

Dr. Mario Motta, MD, FACC

- Board certified in cardiology
- Associate professor of medicine at Tufts University School of medicine
- Fellow of the American College of Cardiology and of the American Society of Nuclear Cardiology
- Past president of the Massachusetts Medical Society
- AMA Council of Science and public health for 8 years 2008-2016
- AMA trustee June 2018-2022
- Past member of Board of IDA
- Dark and quiet skies, UN office for outer space affairs

Light Pollution affects Human Health

- Interferes with circadian rhythms
- Melatonin suppression inhibits immune system
- Endocrine related carcinomas (Breast, prostate, Thyroid, pancreatic)
- ?? Colorectal Cancer
- Sleep, mood and depression, psychiatric disturbances
- Obesity and diabetes
- Coronary events and carotid disease
- Glare into roadways creates dangerous conditions for drivers and pedestrians
- Loss of our natural nocturnal environment contributes to loss of connection to nature and the inspiration of a star filled night sky

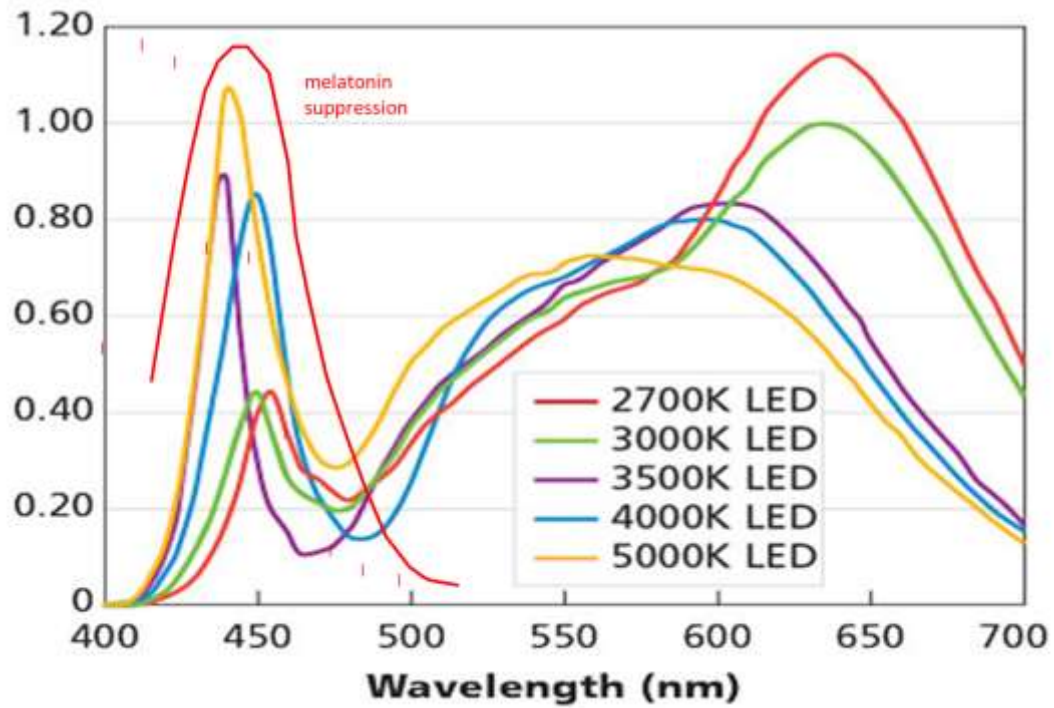


2700K

3000K

4000K

6000K

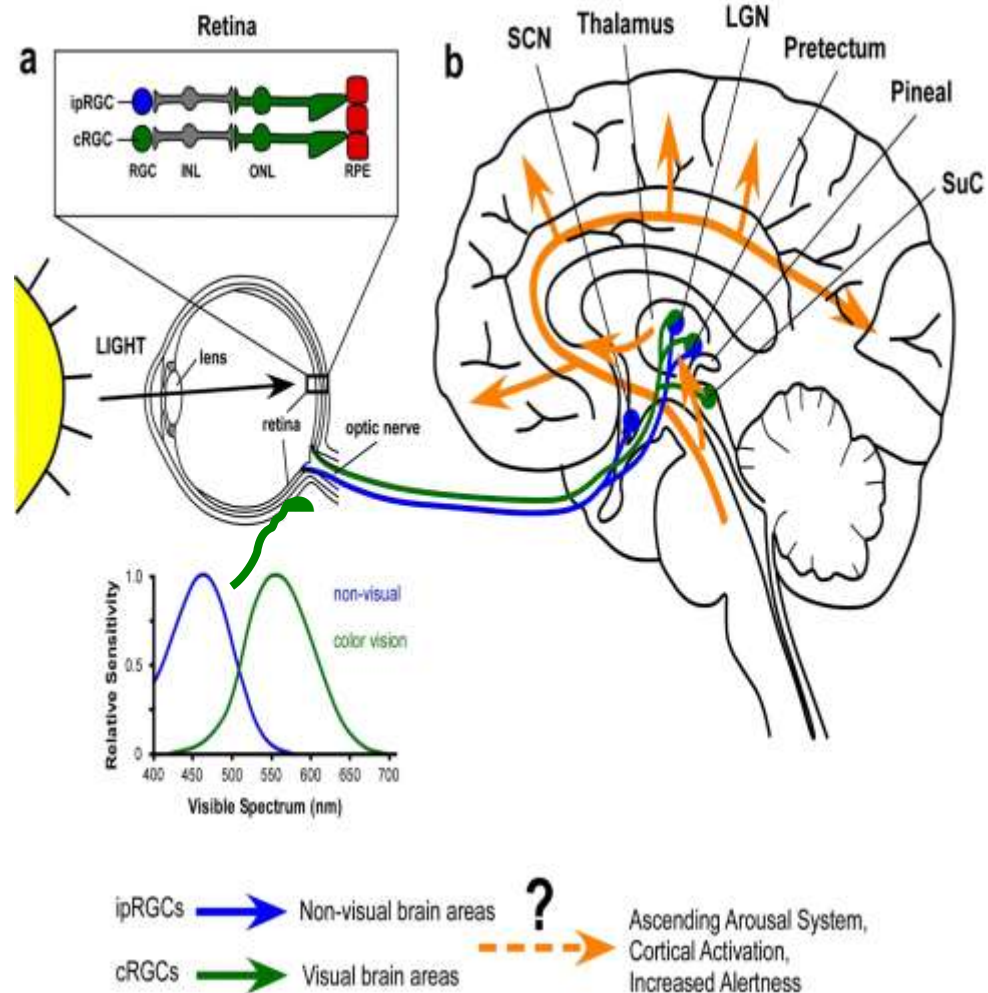


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Circadian Rhythmicity

- Regulates 10% of all human genes
- core body temperature
- sleep/wake cycle
- physical activity
- hunger and appetite
- metabolism
- hormone production (e.g., melatonin)
- expression of the circadian genes
- Immune adjunct



Adapted from Lockley & Gooley, Curr Biol 2006



The effect of reduced street lighting on road casualties and crime in England and Wales: controlled interrupted time series analysis

- Steinbach R, et al. J Epidemiol Community Health 2015;69:1118–1124. doi:10.1136/jech-2015-206012
- s This study found little evidence of harmful effects of switch off, part-night lighting, dimming, or changes to white light/LEDs on road collisions or crime in England and Wales
- Despite using 14 years of data on road traffic collisions in 62 local authorities, we found no convincing evidence for associations between street lighting adaptations and road traffic collisions.

Street Lighting and Road Safety

The Royal Society for the Prevention of Accidents, May 2018

- The latest evidence concluded that there was no evidence of an association between reduced lighting and nighttime collisions across England and Wales.
- Surveys have shown that the public are in favor of street lighting as a way of improving road safety and that, if anything, it needs to be improved in some areas.
- Misconception and bias among the public

BRIGHTER STREET LIGHTS CAUSE MORE ACCIDENTS

Marchant P, et al. J Epidemiol Community Health 2020;0:1–6. doi:10.1136/jech-2019-212208

- Brighter LED street lights don't prevent accidents – in fact they may do more harm than good, according to a prominent statistician, who says the accepted science on street lighting is wrong.
- No evidence was found for bright lamps leading to an improvement in road safety in any of the analyses. For this city, introducing brighter road lighting may have compromised safety rather than reducing harm.

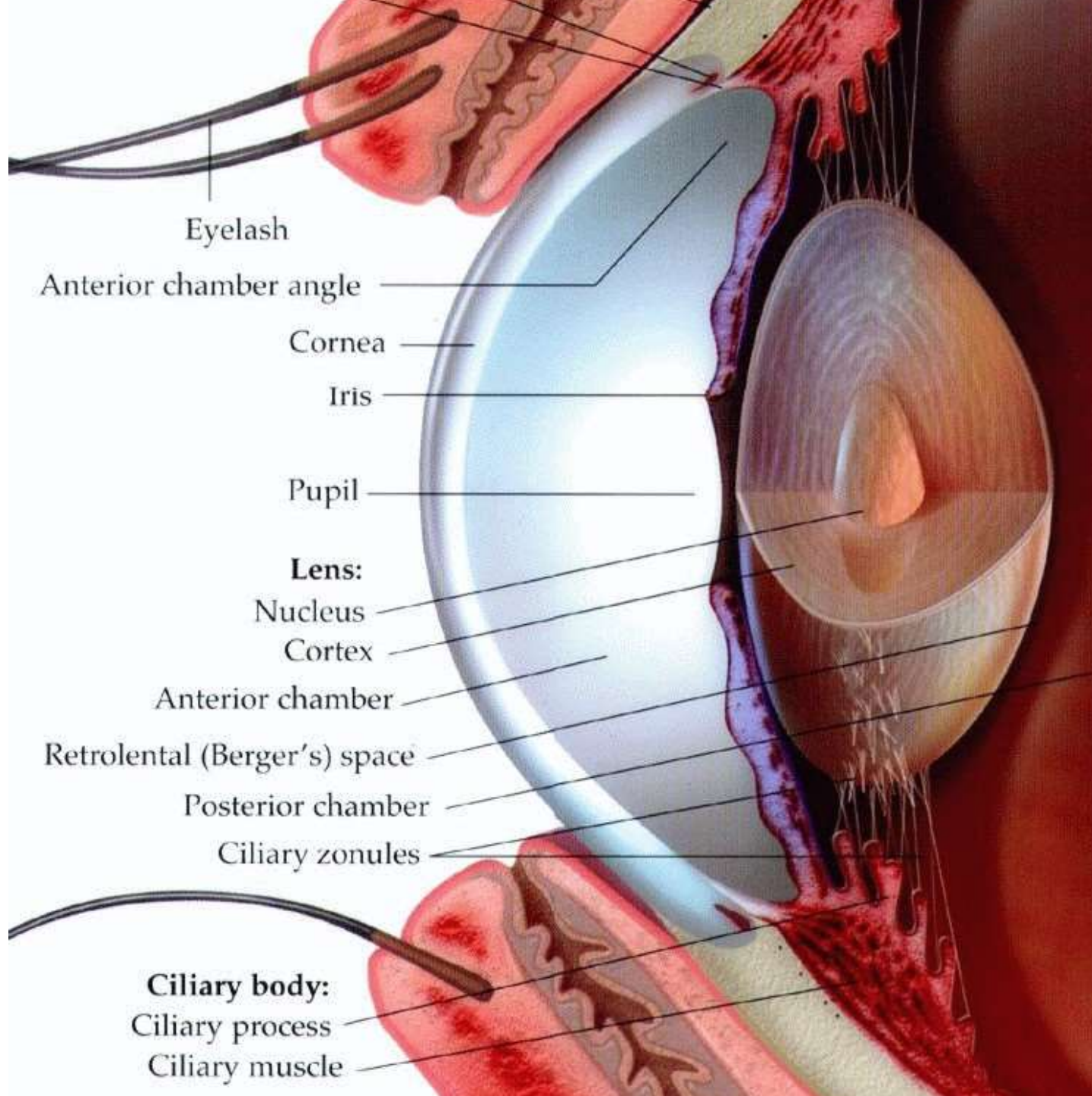
Normal, clear lens



Lens clouded by cataract



A cataract is an opacity of the normally clear lens which may develop as a result of aging, metabolic disorders, trauma or heredity



Eyelash

Anterior chamber angle

Cornea

Iris

Pupil

Lens:

Nucleus

Cortex

Anterior chamber

Retrolental (Berger's) space

Posterior chamber

Ciliary zonules

Ciliary body:

Ciliary process

Ciliary muscle

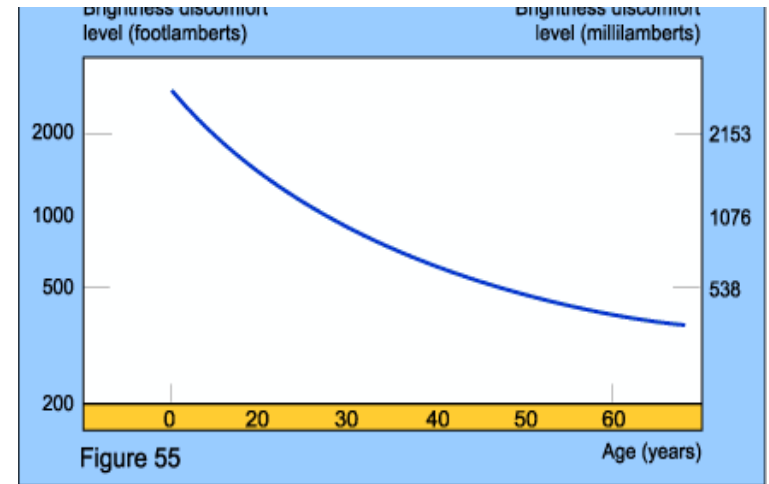
Medical Perspective

GLARE Response: Disability and Discomfort

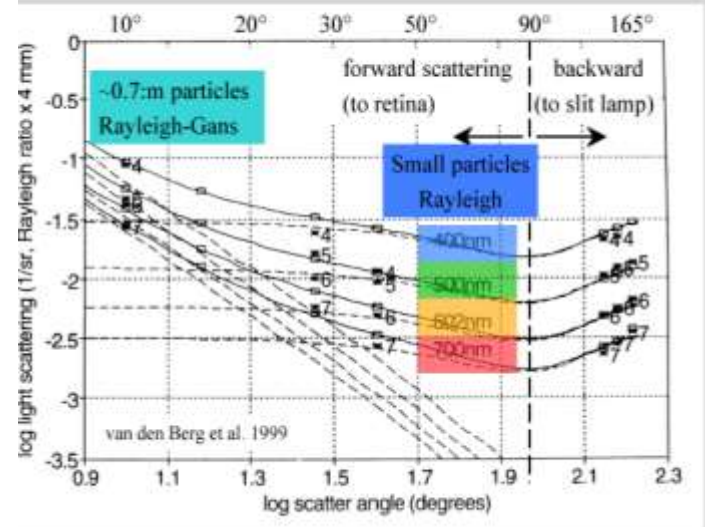
Physical and central nervous system response to light induced ocular stress

Photostress response involving:

- Sympathetic and parasympathetic Pupillary light reflex
- Blink reflex
- Accommodation –convergence reflex
- Miosis
 - ✓ Reduction in situational awareness
 - ✓ Potential for loss of balance and concentration
 - ✓ Age related impacts



Light scattering by isolated donor lenses (here 50 year old donor)



Visual function disturbance by retinal straylight

A typical situation in traffic: blinding by headlights of oncoming cars.

Young and healthy, $\log(s)=1.0$



Corneal haze or early cataract,
 $\log(s)=1.6$





LIGHTING OWNED
AND MAINTAINED BY
CITY OF
GLOUCESTER

19
LED



Detection Distance vs. SPD & Offset

There was no difference in mean detection distances among the different lighting types for the pedestrians stationed closest to the roadway.

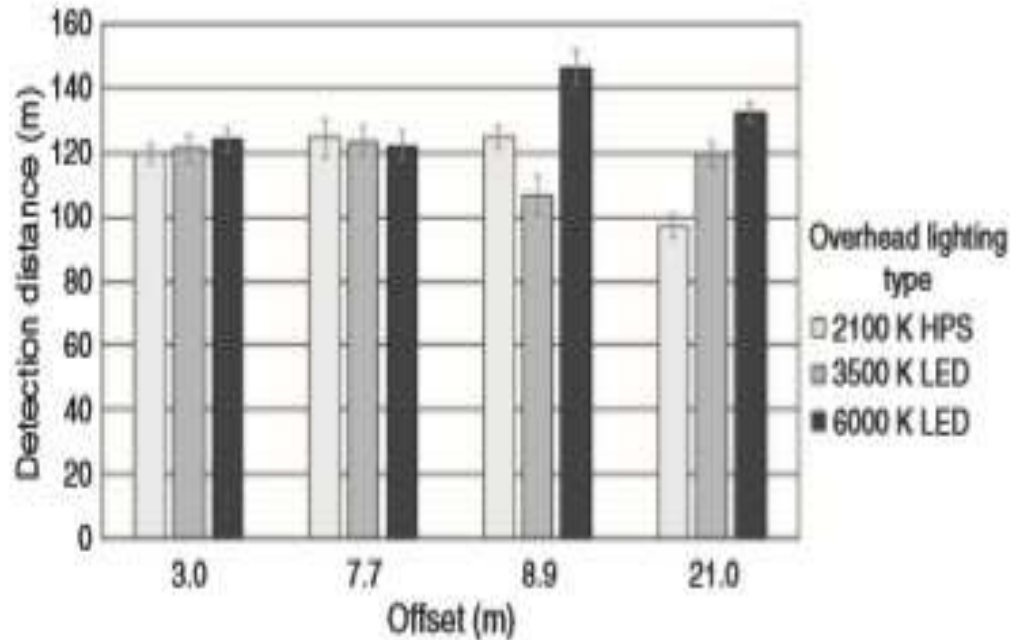
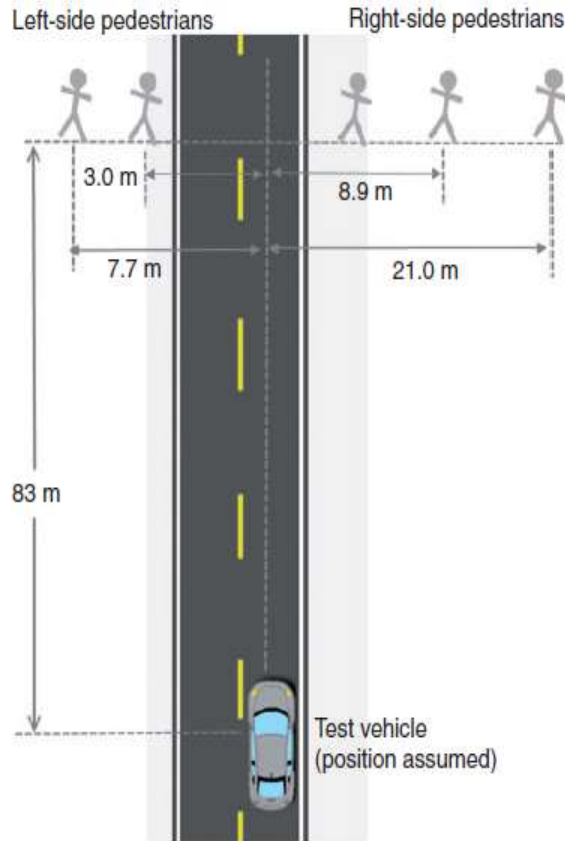


Figure 2. Pedestrian positions and offsets from the roadway

Applicability of mesopic factors to the driving task
Lighting res technology 2016 48(1):70-82

Alan Lewis, Ron Gibbons, et al



- **Panel Paper: Bright Lights, Safe Nights? the Effect of LED Street Lights on Crime in Los Angeles**

- November 9, 2018
- Coolidge - Mezz Level (Marriott Wardman Park)
- **Anthony R Harding** and Christopher Blackburn, Georgia Institute of Technology
-
- Our preliminary results indicate the elasticity of property crime rates with respect to LED intensity is 0.1. So, a 1% increase in the intensity of LEDs corresponds to a 0.1% *increase* in property crime rates.

- **Chicago Alley lighting project: Final report**

- April, 2000
- E Murrow, S Hutton, Research and Analysis Unit
- Illinois Criminal Justice Authority and University of Chicago

Myths of Outdoor Lighting

Myth: “Security Lighting reduces crime in urban outdoor areas.” : CALP

The “Chicago Alley Lighting Project” In multiple steps, the city:

- “upgraded & improved” the city’s 175,000 streetlights, which illuminate the arterial & residential streets.
- repaired & upgraded the lighting in & around viaducts and in Chicago Transit Authority stations.
- boosted lighting levels in alleys across the city.

The plan increased the alley lighting from 90 Watt bulbs to 250 Watts.

The intent of the program was to *increase feelings of safety and decrease crime in the alleys.*

Street lighting may enable rather than hinder street crime

30 March 2022

[Absence of street lighting may prevent vehicle crime, but spatial and temporal displacement remains a concern](#) in *Journal of Quantitative Criminology*

- Dr Edwards continued: “We didn’t set out to find the reasons for the observed changes, but it is possible that when lighting is switched off after midnight, offenders consider that the costs of committing a crime, such as using a torch, would likely raise suspicion among residents and risk being witnessed, outweigh the benefits.
- “When lighting is switched off after midnight the streets are likely to be in near darkness, which means that any would-be offenders may find it challenging to see if there are any valuable goods left unsecured in vehicles, so offenders may choose to move elsewhere to fulfil their intentions.”

Cities requiring 3000K or lower

- New York City
- Chicago
- San Francisco
- Los Angeles
- San Diego
- Tucson
- Phoenix
- Toronto **AMA compliant lighting**
- Montreal
- Davis
- Recently Seattle, Pittsburgh changing out old 4000K



Why all the debate when citizens prefer warmer light at night?

2009 AMA Council of Sciences and Health Resolution

Excessive light pollution comprises an inefficient use of energy and is a public health hazard for drivers, as well as an environmental disruption for several species.

AMA Policy – H27-135.932

Advocates for light pollution control and reduced glare from (electric) artificial light sources to both protect public safety and conserve energy

RESOLVED That our AMA develop and enact a policy that supports light-pollution reduction efforts and glare-reduction efforts at both the national and state levels; and be it further

RESOLVED That our AMA support that all future streetlights will be of a fully shielded design or similar non-glare design to improve the safety of our roadways for all, but especially vision impaired and older drivers.



2012 AMA CSAPH Rep. 4-A-12. "Light Pollution: Adverse Health Effects of Nighttime Lighting". Action of the AMA House of Delegates 2012 Annual Meeting: Council on Science and Public Health Report 4 Recommendations.

David Blask, PhD,
MD
Tulane

George Brainard,
PhD
Thomas Jefferson

Ronald Gibbons,
PhD
Virginia Tech

Steven Lockley, PhD
Harvard

Richard Stevens,
PhD
Univ Connecticut

Mario Motta, MD
Tufts

- **Supports the need for developing and implementing technologies to reduce glare from vehicle headlamps and roadway lighting schemes and developing lighting technologies at home and at work that minimize circadian disruption**
- Recognizes that exposure to excessive light at night, including extended use of various electronic media, can disrupt sleep or exacerbate sleep disorders, especially in children and adolescents. This effect can be minimized by using dim red lighting in the nighttime bedroom environment.
- Alerts public of the potential dangers of LAN on multiple health issues
- Supports the need for further multidisciplinary research on the risks and benefits of occupational and environmental exposure to light-at-night. That work environments operating in a 24/7 hour fashion have an employee fatigue risk management plan in place.
- Suggests using lower blue emission lighting
- 134 peer reviewed references



Human and Environmental Effects of Light Emitting Diode (LED) Community Lighting, 6/2016, CSAPH

AMA Policy:

- That our American Medical Association (AMA) support the proper conversion to community-based Light Emitting Diode (LED) lighting, which reduces energy consumption and decreases the use of fossil fuels. (New HOD Policy)
- That our AMA encourage minimizing and controlling blue-rich environmental lighting by using the lowest emission of blue light possible to reduce glare. (New HOD Policy)
- **That our AMA encourage the use of 3000K or lower lighting for outdoor installations such as roadways. All LED lighting should be properly shielded to minimize glare and detrimental human and environmental effects, and consideration should be given to utilize the ability of LED lighting to be dimmed for off-peak time periods. (New HOD Policy)**





RECOMMENDED PRACTICE FOR DESIGN AND MAINTENANCE OF ROADWAY AND PARKING FACILITY LIGHTING



Light Pollution and Cancer

William H. Walker, et al, Int. J. Mol. Sci. 2020, 21, 9360; doi:10.3390/ijms21249360

- exposure to artificial light at night (ALAN) is associated with several disorders, including increased incidence of cancer, metabolic disorders, and mood disorders
- Review article, multiple studies reviewed
- Several key processes involved in cancer growth are governed by circadian rhythms and there is a clear bidirectional relationship between circadian rhythms and cell division. Disruption of circadian rhythms influences oncogenesis. Indeed, clinical studies demonstrate a significant association between ALAN and breast cancer, and a modest relationship between ALAN and other cancers

The Influence of Melatonin on Immune System and Cancer

Anna Gry Vinther and Mogens H. Claesson

. Int J Cancer Clin Res 2015, 2:4

- Melatonin has been shown to play a fundamental part in neuro immune modulation. Besides regulating the circadian rhythm it works as a natural antioxidant with immune stimulatory and anti-cancer properties. Melatonin is a regulator of hemopoiesis and modifies various cells and cytokines of the immune system.

Melatonin elicits oncostatic properties in a variety of different tumor cells. A number of studies have documented that melatonin, given in combination with chemotherapy to patients with disseminated disease, increases the overall survival and reduces toxic side effects

Light at night and risk of breast cancer: a systematic review and dose–response meta- analysis

Urbano et al. *Int J Health Geogr* (2021) 20:44 [https://doi.org/10.1186/s12942-021-00297-](https://doi.org/10.1186/s12942-021-00297-7)

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- We performed a systematic review of epidemiological evidence on the association between LAN exposure and breast cancer risk, using a dose–response meta-analysis to examine the shape of the relation. We retrieved 17 eligible studies through September 13, 2021
- The dose–response meta-analysis, performed only in studies investigating outdoor LAN using comparable exposure assessment, showed a linear relation up to 40 nW/cm² /sr after which the curve fattened, especially among premenopausal women. This assessment of the dose–response relation between LAN and breast cancer supports a positive association in selected subgroups, particularly in premenopausal women.

- Comprehensive Longitudinal study 1989 – 2013
- 110K women NURSES STUDY
- Women exposed to the highest levels of outdoor light at night—those in the top fifth—had an estimated **14% increased risk of breast cancer** during the study period, as compared with women in the bottom fifth of exposure...As levels of outdoor light at night increased, so did breast cancer rates.- <https://www.hsph.harvard.edu/news/press-releases/outdoor-light-night-breast-cancer/>
- The study found a direct relationship between a woman's neighborhood nighttime light level before diagnosis and her later risk of developing breast cancer: The higher the light level, the higher the risk. These findings held even when taking into account many other factors that may also affect risk such as age, number of children, weight, use of hormone medications and a long list of additional potential confounders.

Peter James, Kimberly A. Bertrand, Jaime E. Hart, Eva Schernhammer, Rulla M. Tamimi, Francine Laden, Outdoor (2017) **Light at Night and Breast Cancer Incidence in the Nurses' Health Study II,** *Environmental Health Perspectives*, August doi: 10.1289/EHP935

Mario Motta, US



Evaluating the Association between Artificial Light-at-Night Exposure and Breast and Prostate Cancer Risk in Spain (MCC-Spain Study), Environmental Health Perspectives, April 2018

Qian Xiao, Peter James, Patrick Breheny, Peng Jia, Yikyung Park, Dong Zhang, Jared A. Fisher, Mary H. Ward, Rena R. Jones. Outdoor light at night and postmenopausal breast cancer risk in the NIH-AARP diet and health study. *International Journal of Cancer*, 2020; [USA](#)

Kloog, I., A. Haim, R. G. Stevens, M. Barchana, and B. A. Portnov. 2008. Light at night co-distributes with incident breast but not lung cancer in the female population of [Israel](#). *Chronobiology International* 25:65–81.

Kloog, I., A. Haim, and B. A. Portnov. 2009. Using kernel density function as an urban analysis tool: investigating the association between nightlight exposure and the incidence of breast cancer in [Haifa, Israel](#). *Computers, Environment and Urban Systems* 33:55–63.

Kloog, I., R. G. Stevens, A. Haim, and B. A. Portnov. 2010. Nighttime light level co-distributes with breast cancer incidence worldwide. *Cancer Causes & Control* 21:2059–2068.

Li Q, Zheng T, Holford TR, Boyle P, Zhang Y, Dai M. Light at night and breast cancer: results from a population-based case-control study in [Connecticut, USA](#). *Cancer Causes Control*. 2010;21:2281-2285.

Rybnikova N, Haim A, Portnov BA. 2015. Artificial light at night (ALAN) and breast cancer incidence [worldwide](#): A revisit of earlier findings with analysis of current trends. *Chronobiol Int* 32(6):757–773,

Keshet-Sitton A, Or-Chen K, Huber E, Haim A. 2016a. Illuminating a risk for breast cancer: A preliminary ecological study on the association between streetlight and breast cancer. *Integr Cancer Ther*,

Anbalagan M, Dauchy RT, Xiang S, et al. Disruption of the circadian melatonin signal by dim light at night promotes bone-lytic breast cancer metastases. Presented at: ENDO 2019; March 23-26, 2019

Kim YJ, Lee E, Lee HS, Kim M, Park MS. 2015. High prevalence of breast cancer in light polluted areas in urban and rural regions of [South Korea](#): An ecologic study on the treatment prevalence of female cancers based on National Health Insurance data. *Chronobiol Int* 32(5):657–667,

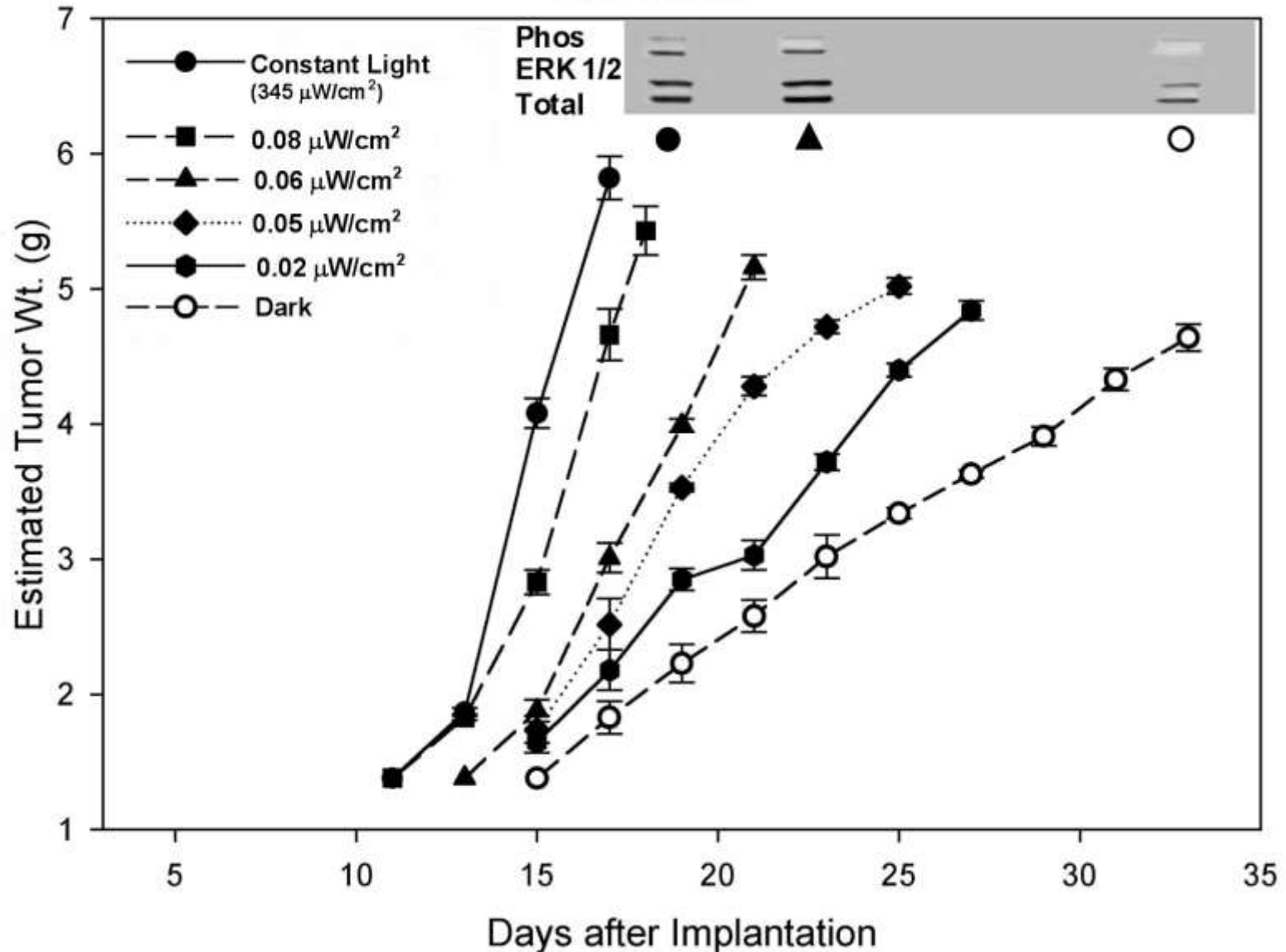
Mario Motta, US

One negative study from Canada has been published (Ritonja, 2020), possibly explained by higher use of blackout shades for northern summer sleeping. "Outdoor light at night at residences and breast cancer risk in [Canada](#)." *European Journal of Epidemiology* (2020)1-11



GROWTH RATES vs. LIGHT INTENSITY FOR HUMAN BREAST CANCER XENOGRAFTS

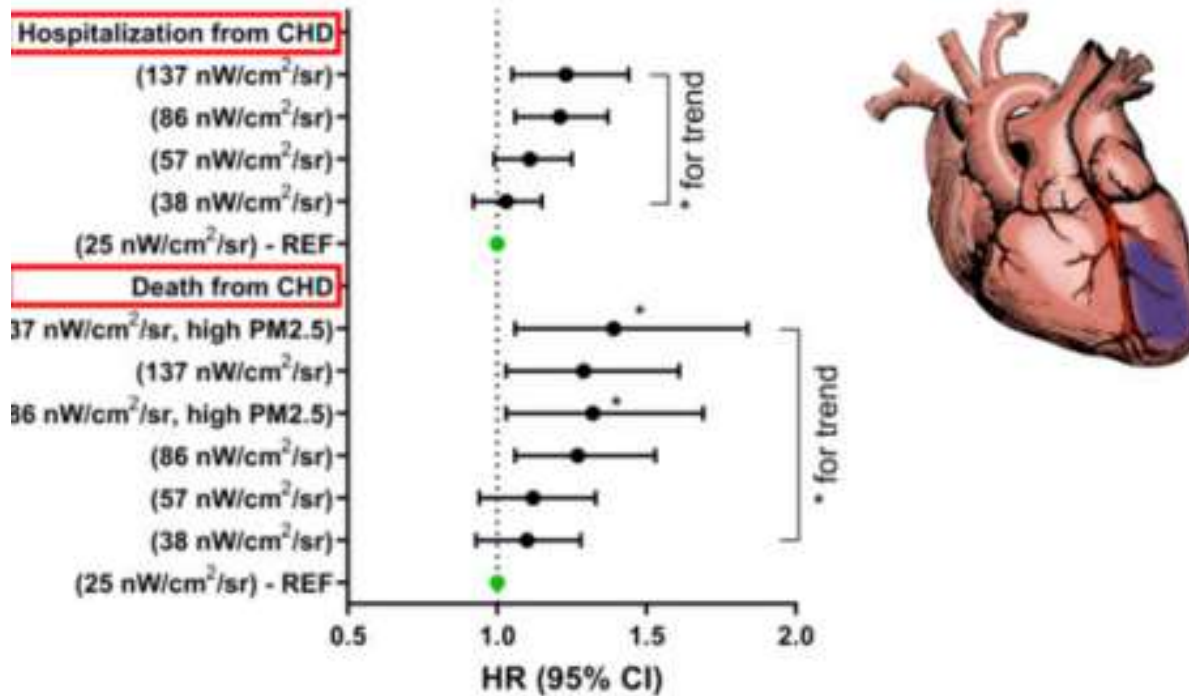
Blask et al, Tulane



The dark side of nocturnal light pollution. Outdoor light at night increases risk of coronary heart disease

Thomas Munzel et al, *European Heart Journal* (2021) 42, 831–834 EDITORIAL doi:10.1093/eurheartj/ehaa866

The impact of nocturnal light exposure on cardiovascular risk



Environmental Impacts from LAN

- Plants (trees, soy beans, budding, crop yields)
- Insects (reproduction, disruption, pollination)
- Birds (migration, foraging, sleep cycle disruption)
- Fish(predation, reproduction and life cycle disruptions)
- Faint skyglow affects 60% invertebrates, 30% vertebrates

“If a lighting environmental effect on a particular species has not yet been documented its probably because it has not yet been studied. In every case where a study has been performed, an effect has been determined !!” *Nature, Jan 16,2018, Travis longcore*



Blue light at night is bad for wildlife



Nocturnal pollinators go dark under street lamps

Plants illuminated by artificial lights see a drop in the number of insects that move pollen at night.

Jason Bittel

02 August 2017

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Disruptions to night-time pollination activities could also harm day-time pollinators such as bees and butterflies.

Researchers study effects of artificial light on fireflies

August 4, 2016 by Farisa Samarai



Fireflies are a summertime staple, a magical element in many childhoods. But the numbers of "lightning bugs" appear to be dropping. A UVA study is examining whether their ancient signals might be lost in the glare of artificial lighting. Credit: University of Virginia



QUESTIONS ?

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<https://zenodo.org/record/5874725#.YlR-xcjMIpd>