

Electric light can disrupt circadian rhythms in children: is that a problem?

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Life on Earth has evolved for several billion years with a daily solar cycle of bright days and dark nights. However, in the modern world of humans, nighttime is awash in electric light. This provides ample opportunity for disruption of our endogenous circadian rhythmicity, which depends on a dark night. It has become clear in only the last decade or so, that circadian biology is central to all of our biology, with ~10% of our genes under direct circadian control, and many more indirectly. This means that disruption of circadian gene expression has pervasive effects throughout the body.

The basis for concern about cancer in children is the fact that ill-timed electric light can disrupt circadian rhythms, and circadian disruption has been implicated in cancers in adults, as well as obesity, diabetes, and depression (Stevens & Zhu, 2015), although few if any studies have directly examined cancer in children. The evidence for an effect in children is indirect (Stevens, 2012), but the issue is critical.

Important new evidence shows that young children are more sensitive than adults to nighttime electric light in the suppression of the hormone melatonin, both a marker of circadian status and a driver of the rhythm (Akacem *et al*, 2018; Crowley SJ *et al*, 2015).

Leukemia is the most common childhood cancer. It is a disease of uninhibited growth of white cells in the blood. These white cells are generated by stem cells, which when behaving normally produce just enough for a healthy immune system to function as it should. When the stem cells go haywire, the result is leukemia. Too much light at night could destabilize stem cell growth because it has recently been reported that the proliferation of stem cells is under circadian control (Weger *et al.*, 2017).

There is growing evidence that nighttime light exposure can increase risk of obesity and overweight (Gangwisch, 2014). There is also limited evidence that light during the night may raise circulating estrogen in women (Nagata *et al*, 2008). For pregnant women, higher body weight could affect the subsequent child's risk of brain cancer (Harder *et al*, 2008). Maternal elevated circulating estrogen could have many adverse effects on the fetus including increased long-term risk of breast cancer (Trichopoulos, 1990).

Early life, including in utero, is a particularly vulnerable period. The establishment of circadian rhythmicity begins forming early in gestation but is not fully established at birth (as any new parent becomes acutely aware). For these reasons, there needs to be greatly increased research attention directed to effects of ill-timed electric lighting on pregnant women such as alterations in hormone production that could then affect fetal development. Also needed is focus on developmental effects in young children and adolescents. For example, it is unknown the extent to which night-lights in the nursery alter the consolidation of circadian rhythmicity in infants, and whether toddlers exposed to highly lit evenings at home are at risk. This is an urgent issue because adverse effects could launch a child on a lifetime trajectory of ill-health and early death.

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