EINDHOVEN UNIVERSITY OF TECHNOLOGY

CHARACTERISING INTER-INDIVIDUAL VARIABILITY IN SIMULATED PERSONAL LIGHT EXPOSURE

IMPACT OF BODY MORPHOLOGY ON LIGHT-DOSIMETRY

Sietse W. de Vries, John Mardaljevic, and Juliëtte van Duijnhoven

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Figure 1 – 10 of the 2 941 people in the CEASAR database (Yang et al., 2014)

LIGHT-DOSIMETRY

Recordings of personal light exposure (PLE), i.e. the illumination received at the eye(s) over time, are valuable for research on human health and well-being. To record PLE, light-dosimeters (sensors) are worn on the body, acting as a proxy for measurements at the eye. Chest-worn dosimeters (Figure 2) have become more utilised in recent years, as they strike a balance between measurement accuracy and unobtrusiveness for the wearer. Although various studies (e.g. (Figueiro et al., 2013; Aarts et al., 2017)) investigated differences between chest and eye-level measurements, much remains unknown about the inter-individual variability in chest-worn dosimeter measurements.

Figure 2 - Dosimeter worn on the chest as a pendant

BODY SCAN SIMULATIONS

To investigate this inter-individual variability, we leveraged a database of approximately three thousand body scans of standing individuals (Figure 1). On each person, we identified four theoretical dosimeter positions on the chest and one reference position in front of the eyes (Figure 3). For all positions, we quantified the dosimeter's orientation, self-shading by the body, and measured illumination under two indoor illumination scenarios (Figure 4).

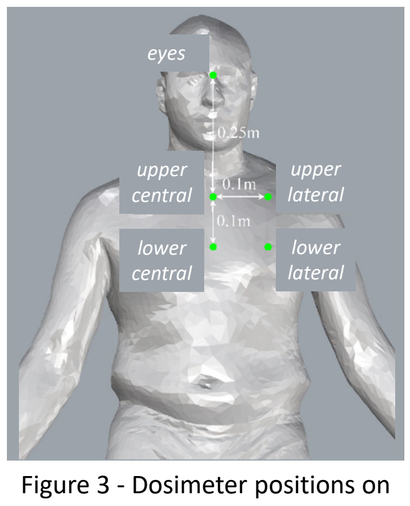

Figure 3 - Dosimeter positions on the chest and at the eyes

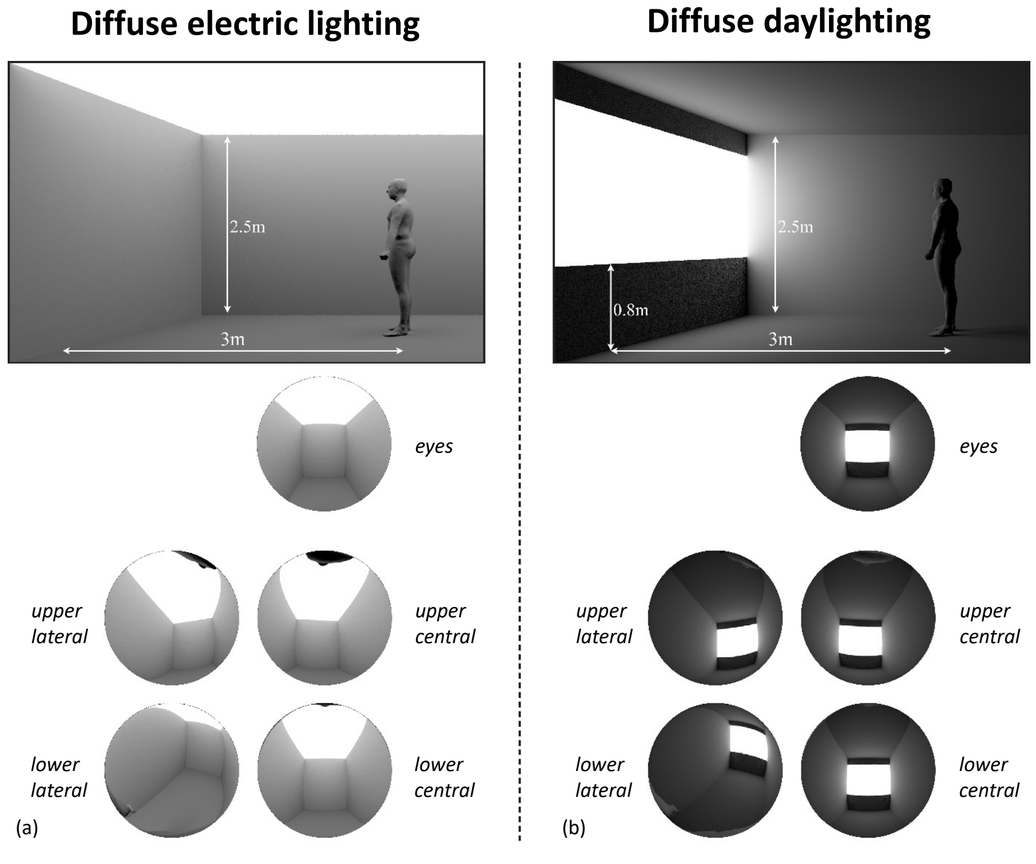

Figure 4 - Two idealised indoor illumination scenarios and example dosimeter views

INTER-INDIVIDUAL VARIABILITY

The differences in measurements between chest-worn and eye dosimeters under both illumination scenarios are shown in Figure 5.

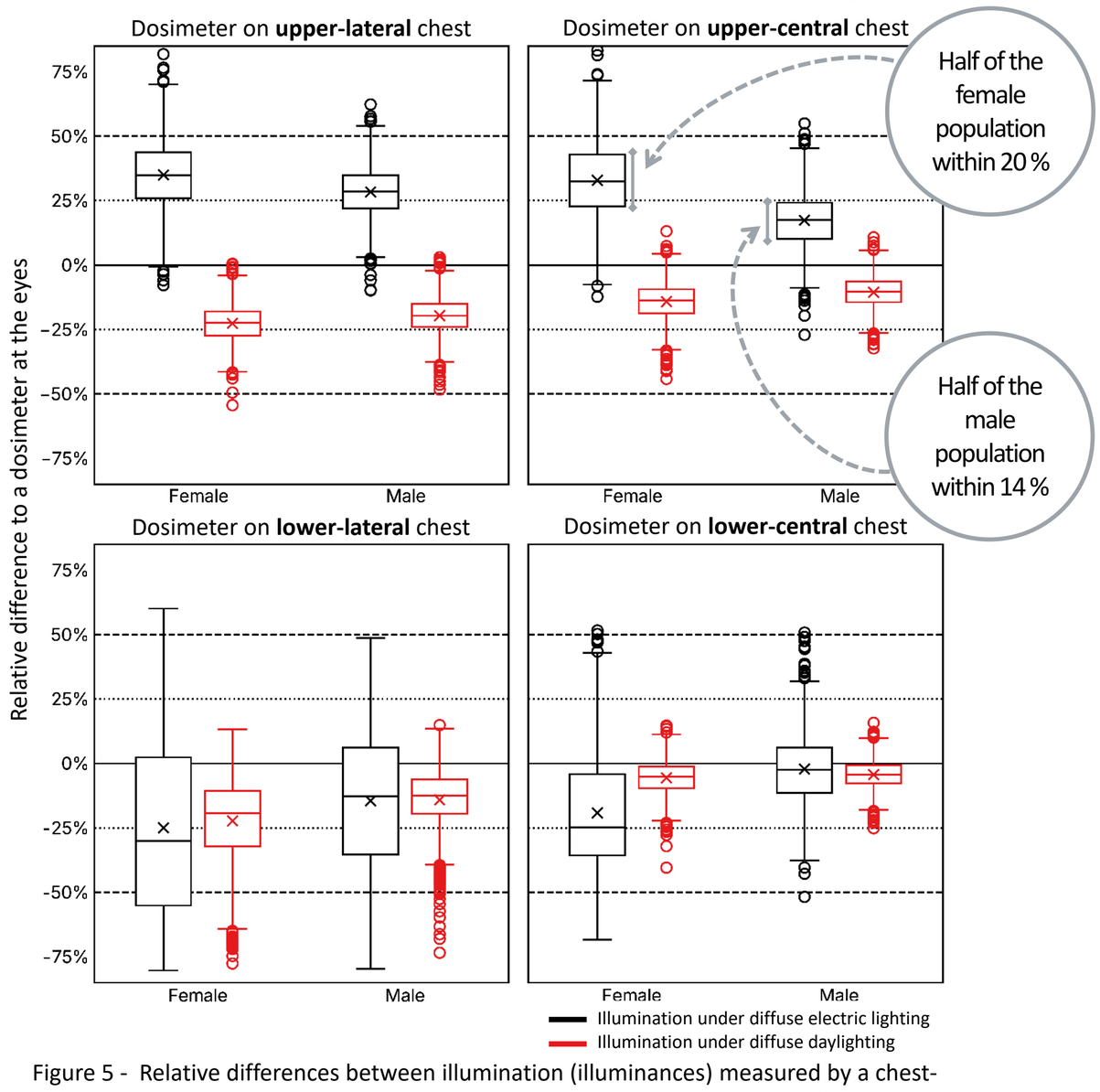

Figure 5 - Relative differences between illumination (illuminances) measured by a chest-worn dosimeter and a dosimeter at the eyes. A positive value indicates that illumination at the chest was higher than at the eyes.

CONSIDERATIONS FOR LIGHT-DOSIMETRY

To reduce inter-individual variability in chest-worn illumination measurements, dosimeters are best placed on the upper chest, where body shapes are more uniform across individuals. However, a dosimeter at this position tends to have a slight upward tilt for nearly all subjects, causing discrepancies from measurements at the eyes. To balance measurement accuracy and inter-individual variability, it may be worthwhile to adopt a more individualised placement strategy: selecting, for each individual, a position on the chest where the dosimeter's orientation closely matches the individual's view direction for typical postures. Real-world illumination fields are invariably more heterogeneous than the diffuse fields used in this study, suggesting that the bounds of variation in dosimeter performance are almost certainly greater than revealed here.

References

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