SUPPLEMENTARY DATA

Actiwatch validation study

The purpose of this validation study was to compare Actiwatch lux values, with those of a calibrated illuminance meter (T-10 A, Konica Minolta Inc., Japan), and determine corresponding illuminance levels under a series of low to high mesopic and photopic luminance levels, measured using a calibrated video photometer (LMK 5 color, TechnoTeam Bildverarbeitung GmbH, Germany), in the same location in a laboratory (Supplementary Table 1). The upper limit of the mesopic zone was defined as 3.0 cd/m². The illuminance levels measured at wrist level by the Actiwatch under these luminance levels helped to determine the following three lighting categories: 1) scotopic to mid-mesopic, 2) high mesopic, and 3) photopic. Actiwatch measurements were also taken while completing several typical everyday activities under low light environments to provide some real-world examples.

Actiwatch illuminance values (sampling at 15 seconds) were compared to lux values obtained from a calibrated illuminance meter (T-10 A, Konica Minolta Inc., Japan) when positioned side-by-side at eye level in a vertical direction facing a blank wall under a series of low to high mesopic (0.1, 0.5, 1.0 and 3.0 cd/m²) and photopic (10.0 and 150.0 cd/m²) luminance levels for a period of 15 minutes. Under mesopic light levels (up to ~20 lux), the association between the lux values of the Actiwatch at eye level and the calibrated illuminance meter was approximately linear (R²=0.991) (Supplementary Figure 1), and the mean difference between these two devices, using Bland and Altman plots, was small (~0.71 ± 0.81 lux) and within the limits of agreement (Supplementary Figure 2), indicating a high level of accuracy.

Additionally, the Actiwatch lux values, when the device was worn on the wrist as was the case in the main study, were compared to a calibrated illuminance meter under various luminance levels. This helped to determine appropriate Actiwatch lux values at wrist-level under low to high mesopic and photopic luminance levels, as the basis of categorization of light levels. Actiwatch illuminance values (sampling at 15 seconds) when worn on the wrist, were also measured while a wearer was walking and sitting in a series of different locations in the laboratory, to reflect normal everyday activities, for a period of 5 minutes. The light exposure measurement at wrist level under high mesopic luminance levels (3 cd/m²) was 19.97 ± 2.10 lux (Supplementary Table 1). Therefore, illuminance values between 10 to 30 lux are likely to reflect these high mesopic levels, consistent with the level used in a previous study to reflect the upper mesopic region. Ambient light levels were thus categorized into the following three levels: Scotopic to mid-mesopic (≤10 lux); High mesopic (>10 - ≤30 lux); and Photopic (>30 lux).
**Supplementary Table 1:** Comparison of light levels recorded by the luxmeter (lux) and the Actiwatch (lux) at the eye and wrist, under a series of mesopic and photopic luminance levels (cd/m²)

| Adaptation zones | Luminance (cd/m²) * | Illuminance (Lux) at eye level † Mean ± SD | Actiwatch light exposure (Lux) at eye level ‡ Mean ± SD | Actiwatch light exposure (Lux) at wrist level ‡ Mean ± SD |
|------------------|---------------------|------------------------------------------|--------------------------------------------------------|--------------------------------------------------------|
| Low and mid-mesopic | 0.10                | 0.03 ± 0.00                             | 0.03 ± 0.01                                            | 2.40 ± 1.30                                            |
|                   | 0.50                | 1.32 ± 0.02                             | 2.23 ± 0.04                                            | 5.02 ± 1.36                                            |
|                   | 1.00                | 2.63 ± 0.02                             | 4.05 ± 0.02                                            | 9.19 ± 1.43                                            |
| High mesopic      | 3.00                | 6.86 ± 0.05                             | 8.35 ± 0.18                                            | 19.97 ± 2.10                                            |
| Photopic          | 10.00               | 21.49 ± 0.40                            | 21.22 ± 0.04                                           | 37.54 ± 3.40                                            |
|                   | 150.00              | 503.62 ± 1.81                           | 124.51 ± 8.07                                          | 265.23 ± 21.40                                          |

* LMK 5 colour, TechnoTeam Bildverarbeitung GmbH, † Konica Minolta T10 A illuminance meter, ‡ Actiwatch 2, Philips Respironics

**Supplementary Figure 1:** Association between light levels measured by a luxmeter and an Actiwatch under mesopic levels. The line indicates an exact match of the illuminance values and dots represents the recordings by luxmeter and Actiwatch.
Supplementary Figure 2: Bland-Altman plot comparing illuminance levels recorded by a luxmeter and an Actiwatch under mesopic levels. The red line represents the mean difference in light levels, and the green and black lines represent upper and lower 95% limits of agreement, respectively.

Ambient illumination under typical low light situations

To illustrate real-world examples of typical low light situations, ambient light exposure (lux) at nighttime was recorded by an Actiwatch (sampling at 15 seconds) worn on the wrist for the following outdoor locations and an indoor location (Supplementary Table 2).

Outdoor locations:
- Suburban pavements (footpaths/sidewalks) at night: Light exposure was measured with the Actiwatch while the wearer walked along two different pavements of a medium density roadway with pole mounted streetlights. Measurements were taken at these locations on two different nights.
- Residential basement car park, with minimal overhead lighting: Light exposure was measured at nighttime with the Actiwatch while the wearer walked through a residential basement car park at night, with overhead fluorescent lights.

Indoor location:
- Home bedroom at nighttime: Light exposure was measured using Actiwatch while the wearer walked around a bedroom, with a table lamp on a bedside table turned on but without any overhead ceiling lighting.

For all these situations, two Actiwatch devices were worn (one on each wrist), and the average of the lux values determined. The average wrist-based lux values recorded were less than 10 lux, consistent with the low to high mesopic light levels conditions determined in the controlled laboratory study.
**Supplementary Table 2**: Real-world examples of low light situations in outdoor and indoor locations.

| Locations | Ambient light levels (lux) |
|-----------|---------------------------|
| **Outdoor pavement (footpath/sidewalk) at nighttime** | Mean (range) |
| Location 1: Suburban pavement along a medium density roadway with lighting provided by streetlights. Data collected over a period of 10 minutes. | 2.6 (0.0 - 34.9) |
| Location 2: Suburban pavement along a medium density roadway with lighting provided by streetlights. Data collected over a period of 10 minutes. | 7.2 (0.1 - 29.3) |
**Basement carpark at nighttime**

Residential carpark located in the basement of a house with lighting provided by two overhead fluorescent lights at the two ends of the carpark. Data collected over a period of 7 minutes.

3.6 (0.1 - 19.4)

**Home Bedroom at nighttime**

Bedroom with lighting provided by a single table lamp on the bedside table, without any overhead ceiling lighting. Data collected over a period of 7 minutes.

2.6 (0.3 - 22.6)

Note: Light exposure data were averaged from the two Actiwatch devices.