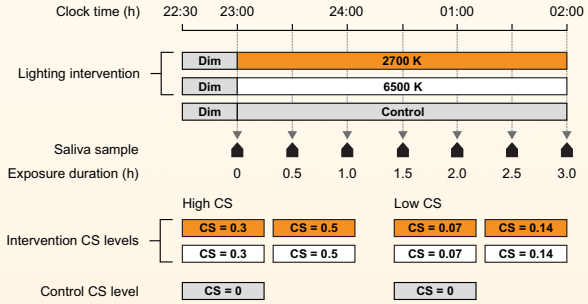
The Effect of Light Exposure Duration, Spectrum, and Age on Melatonin Suppression

Given the diverse role of melatonin in the management of maladies associated with metabolic, cardiovascular, and neuro-degenerative disease, cancer, and circadian rhythm sleep disorders, the present study was conducted to explore threshold characteristics for light's effects on the body's production of melatonin. Specifically, the study investigated the effect of CS levels (0.07, 0.14, 0.30, 0.50) and extended nighttime exposure durations (0.5–3.0 h) on acute melatonin suppression, for 2 contrasting white light spectra (2700K, 6500K), with an aim to highlight potential changes in absolute circadian sensitivity.

Methods

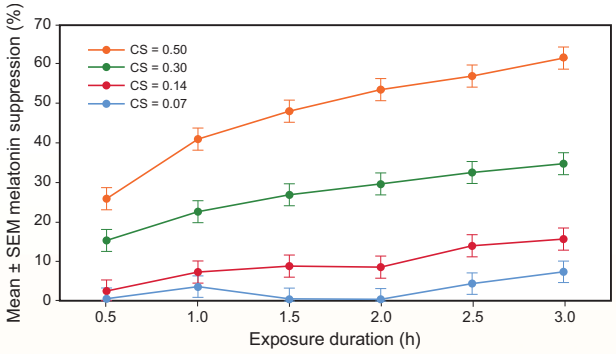
The study's 32 participants were comprised of 16 adolescents (mean ± standard deviation (SD) age of 15.9 ± 1.1 years, 8 females) and 16 adults (mean ± SD age of 42.4 ± 10.9 years, 9 females). Each participant experienced 4 corneal target CS levels of 0.07, 0.14, 0.30, and 0.50 for each light source spectrum, in addition to 2 dim-light (< 5 lux) control nights. Lighting apparatus comprised of RGB color-tunable, linear LED light bars (G2, High Output Linear Accent, Ketra, Austin, TX, USA). Salivary melatonin was collected from participants 7 times per night. Analysis was performed using linear mixed effects model analysis of variance (ANOVA).



The protocol for the study. Participants arrived in the laboratory and were held in dim light (< 5 lux at the eye) until the first saliva sample was obtained at 23:00 h. Six additional saliva samples were collected at 30-min intervals.

Results

- The overall hourly rate of suppression was 18.2% (after 1 h), 11.5% (after 2 h), and 9.7% (after 3 h), highlighting that light pulses of constant intensity are more effective for suppressing melatonin at the beginning of the exposure period.
- As exposure duration increased, lower light levels were required to reach the constant threshold criterion of 10% melatonin suppression.



The significant interaction between exposure duration and target CS level ($p < 0.001$).

Exposure duration (h)	Threshold photopic illuminance (lux)				Half-maximum saturation photopic illuminance (lux)			
	2700 K		6500 K		2700 K		6500 K	
	Adolescents	Adults	Adolescents	Adults	Adolescents	Adults	Adolescents	Adults
1	154	185	71	85	582	713	294	402
2	125	138	53	74	406	411	169	238
3	86	104	36	49	294	312	109	163

Threshold (CS = 0.1) and half-maximum saturation photopic illuminance levels for each light source and age group by hourly exposure duration derived from dose-response curves generated separately for the 2 age groups and light sources, at each hourly exposure duration using a sigmoidal 4-parameter logistic function.

Conclusions

- The dose-response curves and deduced threshold light levels can be used as a guideline for further discussion considering non-visual responses for general applications such as offices, schools, residences, and healthcare facilities.
- The threshold of 30 lux of a warm color light at the eye for 30 min prior to bedtime proposed by LRC researchers (Bullough et al., 2008; Rea and Figueiro, 2013) is acceptable.

References

Bullough JD, Bierman A, Figueiro MG, et al. (2008) On melatonin suppression from polychromatic and narrowband light. *Chronobiology International* 25: 653-656.

Rea MS and Figueiro MG. (2013) A working threshold for acute nocturnal melatonin suppression from "white" light sources used in architectural applications. *Journal of Carcinogenesis & Mutagenesis* 4: 1000150.

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