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Material

Study of Preventive Heatstroke in Basketball Players Participating in the High School "Spring Games"

Risa KURATO*, Mitsushiro NAGAO, Takeshi MIYAKAWA** and Shuji MATSUEDA*****

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1. Introduction

Global warming has caused a rise in air temperature. Damage to health due to global warming includes heat stroke as reported by the fourth IPCC evaluation report of the Intergovernmental Panel on Climate Change [1]. The rise in temperature increases the frequency of heat stroke outbreaks resulting in the death of children in school. According to the Ministry of Education, Culture, Sports, Science and Technology, (MEXT), the incidence of heat stroke has been increasing annually such that 1,935 people in 2009, 4,591 people in 2010, and 4,668 people in 2011 suffered from heat stroke [2]. This is the number of students that paid medical expenses for heat stroke that have taken place under management of the school (2011 preliminary figure). However, it is believed that the number of heat stroke victims is actually higher. It is believed that the rise in temperature due to global warming is the major cause of an increase in the number of heatstroke outbreaks. It is being dangerous to making the same conditions. Japan set up heat stroke relevant ministries and agencies in a liaison conference in 2007 [3]. The purpose was to spread knowledge about heat stroke for both prevention and emergency procedures. Securing the cooperation of relevant ministries and agencies to promote the measures, examination of the enforcement policy of heatstroke measures and exchange information. The Ministry of Environment provides weather information, increases awareness, and has prepared a "heatstroke environmental health manual [4]." In Japan, this manual has been distributed by local governments and the Board of Education. The Ministry of Health, Labour and Welfare has prepared a leaflet on heatstroke measures for everyday life. And, The MEXT has prepared a pamphlet called "Let's prevent heatstroke [5]." The preventive measures for heat stroke in schools are carried out by MEXT. The leaflet was distributed to the Nippon Junior High School Physical Culture Association, the Nippon High School Physical Culture Association, school, and the Board of Education. In addition, the MEXT provides lectures on heat stroke measures at school and Board of Education meetings.

The Japan Amateur Sports Association shows an exercise indicator (WBGT) of heat stroke prevention [6]. As mentioned above, although various heat stroke preventive measures are being taken, heat strokes continue to increase every year. Therefore, some new measures are required. Heat stroke often occurs

* Doctoral Program in Health Science, Graduate School of Health Science and Technology, Kawasaki University of Medical Welfare, Kurashiki, Okayama 701-0193, Japan
E-Mail: w8511003@kwmw.jp
** Department of Health and Sports Science, Faculty of Health Science and Technology, Kawasaki University of Medical Welfare, Kurashiki, Okayama 701-0193, Japan
*** Department of Clinical Nutrition, Faculty of Health Science and Technology, Kawasaki University of Medical Welfare, Kurashiki, Okayama 701-0193, Japan

during sports activities at school, particularly high school students. Therefore, it is important to consider the actual water intake of these students. A previous study examined water intake and changes in body weight of high school basketball players at one of their official games. Thus, it is necessary to obtain basic data to help with prophylaxis. The present study examined water intake and change in body weight of high school basketball players at the spring games. This study is descriptive in nature, and the purpose was to determine hydration and changes in the body weight of high school basketball players during an actual spring game.

2. Methods

2.1. Subjects

This study was carried out in March 2012 in a locker room and at a basketball game held in a gymnasium. Eight girls and nine boys participated in this study [mean age ± standard deviation (SD): 16.5 ± 0.6 years]. Informed consent was obtained from all participants after explaining the purpose of this study and the potential risks of the study protocol. Thus, each participant voluntarily joined the study.

2.2. Measurements

The subjects' water intake was monitored without forcing fluid intake (KD-173; TANITA). Body weight (HBF-359; OMRON), pulse rate (palpation), environmental temperature (WBGT-103; Kyoto Electronics Manufacturing Co.), a visual analog scale (VAS) [7] for measuring the subjective sense of thirst (SST), a rating of thermal sensation (RTS) [8], and a rating of perceived exertion (RPE) were measured. These factors were measured at the five following time points: before the warm-up: point A; before the start of the game: point B; halftime of the game: point C; just after the end of the game: point D; and 30 min after the end of the game: point E. Body weight was not measured at halftime. Players took off their uniforms, and body weight was measured in undergarments (Table1). Body weight, pulse rate, and RPE data are presented as mean ± SD and analyzed by one-way analysis of variance to examine differences between measurement points. Results of the SST and RTS are presented as medians. The Friedman test was performed to detect changes in the SST and RTS between the measurement points. In addition, simple correlation analyses were used to analyze the relationships between water intake and quantity of total sweat. A p-value <0.05 was considered significant. The data were analyzed with SPSS ver. 19 for Windows (SPSS, Inc. Chicago, IL, USA).

Table 1 The five time points of measurement

Measurement items \ Points	A	B	C	D	E
Body weight	○	○	×	○	○
Pulse rate	○	○	○	○	○
Water intake	○	○	○	○	○
Environment temperature	○	○	○	○	○
SST	○	○	○	○	○
RTS	○	○	○	○	○
RPE	○	○	○	○	○

○ : Measurement, × : Non-measurement

Table 2 Environmental temperature at each measurement point

Points	Measurement items	WBGT (℃)	Temperature (℃)	Relative humidity (%)
A	Boys	9.9	13.9	36.7
	Girls	10.8	14.7	36.5
B	Boys	11.2	15.0	31.3
	Girls	11.3	15.0	36.1
C	Boys	10.9	14.0	40.8
	Girls	11.6	15.4	37.1
D	Boys	11.4	15.0	40.8
	Girls	12.7	16.3	34.9
E	Boys	11.2	14.9	34.7
	Girls	11.5	15.7	30.7

WBGT : Wet Bulb Globe Temperature

3. Results

3.1. Environmental temperature at each measurement point

The environmental temperature measured WBGT, temperature and relative humidity. WBGT was 21℃, which was in the safe zone (Table2).

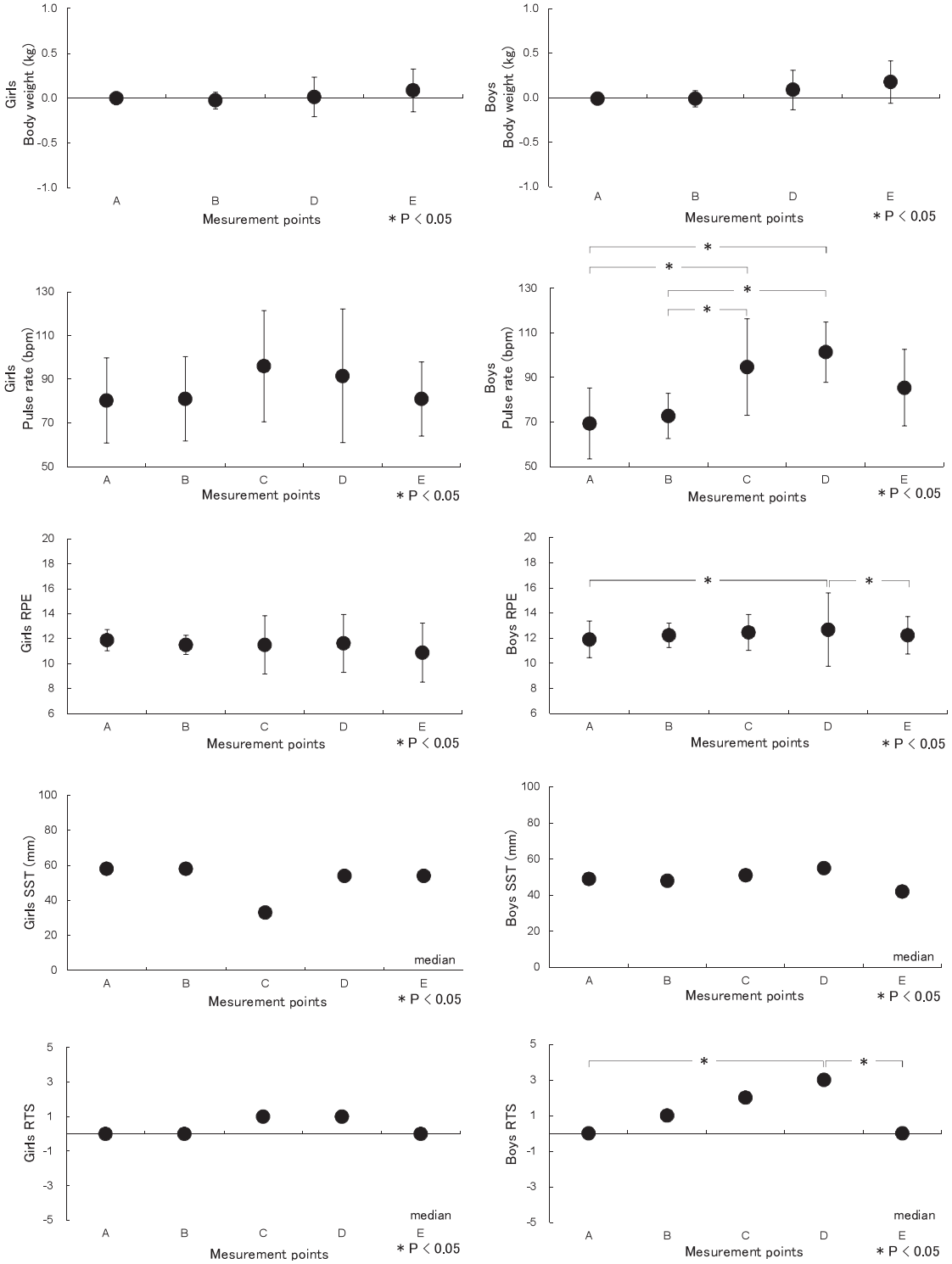

Fig. 1 Changes in body weight, pulse rate, RPE, SST, and RTS at each measurement point

3.2. Changes in body weight, pulse rate, SST, RTS, and RPE

Figure 1 shows the changes in body weight, pulse rate, SST, RTS, and RPE of the subjects. The pulse rate was significantly different between time points in boys ($p<0.05$). The pulse rate in boys was higher at points C and D than at point A ($p<0.05$) and higher at points C and D than at point B ($p<0.05$). RPE in boys was higher at point D than at point A ($p<0.05$) and higher at point E than at point D ($p<0.05$). RTS in boys was significantly higher at point D than at point A ($p<0.05$) and lower at point E than at point D ($p<0.05$).

3.3. Relationship between water intake and total sweat quantity

Figure 2 shows the correlation between water intake per body weight and the total quantity of sweat per body weight of the players. The calculation of total quantity of sweat was (body weight of point A – body weight of point E) + water intake per body weight. No significant correlation was observed between water intake per body weight and the total quantity of sweat per body weight ($r = 0.190$, n.s.).

3.4. Rate of water intake and the rate of weight loss

Table 3 shows the rate of water intake and the rate of weight loss of the players.

The calculation of weight loss was 100 – (point A × 100 / point E). The rate of water intake was 93.2%, and the rate of weight loss was 0.2%.

Table 3 Water intake rate and weight loss rate of subjects

Measurement items	Rate (%)
Water intake	93.2
Weight loss	0.2

(mean)

4. Discussion

Earlier studies reported a significant correlation between water intake and total amount of sweat [9, 10]. However, we found no such correlation in this study. This may have been because the present study was conducted in spring, whereas previous studies were conducted in the summer. Those studies reported that water intake was appropriate for the amount of sweating [11, 12]. Thus, we believed that players could adequately hydrate themselves depending on the amount they sweat. We found that the rate of water intake was 93.2%, which was higher than that in an earlier study. Based on this observation, we believe that players could adequately hydrate themselves based on the amount they sweat. In addition, the Japan Amateur Sports Association proposed that players should not lose more than 2% of body weight during exercise [13]. In this study, no player lost more than 2% of their body weight. It seems that it was less likely that players would develop heat stroke in the spring, but there were players who had low rates of water intake.

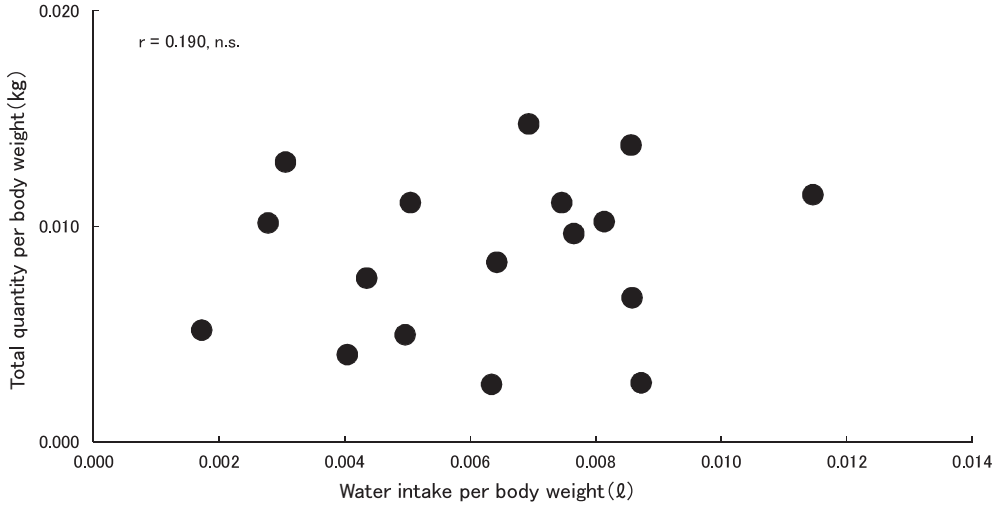

Fig. 2 Relationship between water intake per body weight and total sweat quantity per body weight

5. Conclusion

Our results suggest that heat stroke can be prevented by players who adequately hydrate themselves to compensate for the sweat lost during a game. Although it was unlikely that players would develop heat stroke in a spring game, there were players who did not consume adequate amounts of water. In conclusion, it is necessary to spread knowledge about heat stroke so that players can take preventive measures.

References

1. Ministry of the Environment: IPCC Fourth Assessment Report (official), http://www.env.go.jp/earth/ipcc/4th/ar4syr.pdf, 2007 (in Japanese).
2. Ministry of Education, Culture, Sports, Science and Technology: The outbreak situation of the heatstroke at the management of the school, http://www.mext.go.jp/a_menu/kenko/anzen/_icsFiles/afieldfile/2012/06/22/1307567_1_1.pdf, 2011.
3. Ministry of the Environment: Heatstroke relevant ministries and agencies in a liaison conference guideline, http://www. env.go.jp/chemi/heat_stroke/ic_rma/2301/9, 2007.
4. Ministry of the Environment: *Heatstroke environmental health manual*. Tokyo, Environment Health Department Environment Security Section, 2005 (in Japanese).
5. Ministry of Education, Culture, Sports, Science and Technology, Japan Sport Council: *Let's prevent heatstroke*. Tokyo, Japan Sport Council, 2003 (in Japanese).
6. Japan Sports Association: *Heatstroke prevention guidebook during sports activity*. Tokyo, Nippon International Agency, 1999 (in Japanese).
7. Rolls BJ, Wood RJ, Rolls ET, Lind H, Lind W, Ledingham JG: Thirst folling water deprivation in humans. *Am J Physiol* 239 (5): 476-482, 1980.
8. Ohmichi H, Iwasaki T, Miyashita M: Development of Underwater Ergometer for Leg Extensors. *J Heal Phys Edu Rec* 33(6): 477-482, 1983 (in Japanese).
9. Matsueda S: Sweat Loss and Fluid Intake during Soccer Training. *Kawasaki J med welfare* 5(2): 209-213, 1995 (in Japanese).
10. Kajiwara Y, Kawashima S, Itoh K, Izutsu S, Nozaki T: Environmental Temperature During Summer Baseball Practice as Viewed from Problems of Heat Stress and Physiological Work Load. *J Fac Educ Bunkyo Univ* 36: 73-82, 2002 (in Japanese).
11. Takanishi T, Makoro S, Yoshida T, Nakai S, Yorimoto A, Morimoto T: About dehydration and drop into exercise ability at the time of the summer sports activity of Filed investigation. *Jpn J Phys Fit Sport* 46 (6): 913, 1997 (in Japanese).
12. Sakae R, Suzuki K, Mori S, Asayama M, Miyagawa T: The actual situation of environmental temperature, quantity of sweat, water intake and sports activity during summer sports activity. *Jpn J Phys Fit Sport* 49(6): 2902, 2000 (in Japanese).
13. Japan Sports Association: *Drink water well! sports lively*. Tokyo, Nippon International Agency, 2011 (in Japanese).