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Original Research

Validity and Reliability of Devices That Assess Body Temperature During Indoor Exercise in the Heat

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Abstract

Context: When assessing exercise hyperthermia outdoors, the validity of certain commonly used body temperature measuring devices has been questioned. A controlled laboratory environment is generally less influenced by environmental factors (eg, ambient temperature, solar radiation, wind) than an outdoor setting. The validity of these temperature measuring devices in a controlled environment may be more acceptable.

Objective: To assess the validity and reliability of commonly used temperature devices compared with rectal temperature in individuals exercising in a controlled, high environmental temperature indoor setting and then resting in a cool environment.

Design: Time series study.

Setting: Laboratory environmental chamber (temperature = 36.4 ± 1.2°C [97.5 ± 2.16°F], relative humidity = 52%) and cool laboratory (temperature = approximately 23.3°C [74.0°F], relative humidity = 40%).

Patients or Other Participants: Fifteen males and 10 females.

Intervention(s): Rectal, gastrointestinal, forehead, oral, aural, temporal, and axillary temperatures were measured with commonly used temperature devices. Temperature was measured before and 20 minutes after entering the environmental chamber, every 30 minutes during a 90-minute treadmill walk in the

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heat, and every 20 minutes during a 60-minute rest in mild conditions. Device validity and reliability were assessed with various statistical measures to compare the measurements using each device with rectal temperature. A device was considered invalid if the mean bias (average difference between rectal and device temperatures) was more than ±0.27°C (±0.50°F).

Main Outcome Measure(s): Measured temperature from each device (mean and across time).

Results: The following devices provided invalid estimates of rectal temperature: forehead sticker (0.29°C [0.52°F]), oral temperature using an inexpensive device (−1.13°C [−2.03°F]), temporal temperature measured according to the instruction manual (−0.87°C [−1.56°F]), temporal temperature using a modified technique (−0.63°C [−1.13°F]), oral temperature using an expensive device (−0.86°C, [−1.55° F]), aural temperature (−0.67°C, [−1.20°F]), axillary temperature using an inexpensive device (−1.25°C, [−2.24°F]), and axillary temperature using an expensive device (−0.94°F [−1.70°F]). Measurement of intestinal temperature (mean bias of −0.02°C [−0.03°F]) was the only device considered valid. Devices measured in succession (intestinal, forehead, temporal, and aural) showed acceptable reliability (all had a mean bias = 0.09°C [0.16°F] and $r \geq 0.94$]).

Conclusions: Even during laboratory exercise in a controlled environment, devices used to measure forehead, temporal, oral, aural, and axillary body sites did not provide valid estimates of rectal temperature. Only intestinal temperature measurement met the criterion. Therefore, we recommend that rectal or intestinal temperature be used to assess hyperthermia in individuals exercising indoors in the heat.

Keywords: core body temperature, hyperthermia, tympanic membrane

Matthew S. Ganio, MS, contributed to conception and design; acquisition and analysis and interpretation of the data; and drafting, critical revision, and final approval of the article. Christopher M. Brown, MA, ATC, contributed to conception and design, acquisition and analysis and interpretation of the data, and critical revision and final approval of the article. Douglas J. Casa, PhD, ATC, FNATA, FACSM, contributed to conception and design; acquisition and analysis and interpretation of the data; and drafting, critical revision, and final approval of the article. Shannon M. Becker, MA, ATC, contributed to conception and design, acquisition and analysis and interpretation of the data, and critical revision and final approval of the article. Susan W. Yeargin, PhD, ATC; Brendon P. McDermott, MS, ATC; and Lindsay M. Boots, BS, ATC, contributed to conception and design, acquisition of the data, and critical revision and final approval of the article. Paul W. Boyd, BS, ATC, contributed to acquisition of the data and critical revision and final approval of the article. Lawrence E. Armstrong, PhD, FACSM, and Carl M. Maresh, PhD, FACSM, contributed to conception and design, acquisition of the data, and critical revision and final approval of the article.

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