

BETTER SLEEP STARTS WITH BETTER DAYLIGHT

A White Paper on Daylighting and Human Health

Introduction

We spend roughly one-third of our lives asleep - or trying to. Yet for millions of people, restful, restorative sleep remains frustratingly out of reach. We often blame stress, screen time, or caffeine. But one of the most powerful influences on sleep quality is something most of us never think about: the light in the buildings where we live and work.

Human beings evolved outdoors. For hundreds of thousands of years, our bodies were synchronized with the rising and setting of the sun — bright, energizing, blue-rich light during the day, and darkness at night. This ancient rhythm is encoded deep in our biology. Today, however, we spend an estimated 87 to 90 percent of our time indoors,¹ in homes and offices that often fail to provide enough natural daylight during the day while exposing us to too much static, electric light at night. This disconnect from our natural light environment is one-and often overlooked-potential contributor to the sleep challenges many people experience today.



How Light Controls Sleep

The body's internal 24-hour clock - the circadian rhythm - is located in a region of the brain called the suprachiasmatic nucleus (SCN). The SCN coordinates body temperature, hormone production, metabolism, immune function, and the sleep-wake cycle.² It relies on environmental cues to stay synchronized with the actual 24-hour day, and the most important of these cues, by far, is light.²

When light enters the eyes, it activates specialized photoreceptors, intrinsically photosensitive retinal ganglion cells (ipRGCs), that are particularly sensitive to the blue-rich light of the morning sky.³ These cells send a direct signal to the SCN, triggering a cascade of biological events: melatonin (the sleep hormone) is suppressed and replaced by increasing levels of serotonin, alertness increases, and body temperature begins to rise. Approximately 14 to 16 hours later, the SCN reverses course — serotonin wains and melatonin rises, body temperature falls, and the body prepares for sleep.⁴

This elegant rhythm works beautifully when it receives the right light signals. The problem is that modern indoor environments are profoundly mismatched with the light intensities and spectral content our circadian systems evolved to receive. Outdoor blue-rich daylight can reach 100,000 lux on a clear day; even an overcast sky provides 10,000 to 25,000 lux. Standard indoor lighting in homes and offices typically provides only 100 to 300 lux.² For many people, spending the day indoors provides the circadian system with a much weaker daytime light signal. Research suggests that getting enough daylight during the day makes us less susceptible to the sleep-disrupting effects of artificial light in the evening.⁵

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Why Sleep Quality Matters



Getting enough daylight during the day makes us less susceptible to the sleep-disrupting effects of artificial light in the evening.⁵

Chronic sleep deprivation - consistently getting less than the recommended 7 to 9 hours per night - is associated with a wide range of serious health consequences. People who sleep fewer than 6 hours per night have a significantly higher risk of hypertension, heart attack, and stroke.⁶ Chronic poor sleep disrupts the hormones that regulate hunger and metabolism, increasing the risk of obesity and Type 2 diabetes, and is both a symptom and a cause of depression and anxiety.⁷ Emerging research links it to an increased risk of dementia and Alzheimer's disease.⁷ Long-term poor sleep has been associated with a higher risk of premature mortality.⁸

The consequences extend beyond the individual. A RAND Corporation study estimated that a lack of sleep among the U.S. working population costs the economy up to \$411 billion per year in lost productivity.⁹ Harvard Medical School researchers estimated that insomnia alone costs the average U.S. worker \$2,280 (figure from 2011) in lost productivity every year.¹⁰

How Daylight in Buildings Supports Better Sleep

The connection between daylighting (the art and science of using daylight as a meaningful source for daytime interior illumination) and sleep quality has been directly studied in both residential and commercial settings. A small crossover field study published in the International Journal of Environmental Research and Public Health found that participants who had access to greater daylight in their homes showed improved circadian alignment, better sleep quality, and higher vitality scores compared to periods when their daylight access was reduced.¹¹ In the workplace, a small pilot study published in the Journal of Clinical Sleep Medicine found that office workers with access to windows slept an average of 46 minutes more per night than those without windows, and reported better sleep quality, more physical activity, and better overall quality of life.¹²



Morning light can be especially important for sleep timing. The timing of morning daylight exposure sets the timing of melatonin onset that evening. Bright light early in the morning causes melatonin to rise earlier in the evening, making it easier to fall asleep at a reasonable hour. Missing that morning light signal can delay melatonin onset, keeping individuals awake later and making it harder to wake up the next morning.⁴

Many buildings - whether dense urban homes, older construction, or commercial facilities with large interior footprints - have rooms that receive little to no natural daylight. Spending significant time in these dark spaces during the day means the circadian system is not receiving the light signals it needs for a healthy, optimal circadian response. Standard indoor lighting may not provide a strong daytime signal; access to natural daylight can help.

Practical Steps for a Better Sleep Environment

One impactful change is to ensure exposure to bright natural light within the first hours of the day. Orienting primary morning spaces - kitchens, breakfast areas, primary bathrooms - toward the east makes a meaningful difference. Where these spaces lack natural light, tubular daylighting devices (TDDs) can bring natural morning light directly into interior spaces that cannot be served by conventional windows or skylights.

Keeping interiors bright throughout the day reinforces the "daytime" signal to the circadian system. Identifying the dark zones in a building - the rooms that rarely receive natural light - and finding ways to bring daylight into them is a practical, lasting strategy for supporting a healthy luminous environment.



Project Spotlight

Residential Bedroom

A bedroom may be designed for sleep, but the daylight it receives during waking hours can also play an important role in supporting a healthy sleep-wake cycle. Solatube Tubular Daylighting Devices bring natural daylight into interior spaces that may receive limited light from windows, helping create a brighter daytime environment that changes naturally with outdoor conditions.

Greater exposure to daylight during the day helps reinforce the body's circadian rhythm - strengthening the distinction between bright days and dark nights that supports healthy sleep timing. By extending access to natural daylight deeper into the home, Solatube can help create an indoor light environment that works more closely with the body's natural daily rhythms.

As the sun sets, indoor electric lighting should shift to support melatonin production. Replacing bright, cool-toned (blue-rich) overhead lights with warm, amber-toned (red-rich) light after dinner, and installing dimmer switches, helps prepare the body for sleep. For commercial facilities that operate into the evening, tunable LED systems that automatically shift to warmer color temperatures and lower intensities can help support this transition. Finally, protecting the sleep environment from light at night - using blackout curtains and covering LED indicator lights on electronics - ensures that the circadian system receives the darkness signal it needs to complete the sleep cycle.

Conclusion

Better sleep does not start when we close our eyes at night. It starts the moment we wake up in the morning and take in that first breath of natural daylight. By aligning the light in our homes and workplaces with the natural cycle of the sun - bright and energizing during the day, warm and dim in the evening - we can work with human biology rather than against it. Bringing more natural daylight into the built environment as a meaningful source for daytime illumination is a practical, beautiful, and enduring investment in healthier indoor environments. It is not just about illuminating rooms; it is about illuminating lives.



References

1. Klepeis, N.E., et al. (2001). "The National Human Activity Pattern Survey (NHAPS)." *Journal of Exposure Analysis and Environmental Epidemiology*, 11(3), 231–252.
2. Blume, C., Garbazza, C., & Spitschan, M. (2019). "Effects of light on human circadian rhythms, sleep and mood." *Somnologie*, 23(3), 147–156. PMC6751071. <https://pmc.ncbi.nlm.nih.gov/articles/PMC6751071/>
3. Hattar, S., et al. (2002). "Melanopsin-containing retinal ganglion cells: Architecture, projections, and intrinsic photosensitivity." *Science*, 295(5557), 1065–1070.
4. St. Hilaire, M.A., et al. (2012). "Human phase response curve to a 1 h pulse of bright white light." *The Journal of Physiology*, 590(13), 3035–3045. <https://doi.org/10.1113/jphysiol.2012.227892>
5. Chang, A.M., Scheer, F.A.J.L., & Czeisler, C.A. (2011). "The human circadian system adapts to prior photic history." *The Journal of Physiology*, 589(5), 1095–1102. <https://doi.org/10.1113/jphysiol.2010.201194>
6. "About Sleep and Your Heart Health." Centers for Disease Control and Prevention. <https://www.cdc.gov/heart-disease/about/sleep-and-heart-health.html>
7. "Sleep Deprivation, Sleep Disorders, and Chronic Disease." Preventing Chronic Disease, CDC. 2023. https://www.cdc.gov/pod/issues/2023/23_0197.htm
8. Cappuccio, F.P., et al. (2010). "Sleep duration and all-cause mortality: A systematic review and meta-analysis of prospective studies." *Sleep*, 33(5), 585–592. <https://doi.org/10.1093/sleep/33.5.585>
9. Hafner, M., et al. (2017). Why Sleep Matters—The Economic Costs of Insufficient Sleep: A Cross-Country Comparative Analysis. RAND Corporation. <https://doi.org/10.7249/RR1791>
10. Kessler, R.C., et al. (2011). "Insomnia and the performance of U.S. workers: Results from the America Insomnia Survey." *Sleep*, 34(9), 1161–1171. <https://doi.org/10.5665/SLEEP.1230>
11. Nagare, R., et al. (2021). "Access to Daylight at Home Improves Circadian Alignment, Sleep, and Mental Health in Healthy Adults: A Crossover Study." *International Journal of Environmental Research and Public Health*, 18(19), 9980. PMC8507741.
12. Boubekri, M., et al. (2014). "Impact of Windows and Daylight Exposure on Overall Health and Sleep Quality of Office Workers." *Journal of Clinical Sleep Medicine*, 10(6), 603–611. PMC4031400.



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