Validity and Reliability of Temperature Sensing Devices During and Following Exercise in the Heat

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ABSTRACT

Background: Exertional heat stroke is a danger for athletes that participate in outdoor and indoor sports and can be fatal if not recognized and treated properly. Oral temperature is currently used to assess an athlete’s temperature during exercise, but previous research suggests it may be an invalid and unreliable measurement of core temperature. A company recently designed a mouth guard prototype that changes color when core temperature reaches a specific threshold.

Purpose: The purpose of this study was to determine the reliability and validity of the color-changing mouth guard when the user reaches a core temperature of 39°C.

Methods: Thirteen volunteers participated in the study (26 ± 5.3 yrs; 171 ± 8.14 cm; 70.1 ± 11.6 kg; 17.0 ± 4.75% body fat) each completed one trial of exercise in the environmental chamber with the goal of reaching >39°C. Every 5 minutes, a photo of the mouth guard was taken, and temperature measurements were recorded. Exercise ceased when the participant wanted to stop, if they reached 40°C, or if they showed symptoms of heat exhaustion. After exercise, they sat in the chamber for 5 minutes, outside of the chamber for 5 minutes, and in a cold-water bath at 4.5°C for 5 minutes. A photo of the mouth guard and temperature measurements were taken after each of these events. After data collection, oral temperatures were compared to intestinal temperature in order to determine reliability and validity. Water baths were used to confirm that the mouth guards changed color at its reported temperature.

Results: The mouth guard changed color at the correct temperature. Participants exercised for a mean of 47 ± 14 minutes. The participants reached a mean intestinal temperature of 39.08 ± 0.39°C, which was significantly greater than maximal oral temperature of 37.33 ± 0.59°C, p<.001. The participants ingested an ingestible thermometer 5-6 hours prior to their assigned trial time.

Conclusion: The findings of this study support the idea that oral temperature is not a valid or reliable measurement of core body temperature during exercise. It would be unsafe for athletic trainers to use this mouth guard as a diagnostic or preventive tool for heat illnesses.

INTRODUCTION

• Exertional heat stroke (EHS) is an elevated core temperature above 40°C, with central nervous system dysfunction.1
• EHS can affect athletes in all settings and does not always occur in extreme heat.2
• EHS can be fatal so early recognition is important.1,4
• The National Athletic Trainers’ Association reports that rectal temperature is the most valid way to assess core body temperature in an athlete that has been exercising.6
• Ingestible thermistors are a valid measurement of core body temperature during exercise.6
• Oral temperature has been found to be an invalid and unreliable measurement of core body temperature during exercise.5,6
• A company recently designed a mouth guard prototype that claims to change color when an athlete’s core temperature reaches 39°C.3

PURPOSE

The purpose of this study was to determine the reliability and validity of the color-changing mouth guard when the user reaches a core temperature of 39°C.

RESULTS

• The mouth guard changed color at its threshold temperature of 39°C in the water bath.
• The participants exercised for a mean of 47 ± 14 minutes.
• The participants reached a mean intestinal temperature of 39.08 ± 0.18°C, which was significantly greater than the maximal oral temperature of 37.33 ± 0.39°C, p<.001.
• The oral temperatures and intestinal temperatures of the participants throughout the trial are compared in Figure 3.
• Even though the participants’ core body temperature was above 39°C, none of the mouth guards changed color during any of the trials.

Figure 1: Ten of the participants (26 ± 5.3 yrs; 171 ± 8.14 cm; 70.1 ± 11.6 kg; 17.0 ± 4.75% body fat) each completed one trial of exercise in the environmental chamber with the goal of reaching >39°C.

Figure 2: On the left is a photo of the mouth guard at room temperature. On the right is a photo of the mouth guard after being heated in boiling water to 39°C.

Figure 3: The peak of average intestinal temperature (TIG Temp 1; 39.08°C; TIG Temp 2; 39.0°C; average oral temperature experienced a decrease (oral Temp 1; 0.1°C; Oral Temp 2; 0.6°C).

CONCLUSION

None of the mouth guards changed color throughout any of the trials, further supporting the evidence that oral temperature is not a valid or reliable measurement of one’s core body temperature. It would not be safe to use this mouth guard to assess an athlete’s core temperature in a clinical setting.

REFERENCES


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