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Correspondence: An appraisal of the effects on human health and the environment of using light-emitting diodes

In May 2019, a collective appraisal report of the effects on human health and the environment of systems using light-emitting diodes (LEDs) was published by ANSES, the French Agency for Food, Environmental and Occupational Health and Safety. Here, the experts involved in this work provide an overview of their conclusions and recommendations.

We first confirmed the retinal phototoxicity of an acute exposure to blue light in humans and to high correlated colour temperature (CCT) white light in animal models. This is the well-known blue light hazard. Concerning cumulative exposure, epidemiological studies have shown that there is a long-term contribution of blue light to the occurrence of age-related macular degeneration. Since cold-white LEDs emit more blue light than lower CCT light sources, they have a stronger impact. We underlined the need to update the retinal exposure limits for blue light and pay particular attention to children, whose ocular tissues transmit more blue light than adult tissues.

Measurements were performed on LED devices including lamps, automotive headlights, electronic displays, flashlights and toys. Some of the tested LED light sources were associated with higher exposure levels to blue light than those associated with older lighting technologies. This was the case of LED-based low-beam automotive headlights which were shown to significantly increase the exposure of children to the retinal blue light hazard. We have recommended adapting the regulatory framework to include the photobiological safety of automotive lighting.

Detailed spectral and temporal profiles of retinal exposure were computed based on realistic annual schedules of exposure to artificial light and daylight. The contribution of artificial light sources is not negligible compared to daylight, even when considering different climates and different times spent outdoors. Over a year, artificial light can represent up to 30% of the retinal exposure dose in the spectral range of the blue light phototoxicity.

We have concluded that the disruption of circadian rhythms induced by exposure to artificial light in the evening or at night is established. Children and adolescents constitute a particularly sensitive population. LED-based displays are the first contributors to the retinal exposure dose received in the blue part of the spectrum during the evening and at night. Their growing use has an impact on sleep quality by inducing or maintaining unhealthy sleep habits. Circadian disruption has also been associated with many pathologies such as depression, cardiovascular disease, metabolic conditions, cancer and sleep disorders.

Regarding temporal light modulation (TLM), we confirmed the occurrence of undesired visual effects (flicker, stroboscopic effect and phantom array effect) with LED devices. The relationship between TLM and migraines or headaches was found to be possible, deserving further research. Populations sensitive to TLM include children, adolescents and young adults. Since almost half of the tested LED lamps and luminaires had a higher level of TLM than halogen and discharge lamps using electronic

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ballasts, we have recommended the introduction of mandatory TLM limits in future regulations.

Replacing current outdoor lighting and displays by LED technologies can reduce light pollution, but only in the case of well-designed street and road lighting. Overall, the transition to LEDs is responsible for an increase of light pollution in numerous other cases (increasing number of luminous advertisements, brighter commercial lighting, innovative agricultural lighting, etc.). Using LEDs, artificial light at night may be favourable to a few species but remains toxic to a vast majority, with direct and indirect effects on both nocturnal and diurnal species in a given biotope. An increase in mortality and decline in biodiversity has been largely observed for animals and plants.

The ANSES report (458 pages) is available through the ANSES website (in French, https://www.anses.fr/fr/system/files/AP2014SA0253Ra.pdf), together with technical appendices (https://www.anses.fr/fr/system/files/AP2014SA0253Ra-Anx.pdf) and the official ANSES opinion (24 pages), is available in French and English at https://www.anses.fr/fr/system/files/AP2014SA0253EN.pdf.

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