

1-1-2019

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Gamage, P. J., Fortington, L. V., & Finch, C. F. (2019). Risk perceptions for exertional heat illnesses in junior cricket in Sri Lanka. *BMJ Open Sport and Exercise Medicine*, 5(1). Available [here](#).

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# Risk perceptions for exertional heat illnesses in junior cricket in Sri Lanka

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**To cite:** Gamage PJ, Fortington LV, Finch CF. Risk perceptions for exertional heat illnesses in junior cricket in Sri Lanka. *BMJ Open Sport & Exercise Medicine* 2019;**5**:e000508. doi:10.1136/bmjsem-2019-000508

Accepted 29 January 2019

## ABSTRACT

**Objectives** Exertional heat illnesses (EHI) can occur when sport is played in hot and humid environments, such as those common across Asia. Measures to reduce the risk of EHI are important; however, causal data on EHI occurrence are limited and challenging to capture. To gain an initial understanding of EHI risks, we aimed to assess the risk perceptions of EHI of youth cricketers.

**Methods** A descriptive cross-sectional survey, comprised of 14 questions on EHI risks, was conducted with 365 Sri Lankan junior male cricketers (age=12.9±0.9 years) who typically play in hot and humid conditions.

**Results** For climate related risks, relative humidity was perceived as having a low risk of EHI compared with ambient temperature. The EHI risk associated with wearing protective gear, as commonly used in cricket, was perceived as low. Most junior cricketers perceived a low level of risk associated with recommended preventive measures such as body cooling and heat-acclimatisation.

**Conclusion** This is the first study to explore EHI risk perceptions in any sporting context. Young players may not be mindful of all risks. Therefore, leadership and initiative from competition organisers and parents is required to promote countermeasures.

## INTRODUCTION

Exertional heat illnesses (EHI) are a concern for youth sports and exercise participation due to the morbidity and mortality associated with the condition.<sup>1,2</sup> Objective recognition of the early, milder forms of EHI (eg, heat syncope, cramps) is challenging due to the non-specific nature of the symptoms and signs.<sup>3</sup> On the other hand, the latter stages such as heat strokes can result in debilitating neurological sequelae and even death.<sup>4,5</sup> Therefore, risk recognition and mitigation through appropriate preventive measures is the main strategy recommended for minimising the incidence and severity of EHI.<sup>6,7</sup>

Understanding risk perceptions is useful to identify areas of potential injury prevention. Risk perception refers to an individual's personal judgement and evaluation of a risk that they might be exposed to.<sup>8</sup> Understanding risk perceptions can support populations through better identification of strategies to support the adoption of behaviours that

## What are the new findings?

- ▶ Most risk perceptions among junior cricketers can be considered as appropriate and reasonable for this population.
- ▶ It will be beneficial for junior cricketers to be educated on different types of risks for exertional heat illnesses (EHI). Particularly in relation to their relatively poor understanding of high humidity as a contributory factor for developing EHI, and EHI risk associated with helmets and other protective gear use during cricket play.
- ▶ The junior cricket support staff in schools (eg, coaches, teachers, parents) and those responsible for competition management (eg, umpires, match officials) should take the lead in monitoring players and initiating appropriate measures as juniors may not be mindful of some risks.

seek to prevent injuries.<sup>9</sup> Musculoskeletal injury risk perceptions in junior sports have received some attention over the last two decades in sports such as soccer, cricket and Australian Football League.<sup>10–13</sup> These studies have recognised some specific risk perceptions that assisted with understanding risk taking decisions and behaviours among junior athletes.<sup>14</sup> In the area of EHI, risk perceptions and adaptive behaviours have been studied among general adult populations from Australia, China and UK, mainly in consideration of population heat-wave risks.<sup>15–17</sup> These studies showed how improved understanding of heat illness risk perceptions assisted with identifying individuals who were vulnerable to heat strokes and their adaptive behaviours. To date, heat illness risk perceptions have not been investigated among athletic populations, including youth, and yet could be important information to underpin the development of measures to minimise the risks associated with developing EHI among the participants in sports and exercise.

EHI in cricket are anecdotally known to occur but are difficult to quantify. Analysis of sports-related EHI hospitalisation data in two studies from Australia showed that the proportion of EHI cases in cricket was similar to that in endurance sports such as marathon



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running, cycling and triathlon where the risk is more recognised.<sup>18 19</sup> In both these studies, cricket had the second highest EHI hospitalisation cases over a 2-year period, Australia wide<sup>19</sup> and a 4-year period in NSW.<sup>18</sup> There is no similar published data on EHI in cricket from the Indian subcontinent region; however, the heat stress experienced by cricketers playing cricket in this region is acknowledged.<sup>20</sup> An alternative approach to traditional epidemiological studies directly documenting the incidence rate of EHI, is to identify risk perceptions to gauge understanding of risk levels.

In cricket, injury risk perceptions have previously been reported among junior cricketers from Australia<sup>10</sup> and Sri Lanka,<sup>13</sup> but these studies have focused only on musculoskeletal injuries. Therefore, for the purpose of this study, we selected a group of junior cricketers to assess their understanding of EHI risk. The primary objective was to evaluate the EHI risk perceptions of junior cricketers in Sri Lanka focusing on specific characteristics known to be directly associated with developing EHI. These factors include risks associated with climate (eg, ambient temperature, relative humidity), clothing and protective gear, personal factors (eg, being overweight, physical fitness) and mitigation strategies (eg, cooling, acclimatisation, hydration).<sup>21</sup>

## METHODS

This study was conducted as part of a larger project called Juniors Enjoying Cricket Safely in Sri Lanka (JECs-Sri Lanka). There were three distinct aims in the JECs-Sri Lanka study. The first aim focused on understanding risk perceptions of musculoskeletal injuries and this has been reported elsewhere.<sup>13</sup> The second aim was quantification of injury occurrence. This paper reports findings for the third aim focused on EHI.

### Development of the survey questionnaire

The items of the questionnaire comprise 14 questions related to EHI risks that were derived from the information presented in two recently published consensus and position statements on EHI.<sup>7 21</sup> The first of these position statements was published in 2015 by the American National Athletic Trainers Association, the peak body for athletic trainers.<sup>21</sup> The second document was also published in 2015, by a roundtable panel of international experts, following a 'Training and Competing in the Heat' research meeting held in Qatar.<sup>7</sup> Drawing on these two consensus recommendations on EHI, the most recent and up to date information representing different countries and institutions globally, were listed. From this, a list of risk factors related to EHI that were considered to be of most relevance for junior cricketers was selected by the lead author in consultation with the co-authors. **Table 1** describes the 14 identified risk factors.<sup>7 21</sup>

Part-A of the EHI risk perception survey focused on demographics (eg, age, gender) and participation in cricket (eg, playing experience). Part-B consisted of the questions that looked at how junior cricketers perceive

their risk of developing EHI when playing cricket under 14 different scenarios. Risk perceptions were measured on a 3-point Likert-scale ('no-chance', 'a small-chance', 'a high-chance'), with an additional response option of 'don't know'. At the beginning of the questionnaire, a general statement was given to define EHI and to assist understanding by junior cricketers: '*Heat illnesses are a group of conditions that occur when your body gets too hot during exercise and sports (increase in your body temperature); How much chance do you think there is of getting heat illness in the following situations?*'

The newly developed English version of the EHI risk perception questionnaire was then translated into the two main languages used in Sri Lanka, Sinhala and Tamil, described in full elsewhere.<sup>22</sup> The Sinhala and Tamil questionnaires were trialled with two groups of under-13 cricketers from a Sinhala (n=24) and a Tamil (n=30) language-based school to assess test-retest reliability and achieved strong reliability scores for all items (kappa value of >0.6). The questionnaire also underwent content validity checking by two school teachers, examining for language accuracy, clarity and age appropriateness.

### Survey sampling

Respondents were junior school male cricketers in the under-13 year age category, who took part in the 2016 interdistrict cricket tournament across Sri Lanka. Forty-eight teams representing all nine provinces in Sri Lanka were invited to participate. The study was conducted in collaboration with the Sri Lanka School Cricket Association, the governing body of Sri Lanka school cricket.

### Survey administration

The data collection was carried out during the interdistrict cricket tournament from October to December 2016. Before the tournament, 15 sets of questionnaires in three languages (Tamil, Sinhala and English) were posted to each coach of the selected 48 district teams. Players were asked to complete the questionnaires anonymously in their preferred language and by themselves, with support from their parents to clarify any questions that were difficult to understand. The team-coach collected and returned the completed questionnaires to the research team via post.

Written instructions were given through the plain language information sheet, detailing the aim of the study, data collection procedure, benefits and potential risks. Informed written consent was obtained from both players and their parents before commencing the data collection. Each questionnaire was distributed to the participants in a separate envelope that was to be sealed on return to ensure participants' confidentiality. Ethical approval was obtained from the Human Research Ethics Committee of the Federation University Australia (project approval number: A16-039).

**Table 1** Fourteen survey questions and related recommendations drawn from two consensus statements<sup>7,21</sup> on recognising and preventing EHI in sport

Risk domains	Survey question statements	Recommendations are drawn from the consensus statements*
Climate-related risks	Playing in very hot and sunny conditions	'Hot and humid environmental conditions can more readily predispose an individual to exertional heat strokes' <sup>21</sup>
	Playing in high humidity conditions	'When humidity is high, evaporative heat loss is severely diminished, which can lead to a rapid rise in core body temperature and an extreme risk for exertional heat strokes' <sup>21</sup>
Risks related to the individual (intrinsic risks)	Suffering from fever and other infections	'Individuals who are currently or were recently ill may be at increased risk for EHI because of fever, dehydration, or medications' <sup>21</sup> 'Prior viral infection is emerging as a potentially important risk factor for heat injury/stroke' <sup>7</sup>
	Being overweight	'Increased body mass index: Obese people are at increased risk for EHI because they are less efficient in dissipating heat and produce more metabolic heat during exercise' <sup>21</sup>
	Not having a good physical fitness level	'Poor physical condition: Untrained individuals are more susceptible to EHI than trained individuals' <sup>21</sup>
	Not having enough sleep during the previous night	'The effects of heat are cumulative; athletes should be encouraged to sleep at least 7 hours per night in a cool environment' <sup>21</sup>
	Having experienced heat illness in the past	'Athletes with a history of heat illness are often at greater risk for recurrent heat illness during strenuous physical activity' <sup>21</sup>
Risks related to clothing and equipment (extrinsic risks)	Wearing tight fitting clothes	'Barriers to evaporative heat loss: Athletic equipment and rubber or plastic suits used for weight loss do not allow water vapour to pass from the skin to the environment and, as a result, inhibit evaporative, convective, and radiant heat loss' <sup>21</sup>
	Wearing excess amounts of clothes	'Excessive clothing or equipment decreases the body's ability to thermoregulate and may cause greater absorption of radiant heat from the environment' <sup>21</sup>
	Wearing helmets and pads	'Participants who wear equipment that does not allow for heat dissipation are at an increased risk for heat illness. Wearing a helmet is also a risk factor because a significant amount of heat is dissipated through the head' <sup>21</sup>
Risk minimising strategies	Resting in a cool shaded place	'Rest breaks should be in the shade or in a predetermined cooling zone and should allow enough time for all athletes to consume fluids' <sup>21</sup>
	Cooling the body with cold towels or ice packs	'Cooling methods include external (eg, application of iced garments, towels, water immersion, or fanning) and internal methods (eg, ingestion of cold fluids or ice slurry) <sup>7</sup> 'The athlete should be moved to a cool or shaded area and body cooling should be accomplished via fans or ice towels if necessary' <sup>21</sup>
	Playing without taking enough water	'Individuals should maintain euhydration and appropriately replace fluids lost through sweat during and after games and practices' <sup>21</sup> 'Athletes should be cautious to undertake exercise in a euhydrated state and minimised body water deficits through proper rehydration during exercise' <sup>7</sup>
	Getting used to environment conditions during training	'Individuals should be acclimatised to the heat gradually over 7 to 14 days' <sup>21</sup> 'Athletes planning to compete in hot ambient conditions should heat-acclimatise' <sup>7</sup>

\*Recommendations are direct quotations of the two consensus statements. EHI, exertional heat illness.

### Statistical analysis

Survey data were entered into Microsoft Excel database and then exported to SPSS for statistical analysis (V.24, IBM, Armonk, New York, USA). Demographic data were analysed using descriptive statistics (n, %). Risk perception questions with Likert-scale responses were analysed

and presented as frequencies (%) with 95% CI. The three valid response categories in the Likert-scale questions were coded as 'no-chance=1', 'a small-chance=2', 'a high-chance=3' and a collective mean and median score was calculated for each question across all respondents. 'Don't know' responses were removed before calculating

**Table 2** Junior cricketers' perceptions about the risk of exertional heat illnesses under different conditions (n=365)

	Chance of developing exertional heat illness				Risk perception score*		
	No-chance (%)	Small-chance (%)	High-chance (%)	Don't Know (%)	Mean*	95% CI*	Median (range)†
Suffering from fever and other infections	14 (3.8)	79 (21.6)	230 (63)	42 (11.5)	2.67	2.61 to 2.73	3 (1–3)
Not having a good physical fitness level	21 (5.8)	89 (24.5)	219 (60.2)	35 (9.6)	2.60	2.54 to 2.67	3 (1–3)
Playing in very hot and sunny conditions	18 (4.9)	107 (29.4)	212 (58.2)	27 (7.4)	2.58	2.51 to 2.64	3 (1–3)
Playing without taking enough water	15 (4.1)	117 (32.3)	209 (57.7)	21 (5.8)	2.57	2.51 to 2.63	3 (1–3)
Having experienced heat illness in the past	32 (8.8)	71 (19.6)	185 (51.1)	74 (20.4)	2.53	2.45 to 2.61	3 (1–3)
Being overweight	25 (6.9)	96 (26.4)	169 (46.6)	73 (20.1)	2.50	2.42 to 2.57	3 (1–3)
Not having enough sleep during the previous night	22 (6.1)	107 (29.6)	165 (45.6)	68 (18.8)	2.49	2.41 to 2.56	3 (1–3)
Playing in high humidity conditions	25 (6.9)	163 (44.9)	99 (27.3)	76 (20.9)	2.26	2.19 to 2.33	2 (1–3)
Wearing tight fitting clothes	56 (15.5)	115 (31.8)	129 (35.6)	62 (17.1)	2.24	2.16 to 2.33	2 (1–3)
Wearing excess amounts of clothes	48 (13.3)	123 (34)	114 (31.5)	77 (21.3)	2.23	2.15 to 2.32	2 (1–3)
Getting used to environment conditions during training	61 (16.8)	181 (49.7)	48 (13.2)	74 (20.3)	1.96	1.88 to 2.03	2 (1–3)
Wearing helmets and pads	89 (24.5)	150 (41.3)	65 (17.9)	59 (16.3)	1.92	1.84 to 2.00	2 (1–3)
Cooling the body with cold towels or ice packs	112 (31.0)	145 (40.2)	51 (14.1)	53 (14.7)	1.80	1.72 to 1.88	2 (1–3)
Resting in a cool shaded place	186 (51.1)	129 (35.4)	24 (6.6)	25 (6.9)	1.52	1.46 to 1.59	1 (1–3)

Shaded cells indicate the most common response obtained for each question.

\*Mean scores were calculated for each response variable with 95% CI, after removing the 'don't know' responses.

†Risk perception scores ranged from 1 to 3.

the mean and median scores. Wilcoxon signed rank tests were used to compare median scores across questions of interest (eg, between temperature risk and humidity risk). The statistical significance level was set at  $p < 0.05$ .

## RESULTS

Of 48 teams, 33 returned questionnaires achieving a team response rate of 69%. A total of 720 questionnaires were distributed among the teams (15 questionnaires/questionnaires per team), of which 365 were returned (Sinhala=251; Tamil=114; English=0), giving an overall average response of 11 players per team. At least one team from each of the nine provinces in Sri Lanka returned the questionnaires, resulting in countrywide representation. The mean age of the players was  $12.9 \pm 0.9$  years, and they had been playing competitive cricket at school level for  $2.6 \pm 1.8$  years on average.

The risk perception responses of the junior cricketers in relation to EHI risk are presented in table 2. For the climate-related risks (temperature and humidity), a majority of junior cricketers perceived playing in hot environments as having a 'high-chance' (58% of all

respondents) of developing EHI, compared with a 'small-chance' (45%) when playing in high humidity conditions. Similarly, most junior cricketers believed there to be a high-chance of developing EHI when playing without taking adequate water (58%). 'Suffering from a fever and other infections' (63%) and 'not having good physical fitness level' (60%) were the two risk scenarios that were perceived as having the greatest chance of developing EHI. Most junior cricketers perceived 'resting in a cool shaded place' was associated with 'no-chance' (51%), and 'getting used to environment conditions during training' had only a 'small-chance' (50%) of developing EHI.

The mean (with 95% CI) and median risk perception scores are presented in table 2. The three scenarios with the highest mean scores were 'suffering from fever and other infections', 'not having good physical fitness', 'playing in very hot and humid conditions'. In the climate-related risks, the mean risk perception of the response 'playing in very hot and sunny conditions' (median=3) were greater than 'playing in high humid conditions' (median=2;  $p < 0.001$ ). Junior cricketers perceived a lesser chance of developing EHI when



playing cricket 'wearing helmets and pads', compared with wearing tight clothes or excessive clothes.

## DISCUSSION

This study provides novel insight into the risk perceptions held by Sri Lankan junior male cricketers about 14 different risk factors that contribute to the development of EHI. To our knowledge, there have been no previous studies that have examined the EHI-related risk perceptions among sports participants, at any level. As explained in the Health Belief Model, risk perceptions influence and determine individuals' subsequent behaviours and actions.<sup>9</sup> Therefore, information on how sports participants understand heat illness risk is an important precursor for developing and implementing appropriate EHI mitigation strategies.

Overall, most risk factors were responded to in a manner that would be expected based on the scientific evidence linking them to actual risks (eg, high temperatures lead to higher chance of developing EHI). However, there were some examples of modifiable risk factors (eg, wearing protective gear) and non-modifiable risk factors (eg, humidity) for which it appears many of the junior cricketers had a limited understanding. This misperception could potentially place them at higher risk of EHI if it influenced their behaviours. These risk factors need to be addressed, whether through educating juniors about them or placing greater emphasis on the responsibility of those organising the events and competitions.

### Climate-related risk perceptions

Ambient temperature and relative humidity are the two main climate-related risk factors known to contribute to the development of EHI, with wind speed and radiant heat being additional contributory parameters.<sup>21</sup> Collectively, these four parameters are used to formulate the most widely used index of heat stress, the Wet Bulb Globe Temperature.<sup>21 23</sup> Understanding the effects of climate-related risks other than the ambient temperature in developing EHI will allow participants to adopt avoidance behaviours in high-risk environment conditions.<sup>24</sup> A high relative humidity greatly reduces the evaporative heat loss capacity of the body, resulting in a rise in core body temperature, especially when the ambient temperature is greater than body's skin temperature.<sup>21</sup> Nevertheless, understanding the effects of climate-related risks other than the ambient temperature in developing EHI will allow participants to adopt avoidance behaviours in high risk environment conditions.<sup>24</sup> A majority of junior cricketers (59%) associated playing in a hot environment with a high-chance of developing EHI, but only one in four players (27%) considered high relative humidity as a risk. In addition, 21% of the participants gave the response 'don't know' for high relative humidity as a risk, which indicates their uncertainty about this particular risk. The reason why humidity was not clearly linked with a higher chance of developing EHI is probably due to a simple lack of knowledge about humidity, as these respondents

were only an average of 12 years of age. It is therefore important that organisers of junior cricket need to have a very good understanding of the risks of participating in high humidity and take control of monitoring conditions and implementing risk reduction strategies, on behalf of these young participants.

### Risk perceptions related to hydration, acclimatisation and body cooling

The most effective, practical, preventive strategies for EHI are: (1) heat-acclimatisation, (2) hydration and (3) cooling strategies,<sup>7</sup> which can all be managed by both the event organisers and the junior cricket participants themselves. For the survey respondents, playing cricket while dehydrated was perceived as being associated with a high-chance of developing EHI, whereas acclimatisation to the environment and carrying out body cooling was perceived as having a low chance. A good understanding of these modifiable risks can be helpful in implementing risk reduction strategies effectively. For cricket, the format of the game permits a number of official rest breaks (usually every hour) for the fielding team and batters to hydrate and cool their bodies at regular intervals. Therefore, one strategy for cricket is to promote hydration and use of body cooling strategies during these breaks in cricket play. It may be necessary to provide physical resources to support this, such as water and other hydration fluids, ice, cold towels, and cold garments. Likewise, sports authorities should both create opportunities for heat-acclimatisation programmes during the preseason and stage incremental increases in exercise duration and intensity.

### Use of protective equipment

Protective equipment and clothing can be a major contributor to developing EHI as additional garments can interfere with heat dissipation mechanisms of the body through evaporation, convection and radiation.<sup>25 26</sup> Compared with other sports, significantly higher heat illness rates have been reported among high school athletes taking part in American football,<sup>1</sup> where protective gear including helmets, gloves and different types of body pads (shoulder, thigh, knee) are worn by players. Similar types of protective gear are worn by cricketers mainly when they are batting, keeping wickets and fielding close to the batter. Therefore, it is reasonable to assume that, like American footballers, cricketers might also have a higher risk for EHI owing to the use of protective gear.<sup>20 27</sup> However, studies into the heat stress burden and its effects associated with wearing cricket helmets and other protective gear have not been published. In the current study, a majority of junior cricketers perceived a low chance of developing EHI when playing cricket wearing protective gear (41%). One reasonable explanation is that junior cricketers aged 11–14 years may not yet be able to comprehend the association between protective gear use and impaired heat dissipation mechanism and subsequent rise in body temperature. This presents

a unique challenge encouraging the use of protective gear for protection against musculoskeletal injury while concurrently providing education about potential heat concerns. The measures to modify EHI risk related to protective gear use should be implemented while emphasising the importance and promoting the protective gear used to prevent ball-impact injuries in cricket.<sup>28</sup> In terms of behaviour modification interventions, simple strategies such as removing helmets and other protective gear while not taking part in active play should be encouraged.

### Strengths and limitations

This study achieved a good response rate with a representative sample covering countrywide participation from all nine provinces in Sri Lanka. However, with the inclusion of only junior male school cricketers, results should only be considered when looking at similar junior populations in matched climactic regions of South Asia. Future investigations with adult cricketers and other sporting populations would be of value in further understanding which risk factors resonate most with participants, and why so, as to better target these in EHI mitigation strategies. Risks associated with developing EHI are well-recognised in the sports medicine literature, and the list can be lengthy. For the purpose of this study, a selection of 14 well-recognised risk factors representing both modifiable and non-modifiable risk categories that were thought to be of high relevance for junior Sri Lankan cricketers was chosen. Tailoring the questions to specific sports situations might provide responses that are more reflective of participants understanding of EHI within their sporting context.

### CONCLUSION

Most of the risk perceptions can be considered as appropriate and reasonable for this population, except for factors such as humidity and use of helmets. There was relatively poor understanding that high humidity can be a contributor to developing EHI, particularly in comparison to the recognition of the role of ambient temperature. However, given the young age group surveyed, this is perhaps not unreasonable. The results are important from a public health perspective because, along with educating junior athletes' on these types of risks, it is important to target those responsible for competition management, whether it is coaches, umpires, parents or other officials. Those in responsibility roles need to be aware of the importance of promoting a safe playing environment for juniors. Competition organisers must take the lead in monitoring players and instigate the appropriate measures as part of their duty of care as juniors may not be mindful of some risks. This study provides novel insight into EHI risk perceptions among sports participants. Further evaluation and understanding of the adaptive behaviours of athletes associated with non-optimal EHI risk perceptions would be useful for implementing measures to mitigate EHI risks in sports.

**Acknowledgements** Thanks to the under-13 district team junior cricketers who took part in this survey, team coaches in facilitating data collection and Sri Lanka School Cricket Association (SLSCA) for their collaboration.

**Funding** PJG was supported by an Australian Government Research Training Program (RTP) stipend and RTP Fee-Offset Scholarship through Federation University Australia.

**Competing interests** None declared.

**Patient consent for publication** Not required.

**Ethics approval** This study was approved by the Human Ethical Review Committee of the Federation University Australia (A16-039).

**Provenance and peer review** Not commissioned; internally peer reviewed.

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**Author note** Aspects of this research are related to the work of the Australian Centre for Research into Injury in Sport and its Prevention (ACRISP), which is one of the IOC centres of research excellence for the prevention of injuries and promotion of health in athletes.

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