Health impact assessment of introducing LED street lighting in Stockport

1. Background

1.1. The public health team were asked to contribute to assessing the health impact of a proposal to change current street lighting throughout Stockport, to LED lighting. The proposals were to use lights with a colour temperature of 4,000K.

1.2. Following a rapid review of an existing Health Impact Assessment produced for Trafford Council in 2013 and the American Medical Association guidelines published in 2016, an initial recommendation was made that “in residential areas we aim to keep the colour temperature in the range 2,700K to 3,000K and ensure that the spectrum includes some red or infrared A light. This is a precautionary measure, based on a plausible effect with limited evidence rather than on a proven effect”.

1.3. Subsequent advice from the street lighting team then highlighted that a change from LEDs with a colour temperature of 4,000K to 3,000K would result in additional cost of redesigning existing street lighting systems and would make the project unviable (financially) leaving Stockport with the high energy costs and associated CO2 production of the existing street lighting provision.

1.4. A fuller review of the literature was therefore agreed to understand the evidence base for the nature of the health impacts and review these in respect to the proposals for Stockport.

1.5. This report does not cover the background to the proposals for changing to LED street lighting, as this information is included in associated reports produced by Stockport Council’s Highways and Transportation team.

2. Health Impact Assessment

2.1. A health impact assessment (HIA) helps ensure that health and wellbeing are being properly considered in policies and proposals. The process looks at the positive and negative impacts of a development as well as assessing the indirect implications for the wider community. The aim is to identify the main impacts and prompt discussion about the best ways of dealing with them to maximise the benefits and avoid any potential adverse impacts.

2.2. This is a rapid, desktop health impact assessment where the evidence available has been reviewed by a single individual. In a full health impact assessment, a steering group would be identified and the process may include stakeholder workshops to review and assess the evidence in relation to the policy change. In this instance, due to the need to report within a short timescale, the rapid, desktop exercise has been undertaken.

3. Literature review

3.1. A literature search was conducted using NHS Evidence, and Google Scholar. The search terms included: LED street light/ing health/health impacts street light/ing health

artificial light/ing health “light at night” health “LED street lighting” “health risk” LED light health risk “adverse effects. Only studies in English language were reviewed.

3.2. The relevant references from key documents were also sourced and reviewed, these documents were: Health Impact Assessment produced for Trafford Council[1], the Report of the Council on Science and Public Health which informed the American Medical Association guidelines[2] and the Public Health England report “Human responses to lighting based on LED lighting solutions”[3].

4. Summary of evidence of health impacts of LED street lighting

4.1. No direct evidence relating to the specific impact of LED street lighting on health was identified. There is evidence which relates to prolonged, direct exposure to LED lighting, but this set of literature is not relevant in this context. Therefore, the evidence relating to the health impacts of LED street lighting is primarily based on evidence about exposure to artificial light at night and evidence about the impact of light of a ‘blue’ colour temperature.

4.2. Table 1 summarises the potential health impacts relating to LED street lighting with a 4,000K colour temperature.

[1] Vohra, S (2013). Trafford LED Street Lighting Programme Health Impact Assessment. Institute of Occupational Medicine.

[2] Report of the Council on Science and Public Health for the American Medical Association (2016). Human and Environmental Effects of Light Emitting Diode (LED) Community Lighting. Accessed 10th February 2017: https://www.ama-assn.org/sites/default/files/media-browser/public/about-ama/councils/Council%20Reports/council-on-science-public-health/a16-csaph2.pdf

[3] Price, L. Khazova, M & O’Hagan, JB (2016). Human Responses to Lighting based on LED Lighting Solutions. Public Health England (Commissioned by the Chartered Institution of Building Services Engineers and the Society of Light and Lighting).

4.3. **Table 1: Summary of potential health impacts of LED street lighting**

Health impact	**Will the health impacts affect the whole population or will there be differential impacts within the population?**	**Will the health impacts be difficult to remedy or have an irreversible impact?**	**Will the health impacts be medium to long term?**	**Are the health impacts likely to generate public concern?**	**Combining the answers, on balance will the health impacts have an important positive or negative impact on health?**
Sleep disturbance from LED brightness/'white' light	Whole population (some may be more susceptible but no way to assess this).	Can be remedied by appropriate shielding of lighting.	No	Evidence from areas locally where this has been implemented indicates that it is likely to generate some local complaints	No or minor negative impact
Disruption of circadian rhythmicity from increased blue light emissions	Whole population. Some evidence that disrupted circadian rhythmicity can lead to breast cancer, which is more common in women.	Insufficient evidence to imply that LED street lighting would be significantly responsible for disruptions to circadian rhythmicity which may in turn lead to irreversible health impacts.	Unlikely	Yes, evidence from other areas suggests that there may be public concern about this potential health impact.	No or minor negative impact
Visual discomfort and temporary reduced visibility of nearby objects from glare/hotspots	Whole population.	No	No	Yes, nationally members of the public have complained of debilitating after-images due to exposure to LED street lights, as well as experiencing	No or minor negative impact

				visual discomfort and distraction	
Reduced road accidents and increased perceived safety	Whole population. There is a potential for a positive health and wellbeing impact in relation to transport and connectivity if the LED street lighting improves visibility both for pedestrians and motor vehicle drivers. This is likely to be through greater physical activity and social interaction as parents perceive it to be safer for their children to go out in the evening on foot, by cycle or public transport. There is a potential for a moderate positive health and wellbeing impact in terms of transport and connectivity depending on the reductions in road traffic incidents involving children and the increase in physical activity of children in the evenings.				No or minor positive impact

4.4. **Health impact of exposure to artificial light at night (ALAN).**

4.4.1. Evidence indicates that exposure to artificial bright light during the night-time suppresses melatonin secretion, increases sleep onset latency and increases alertness. Chronic ALAN exposure can cause circadian rhythm misalignment which may have negative effects on the psychological, cardiovascular and/or metabolic functions[4].

4.4.2. Some observational studies have shown that outdoor ALAN levels are a risk factor for breast cancer and report that indoor light intensity and individual lighting habits were relevant to this risk[4].

4.4.3. Additional evidence showed that outdoor ALAN was significantly associated with obesity after adjusting for age and sex, even after controlling for various other confounding factors[5].

4.4.4. These health impacts are related to all ALAN sources, not specifically LED street lighting.

4.5. **Health impact of exposure to shorter wavelength (blue) light.**

4.5.1. Approximately 29% of the spectrum of 4,000K LED lighting is emitted as blue light, which the human eye perceives as a bright white colour. At 3,000K, the light has approximately 21% of its emission in the blue-appearing part of the spectrum[2].

4.5.2. There is some evidence to suggest that shorter wavelengths of light (towards the blue end of the spectrum) preferentially disturb melatonin secretion and cause circadian phase shifts, even if the light is not bright[4].

4.5.3. In relation to street lighting, light scattering in the atmosphere is greater for shorter wavelengths and the non-visual system (the pathway that governs unconscious responses to ambient light) is also relatively more sensitive to shorter wavelengths of visible light. The blue LED component is preferentially scattered, and the resulting sky-glow may activate the non-visual system more than other street light conditions. The effect would be greatest for the higher colour temperature LED street lights, which some evidence suggests could increase sky glow by a factor of 5, and lights that emit above a certain angle from the vertical[6].

4.5.4. Due to the small emitter size, the light from LED street lights can in theory be carefully directed, so there is a potential for light spill from street lighting to be reduced by LED technology[3].

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[4] Cho, Y-M et al (2015). Effects of artificial light at night on human health: A literature review of observational and experimental studies applied to exposure assessment. Chronobiology international Vol 32(9). http://dx.doi.org/10.3109/07420528.2015.1073158

[5] Koo, YS et al (2016). Outdoor artificial light at night, obesity, and sleep health: Cross-sectional analysis in the KoGES study. Chronobiology International Vol 33(3). http://dx.doi.org/10.3109/07420528.2016.1143480

[6] Falchi F, et al (2011). Limiting the impact of light pollution on human health, environment and stellar visibility. Journal of Environmental Management. Issue 92. http://www.sciencedirect.com/science/article/pii/S030147971100226X

4.6. **Other health impacts of LED street lighting**

4.6.1. Glare and hotspots. Glare from lighting, including from hotspots, can be uncomfortable and reduce the visibility of nearby objects even for lighting within retinal safety limits. Visual impairment effects are transient, but should nevertheless be considered as adverse human responses.

4.6.2. The current design of LED street lights consists of discrete bright spots of light, which may result in temporary visual impairment after looking directly into the lamp. Members of the public have complained of debilitating after-images due to exposure to LED street lights, as well as experiencing visual discomfort and distraction[7].

5. Summary and conclusions

5.1. The evidence found for this review was very limited. There was no evidence which demonstrated any health impact of LED street lighting directly (beyond alternative sources of lighting).

5.2. There is some evidence to suggest that exposure to artificial light at night can have some negative impact on the body's natural circadian phasing due to the interference with melatonin production. There is some emerging evidence that this effect can lead to negative health impacts including certain cancers, and obesity. This effect of disrupting melatonin production may be greater when the light in that exposure is shorter wavelength (i.e bluer). There is more blue light emitted by LEDs of a higher colour temperature (4,000k). These factors suggest a plausible risk to health from street lighting, that may be increased by using LED street lighting with a colour temperature of around 4,000k. However, the quantity and quality of the evidence available at this time is deemed insufficient to warrant a recommendation that this level of lighting should not be used, nor is there sufficient evidence to suggest a 'safe' colour temperature threshold.

5.3. Whilst it would be precautionary to suggest installing LED street lighting at a lower colour temperature (i.e.2,700-3,000K), it is clear that this would be financially unviable for Stockport Council. If this scheme were not to be implemented, cost savings to the equivalent value would need to be delivered from alternative schemes. It is considered likely that any other such schemes may have health impacts of a similar or greater likelihood and/or magnitude, but that would need to be reviewed by a health impact assessment of any alternative proposals.

5.4. To minimise any potential increased risk as described above, it is recommended that the street lighting team considers the following as part of the testing and implementation of LED street lighting within Stockport. These are suggested as precautionary response to a plausible but not proven effect on health due to increased dispersion of blue light from LED street lighting with a colour temperature of 4,000K:

- The lighting should be directed downwards, dispersed as little as possible from the vertical

[7] Ayama, M et al (2015). Discomfort glare of led street lights with different correlated color temperatures. in Proceedings CIE Session 2015, Vol. 1, Part 1.

- The lighting units in residential areas are installed with shielding surrounding them to minimise direct and dispersed light entering residents' homes (particularly bedrooms).
- It would be advisable to design the LED luminaire so that hotspots are not visible within the road user's normal field of view. Low-cost plastic beam-shaping optics could be used to diffuse the source and to tailor the footprint of the light pattern at ground level. Alternatively, the LEDs could be recessed within the unit.

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