

# A checklist for measuring skin temperature with infrared thermography in sports and exercise medicine

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## SUMMARY

This short report introduces a recently published checklist for reporting thermographic studies in sports and exercise medicine. The checklist is the result of a Delphi consensus process, which was achieved after intensive discussion among 24 experts from different fields such as sport sciences, physiology, physiotherapy and medicine. The checklist contains in total 15 items in the domains "participants' demographic information" (3 items), "Camera/exam room or environmental conditions" (8 items) and "Recording and analysis of the thermal image" (4 items). Applying the checklist will improve the comparability and thus data pooling of thermographic studies.

**KEY WORDS:** Infrared thermography, checklist, Delphi process

## EINE CHECKLISTE ZUR MESSUNG DER HAUTTEMPERATUR MITTELS INFRAROT-THERMOGRAFIE IN DER BEWEGUNGS- UND SPORTMEDIZIN

Dieser kurze Bericht stellt eine vor kurzem veröffentlichte Checkliste für die Berichterstattung von thermografischen Untersuchungen in der Sport- und Bewegung-Medizin vor. Die Checkliste ist das Ergebnis eines Delphi Konsens, der nach intensiver Diskussion von 24 Experten aus verschiedenen Bereichen Sportwissenschaft, Medizin, Physiologie und Physiotherapie erreicht wurde. Die Checkliste enthält in insgesamt 15 Fragen in den Bereichen "demografische Informationen der Studienteilnehmer" (3 Fragen), "Kamera/Untersuchungszimmer oder Umweltbedingungen" (8 Fragen) und "Aufnahme/Analyse des Wärmebildes" (4 Items). Die Anwendung der Checkliste könnte die Vergleichbarkeit und damit die Daten-Bündelung von thermografische Untersuchungen verbessern.

**SCHLÜSSELWÖRTER:** Infrarot-Thermographie, Checkliste, Delphi-Prozess

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## Introduction

Measuring skin temperature using infrared thermography is common in the field of sports and exercise medicine. The quality, description and conduction of the protocol for thermographic data collection [1] should be considered as important as the quality of the camera used.

Unfortunately, research using infrared thermography (IRT) in sports medicine differs in the techniques employed and the comparison between studies is difficult as a result of these methodological inconsistencies. In addition, some studies often fail to report detailed information regarding the collection or analysis of the infrared thermography data [2, 3]. These methodological issues regarding the use of IRT have highlighted the need to develop protocols that are reliable and allow a comparison of results between studies.

In an attempt to address this problem a recent Delphi study and consensus statement on the measurement of human skin temperature using thermography in sports and exercise medicine has been published. Moreira et al. [4] developed a detailed checklist for the assessment of skin temperature using infrared thermography settings entitled "Thermographic Imaging in Sports and Exercise Medicine" (TISEM) (Table 1). The consensus statement attempts to standardize the collection and analysis of skin temperature data recorded using infrared thermography, thereby preventing

bias and facilitating the comparison of results between future studies. It is intended that the TISEM will be helpful for a wide array of end-users including practitioners, sports scientists, exercise physicians, and other professionals that need to measure skin temperature using infrared thermography.

## How the TISEM checklist was developed?

Twenty-four world leading experts in IRT covering different fields and expertise (e.g. sport sciences, physiology, physiotherapy and medicine) participated in a series of questionnaires interspersed with controlled feedback [5]. All participants completed three rounds of questionnaires in which they commented and rated each item of a draft according to its validity and applicability. During the process, the items on the checklist were refined through each expert's comment, where each modification was shared and re-evaluated in the subsequent round. In the end, 15 items encompassed the participants' demographic information (items 1, 2 and 3), camera/room or environment setup (items 4, 5, 6, 7, 8, 9, 10 and 11) and recording/analysis (items 12, 13, 14 and 15) were approved using a 80% of agreement as a criteria [5-7].

## Why is it important to use TISEM?

The development of protocols for infrared thermography data collection has many elements with potential to vary,

Table 1.

Thermographic imaging in sports and exercise medicine (TISEM).

<p><b>1) The relevant individual data of the participants must be provided.</b>  Note: These could include, but are not limited to, age, sex, body mass, height, body mass index, ethnicity and whether they are smokers or not. An indication of physical activity profile (e.g. frequency, duration, intensity, and activity description) should be reported.  <input type="checkbox"/> Yes   <input type="checkbox"/> No   <input type="checkbox"/> Unclear</p>
<p><b>2) Participants should be instructed to avoid alcohol beverages, smoking, caffeine, large meals, ointments, cosmetics and showering for four hours before the assessment. Also, sunbathing (e.g. UV sessions or direct sun without protection) should be avoided before the assessment.</b>  Note: This should be confirmed verbally before the assessment. The use of any medicinal treatments or drugs should be recorded. Any condition that could not be avoided should be reported.  <input type="checkbox"/> Yes   <input type="checkbox"/> No   <input type="checkbox"/> Unclear</p>
<p><b>3) Extrinsic factors affecting skin temperature (e.g. physical activity prior to the assessment, massage, electrotherapy, ultrasound, heat or cold exposure, cryotherapy) should be clearly described.</b>  <input type="checkbox"/> Yes   <input type="checkbox"/> No   <input type="checkbox"/> Unclear</p>
<p><b>4) Ambient temperature and relative humidity of the location where the assessment took place must be recorded and reported as mean <math>\pm</math> standard deviation.</b>  <input type="checkbox"/> Yes   <input type="checkbox"/> No   <input type="checkbox"/> Unclear</p>
<p><b>5) The assessment should be completed away from any source of infrared radiation (e.g. electronic devices, lightning) or airflow (e.g. under an air conditioning unit).</b>  Note: Any condition that could not be controlled should be reported.  <input type="checkbox"/> Yes   <input type="checkbox"/> No   <input type="checkbox"/> Unclear</p>
<p><b>6) The manufacturer, model and accuracy of the camera used should be provided.</b>  Note: When available it is recommended to provide the maintenance information of the equipment (e.g. when and where it was completed the last calibration).  <input type="checkbox"/> Yes   <input type="checkbox"/> No   <input type="checkbox"/> Unclear</p>
<p><b>7) An acclimation period in the examination room should be completed.</b>  Note: This item is only applicable for initial baseline measurements or basal analysis.  <input type="checkbox"/> Yes   <input type="checkbox"/> No   <input type="checkbox"/> Unclear</p>
<p><b>8) If necessary the camera should be turned on for some time prior to the test to allow sensor stabilization following the manufacturer's guidelines.</b>  <input type="checkbox"/> Yes   <input type="checkbox"/> No   <input type="checkbox"/> Unclear</p>
<p><b>9) Conditions of image recording such as mean distance between object and camera, percentage of the region of interest within the image should be detailed.</b>  <input type="checkbox"/> Yes   <input type="checkbox"/> No   <input type="checkbox"/> Unclear</p>
<p><b>10) The camera should be positioned perpendicular to the region of interest.</b>  <input type="checkbox"/> Yes   <input type="checkbox"/> No   <input type="checkbox"/> Unclear</p>
<p><b>11) Emissivity settings of the camera must be reported.</b>  Note: 0.98 of emissivity is suggested for a dry clean skin surface.  <input type="checkbox"/> Yes   <input type="checkbox"/> No   <input type="checkbox"/> Unclear</p>
<p><b>12) The time of day at which the images were taken should be reported.</b>  <input type="checkbox"/> Yes   <input type="checkbox"/> No   <input type="checkbox"/> Unclear</p>
<p><b>13) The standard body position of the subject and the regions of interest must be well described and appropriately selected. A visual example (with temperature scale presented and scale of colors properly configured) is recommended.</b>  <input type="checkbox"/> Yes   <input type="checkbox"/> No   <input type="checkbox"/> Unclear</p>
<p><b>14) If the skin is dried (e.g. to remove surface water), the drying method should be clearly described.</b>  <input type="checkbox"/> Yes   <input type="checkbox"/> No   <input type="checkbox"/> Unclear</p>
<p><b>15) The evaluation of thermograms and collection of temperature from the software should be clearly described.</b>  <input type="checkbox"/> Yes   <input type="checkbox"/> No   <input type="checkbox"/> Unclear</p>

such as the information given to the participant prior to the test, the distance from the camera to the subject, the room temperature of the laboratory where infrared thermography is recorded, the time used for temperature stabilization, and the position of the camera. Prior to the TISEM, there was no consensus regarding which aspects were important to consider and which should be reported in a manuscript. Similar checklists have also been used in different contexts by the scientific community and their use typically improve methodological approaches [8, 9]. In this sense, it is expected that TISEM will move the field forward for researchers, peer reviewers, physiologists and clinicians by improving the quality of infrared thermography data collection, analysis and interpretation.

In conclusion, the use of the TISEM when conducting future research will help reduce methodological inconsistencies in the field of sports and exercise medicine. We also hope that the TISEM will be used to evaluate bias in thermographic studies and to guide practitioners using this technique [4].

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