

Healthy Lifestyle Tips to Minimize Chronodisruption By Light Exposure at Night

(from Paula Witt-Enderby, Ph.D.)

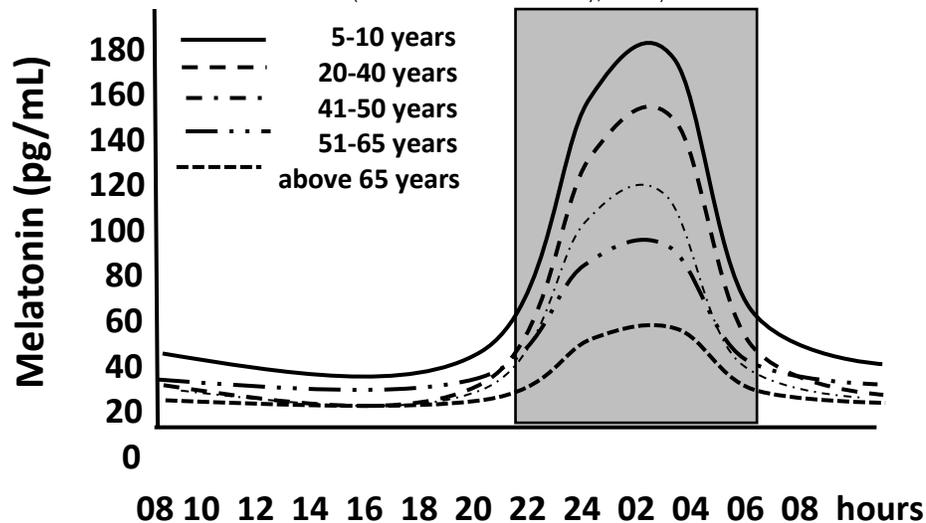


Figure Adapted from J Physiol Pharmacol. 2006 Nov;57 Suppl 5:19-39

Main points:

- (1) As shown in the graph above, melatonin is synthesized and secreted during the hours of darkness (between 2200-0600h). Light inhibits melatonin synthesis and release from the pineal gland whereas a darkness stimulates melatonin production and release from the pineal gland. With age, peak nocturnal levels of melatonin decline and in some elderly individuals there is no discernable nocturnal melatonin peak. This may explain why the elderly have difficulty sleeping (wake up too early or have short sleep duration) (Lassila et al., 2014; Maria and Witt-Enderby 2017; Witt-Enderby et al., 2012).
- (2) Besides age, light exposure at night decreases these nocturnal melatonin peaks. Even light that we cannot see is enough to suppress these melatonin rhythms in our bodies. This can come from the moon (especially a full moon), our street lights, skies, light bulbs (we have moved away from incandescent bulbs which mainly emit low level yellow wavelengths to higher intensity lamps that emit mostly high intensity blue/violet wavelengths=459nm). It is estimated that 90% of people use some form of electronic device within one hour of bedtime (e.g., cell phones, tablets, computers, television sets, etc.) (Navara and Nelson, 2006). Even 39 minutes of usage can significantly suppress melatonin levels (Bedrosian et al., 2016). To minimize light-induced melatonin suppression at night:
 - a. Wear a light fitting eye mask (especially from 11am-5am). They are cheap (\$2-\$3).
 - b. Close your shades at night to minimize light exposure from street lights and the skies
 - c. Filter blue light on your devices. There are many free downloadable apps on the web.
 - d. Remove nightlights, rock salt lamps or any other light-emitting device in the bedroom
 - e. If you watch TV, set a timer so it turns off before midnight.
- (3) Increase daytime exposure to natural lighting. According to US and Canadian population-based surveys, people spend about 12% of their time outdoors (1-2.4h during the summer months and only 0.4-1.3h during winter months no matter where one lives) (Cole et al., 1995, Hubert et al., 1998, Diffey, 2011).
- (4) Have regular mealtimes and finish eating 2 hours before bed. Circadian regulation of the microbiome occurs that is driven by the master biological clock (SCN) where microbial proximity to mucosal surface was highest during the dark phase. Disruption of the circadian clock in the brain disrupts the circadian rhythm of the microbiome. Scheduled feeding restored these rhythms to the dark phase (Thaiss et al., 2016). In a rodent model, melatonin prevented obesity through the modulation of gut microbiota. Melatonin improved metabolic parameters in this model and reduced low grade inflammation, in part, by decreasing the bacteria in the gut responsible for inflammation. Melatonin is synthesized in the GI tract and it is thought that through its antioxidant and free radical scavenging properties, melatonin protects the integrity of the mucosal lining.
- (5) Reduce stress in your life. Humans display rhythmic patterns of cortisol where levels are highest in the early morning (~8am). The SCN (master biological clock) is primarily responsible for driving the diurnal rhythms of cortisol. Cortisol and melatonin levels are inversely related (i.e., when melatonin levels are high, cortisol levels are low and when melatonin levels are low, cortisol levels are high). Shift work, sleep deprivation, workplace lighting (absence of windows) can elevate nighttime and daytime cortisol levels (Bedrosian et al., 2016).

Lifestyle Goals: You want to *increase* your light exposure during the hours of light and *minimize* your light exposure during the hours of darkness. This helps to keep our circadian clock in the brain in sync with the light/dark cycle and will maintain appropriate circadian rhythmicity in peripheral organs like the adrenal glands, bone, liver, and microbiota to keep us healthy.

References (used for Healthy Tips and in Podcast)

- AMSTRUP, A.K. et al., 2015. Melatonin improved bone mineral density at the femoral neck in postmenopausal women with osteopenia: a randomized controlled trial. *J Pineal Research*, 59(2), 221-229.
- AMSTRUP, A.K. et al. 2016. Reduced fat mass and increased lean mass in response to 1 year melatonin treatment in postmenopausal women: A randomized placebo-controlled trial. *Clinical Endocrinology*, 84(3), 342-347.
- BEDROSIAN, T. A. et al., 2016. Endocrine effects of circadian disruption. *Annual review of physiology*, 78, 109-131.
- BLASK, D. E. et al., 2005. Melatonin-depleted blood from premenopausal women exposed to light at night stimulates growth of human breast cancer xenografts in nude rats. *Cancer Res*, 65, 11174-84.
- COLE, R. J. et al., 1995. Seasonal variation in human illumination exposure at two different latitudes. *J Biol Rhythms*, 10, 324-34.
- DIFFEY, B. L. 2011. An overview analysis of the time people spend outdoors. *British Journal of Dermatology*, 164, 848-858.
- DAUCHY, R.T. et al, 2014. Circadian and melatonin disruption by exposure to light at night drives intrinsic resistance to tamoxifen therapy in breast cancer. *Cancer Research*, 74(15): 4099-4110.
- FESKANICH, D. et al., 2009. Nightshift work and fracture risk: the Nurses' Health Study. *Osteopor Int*, 20, 537-42.
- HUBERT, M., DUMONT, M. & PAQUET, J. 1998. Seasonal and diurnal patterns of human illumination under natural conditions. *Chronobiology International*, 15, 59-70.
- KIM, B. K. et al, 2013. Other than daytime working is associated with lower bone mineral density: the Korea National Health and Nutrition Examination Survey 2009. *Calcified tissue international*, 93, 495-501.
- KOTLARCZYK, M. P. et al., 2012. Melatonin osteoporosis prevention study (MOPS): a randomized, double-blind, placebo-controlled study examining the effects of melatonin on bone health and quality of life in perimenopausal women. *J Pineal Res*, 52, 414-426. <http://onlinelibrary.wiley.com/doi/10.1111/j.1600-079X.2011.00956.x/abstract>
- LASSILA, H. et al., 2014. Alternative options to manage menopausal symptoms with a focus on melatonin and osteoporosis. *Clinical Pharmacology and Biopharmaceutics*-open access, Published February 12, 2014. <http://omicsgroup.org/journals/alternative-options-to-manage-menopausal-symptoms-2167-065X.1000115.php?aid=24059>
- MARIA, S. et al., 2017. Melatonin-micronutrients Osteopenia Treatment Study (MOTS): a translational study assessing melatonin, strontium (citrate), vitamin D3 and vitamin K2 (MK7) on bone density, bone marker turnover and health related quality of life in postmenopausal osteopenic women following a one-year double-blind RCT and on osteoblast-osteoclast co-cultures. *Aging*, 9 (1): 256-285, 2017. <http://www.aging-us.com/article/101158>
- MARIA, S. and Witt-Enderby, P.A. 2017 (in press). Circadian Regulation of Bone In *Circadian Rhythms and Their Impact on Aging*. Jazwinski, Belancio and Hill eds., Springer Publishing.
- NAVARA, K. J. & NELSON, R. J. 2007. The dark side of light at night: physiological, epidemiological, and ecological consequences. *Journal of pineal research*, 43, 215-224.
- OHAYON, M. M. & MILESI, C. 2016. Artificial Outdoor Nighttime Lights Associate with Altered Sleep Behavior in the American General Population. *Sleep*.
- PTITSYQUEVEDO, I. & ZUNIGA, A. M. 2010. Low bone mineral density in rotating-shift workers. *Journal of Clinical Densitometry*, 13, 467-469.
- REITER, R.J., et al, 2011. The photoperiod, circadian regulation and chronodisruption: the requisite interplay between the suprachiasmatic nuclei and the pineal and gut melatonin. *J Physiology and Pharmacology*, 62 (3):269-274.
- SMOLENSKY, M. H. et al., 2015. Nocturnal light pollution and underexposure to daytime sunlight: Complementary mechanisms of circadian disruption and related diseases. *Chronobiology international*, 32, 1029-1048.
- STEVENS, R. G. 2006. Artificial lighting in the industrialized world: circadian disruption and breast cancer. *Cancer causes & control*, 17, 501-507.
- THAISS, C.A. et al.. Microbiota diurnal rhythmicity programs host transcriptome oscillations. *Cell*, 167, 1495-1510, 2016.
- XU, P., et al., Melatonin prevents obesity through modulation of gut microbiota in mice. *J Pineal Research*, 2017 doi: 10.1111/jpi.12399
- WANG, K. et al., 2015. The associations of bedtime, nocturnal, and daytime sleep duration with bone mineral density i pre- and post-menopausal women. *Endocrine*, 49, 538-548.
- WITT-ENDERBY, P. A. et al., 2012. Effects on bone by the light/dark cycle and chronic treatment with melatonin and/or hormone replacement therapy in intact female mice. *J Pineal Res*.
- <http://www.medscape.com/medline/abstract/22639972>