A new thermal head manikin for the development of helmet designs with increased thermal comfort

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ABSTRACT

In case of a bicycle accident, a helmet might be crucial to prevent severe head injuries. Despite the proven protective effect, low wearing rates are observed in Europe. One of the main factors limiting helmets acceptance is thermal discomfort. To increase cyclists' wearing comfort, and hence, helmet acceptance, modifications of helmets designs are an ongoing issue for bicycle helmets manufacturers. Helmet design and construction have to comply with protective requirements, provide optimal aerodynamic drag and reduce thermal discomfort. To this end, mainly the effect of helmet design on thermal properties is still not fully understood. Thermal manikins are standardized methodologies for investigating heat transfer through clothing due to their high reliability and reproducibility [1].

A thermal head manikin with a novel segmentation of the head into 9 zones (9zM) is used in our lab to investigate local heat transfer within the cranial section. The aim of this work was to assess the performance and the possibility of a more exhaustive investigation of heat transfer using the 9zM by comparing heat flux measurements with previously published data from a two-zone thermal head manikin (2zM) ([2]). Various bicycle helmets from the aforementioned studies were tested under the same conditions.

Cooling performance averaged for the entire scalp was compared between manikins for each helmet resulting in a similar classification of helmets. However, cooling rate for helmets was lower when investigated with the 9zM. Due to the higher spatial resolution of heat transfer data of 9zM, it was possible to highlight the contribution of the different helmet zones to the global cooling performance of the scalp.

This novel segmentation allows much more precise thermal evaluation of headgear. This knowledge contributes to a better understanding of the thermal interaction of head and helmets and, therefore, to a more evidence based development of optimized headgear designs.

Keywords: Thermal head manikin, thermal comfort, bicycle helmet.

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