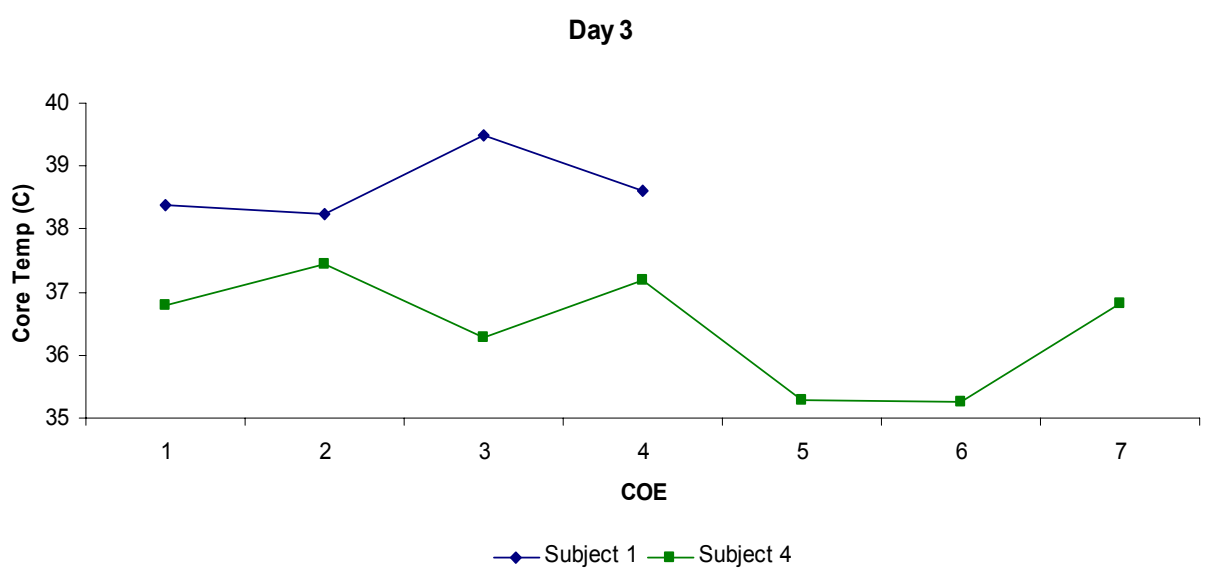


Fig 6. Day three results

Results – Core Temperature

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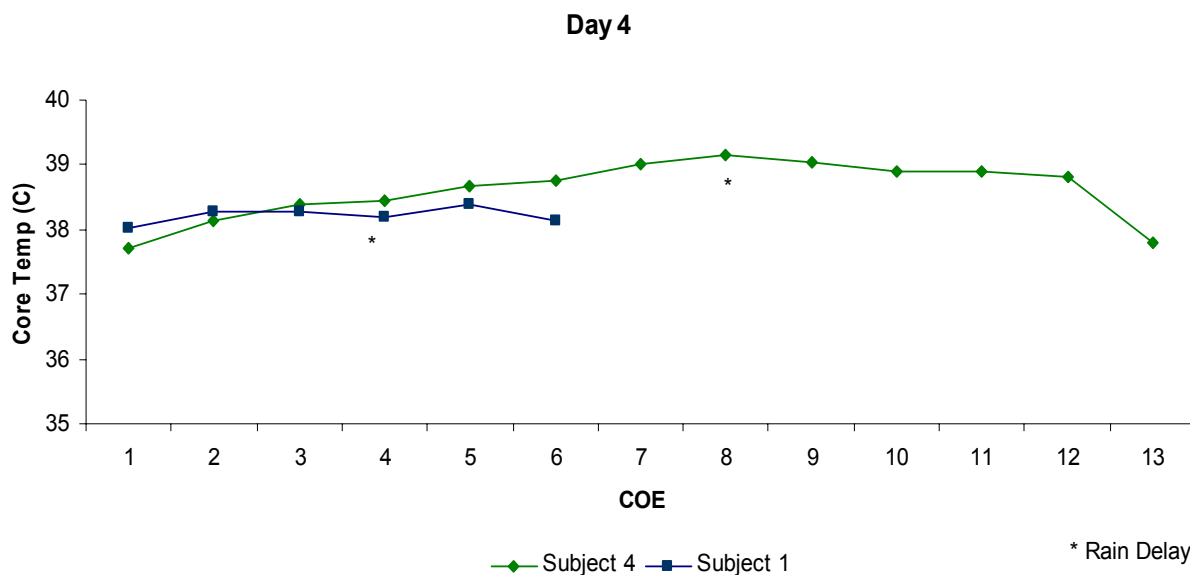


Fig 7. Day four results

Of the original eight subjects two completed the full four days of play, two played two days, with the rest losing in the first round. One subject's first round core temperature data could not be obtained.

Results – Core Temperature

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	Day 1	Day 2	Day 3	Day 4
Subject 1	36.8	37.9	38.7	38.0
Subject 2	37.9	38.7		
Subject 3	36.6	n/a		
Subject 4	n/a	38.1	36.4	38.6
Subject 5	n/a	38.2		
Subject 6	36.5			
Subject 7	38.0			

Table 2. Subjects' mean core temperature data for each day

Table 2 shows all subjects (n = 7) mean core temperature data (expressed in °C) for each day's play.

Regrettably some core temp data was not available (shown as 'n/a' in table) due to technical problems associated with the sensor pill.

Results – Core Temperature

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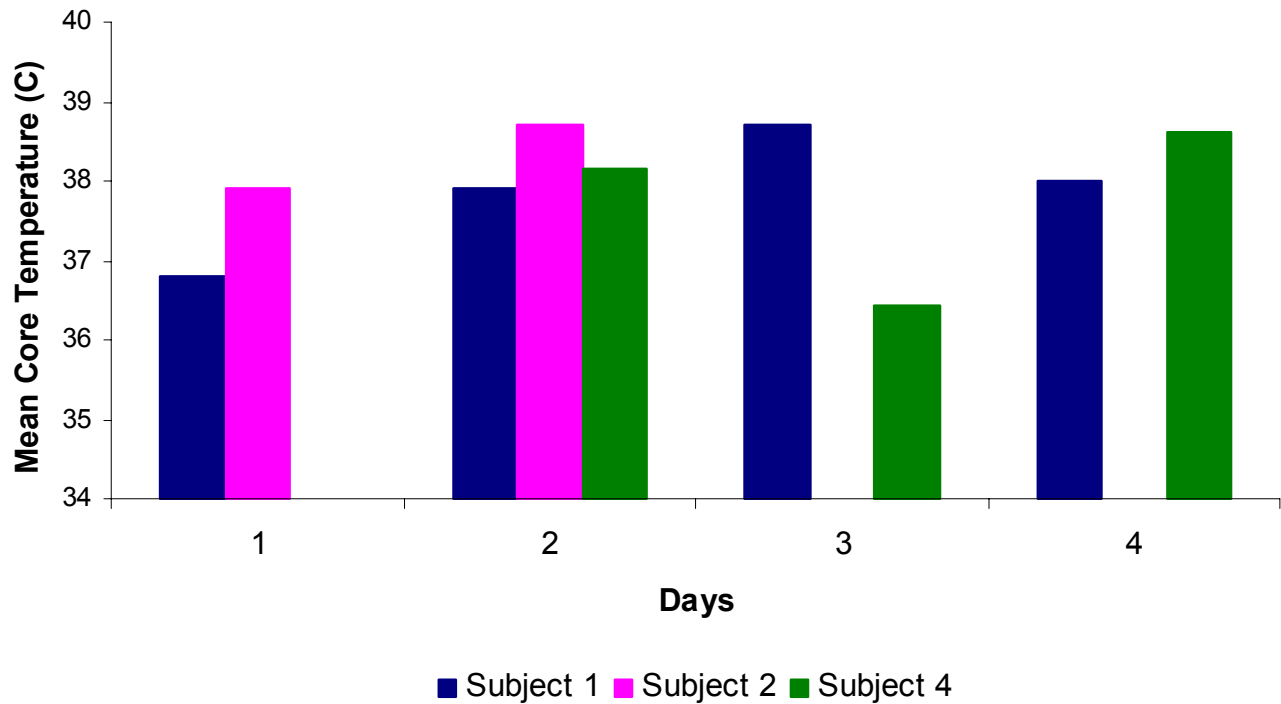


Figure 8. Multiple data recorded in three subjects

Figure 8 shows mean core temperature data recorded in three players (subjects 1, 2 and 4) who progressed part or whole way through the tournament.

Results – Hydration Status

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Urine Analysis found no irregularities in hydration status with all subjects' urine results falling within hydrated range.

Four subjects also gave urine the following day post-match. Results of these samples also fell within hydrated range.

Table 3 shows pre and post match body weight changes for each match.

Results – Hydration Status

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Subject	Round	Pre-match (kg)	Post-match (kg)	% change ↑ or ↓
1	1	68.0	67.4	↓ 0.8
	2	-	-	n/a
	3	67.6	68.95	↑ 2.0
	4	67.25	67.75	↑ 0.7
2	1	70.3	68.55	↓ 2.53
	2	71.05	69.8	↓ 1.76
3	1	89.2	86.6	↓ 2.91
	2	-	-	n/a
4	1	77.1	76.3	↓ 1.04
	2	-	-	n/a
	3	78.0	76.96	↓ 1.33
	4	77.8	75.9	↓ 2.44
5	1	-	-	n/a
	2	64.6	64.45	↓ 0.23
6	1	72.55	70.75	↓ 2.88
7	1	94.4	93.65	↓ 0.79
8	1	87.55	86.0	↓ 1.77

Table 3. Pre and post match bodyweight. Individual results.

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Summary

Only one of the four days of play provided a suitably hot environment over 35°C. On this day (round 1) core temperature results showed that players were able to maintain core temperature throughout play, with minor variations observed.

Hydration results support core temperature results with players remaining hydrated throughout matches and following up hydration post-match.

In players where repeated results were obtained, mean core temperature appeared to be higher on successive days. However further testing is required to validate this observation, particularly with a run of consecutive hot days.

Recommendations

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It appears that players are able to cope with hot temperatures in one off matches. However with players who win and progress through a tournament, the question remains whether a player's "on-court" core temperature remains similar to that first day and if current hydration strategies are suitable for repetitive match play.

Further testing continue under competitive conditions in order to properly understand physical responses in hot weather under consecutive competitive conditions.

Acknowledgements

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The players for volunteering

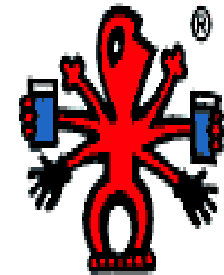
Australian Open Tennis

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Smartplay

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