

A REVIEW FOR UNDERSTANDING THE EFFECTS OF DAYLIGHT EXPOSURE ON THE OCCUPANTS OF DIFFERENT SPACES

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ABSTRACT

This investigation aims to analyze the existing literature on how daylight exposure affects the sleep quality of occupants of different workspaces. Even though several earlier investigations on the potential connection between daylight exposure and sleep quality have been carried out, it is either risky or premature to draw any conclusions. The approach utilized in each of the understudied publications will be examined to identify the common elements and processes for developing standardized criteria. Although sleep quality depends on a variety of personal characteristics. This investigation aims to explore affects of how productive users of various workplaces are. The main goal of this study was to identify the most popular approach and assess the necessity for additional characteristics to ensure that further investigation of this enormous issue is as precise as feasible.

Keywords: Sleep Quality, Circadian Cycle, Occupants of Workspaces, Performance.

INTRODUCTION

Retinal light has a great impact on people's health and performance as it sets off the brain's circadian clock. The time of the circadian rhythm, which forces us all to sleep every night and stay awake during the day in synchrony with the Planet's 24-hour rotating movement, is determined by the regular pattern of darkness and light striking our retinas. The body's circadian clock operates for a little longer than 24 hours when there is constant darkness. (Mariana Figueiro, 2017). For the biological clock to advance and align with the planet's local time, there must be consistent dawn light. (Mariana Figueiro, 2017)

Many employees over the globe work in cramped quarters or basements, with little daylight, such as subway operators, industrial labourers, and office employees. Such a group

develops tiredness in this manner, which immediately contributes to feeling wearier throughout the day, the formation of mood changes, or impaired functioning and drowsiness (Ohayon, 2002). Deprivation of sunlight is also recognized as a prevalent cause of sleeping difficulties in a large number of office workers. For instance, one out of every five employees in industrialized nations works late at night, and it has been widely established that night-shift employment significantly influences time and tiredness (Akertedt Kecklund, 2007).

Hypersomnia is described as the regular occurrence of bouts of drowsiness throughout daily living, affecting 4% to 6% of the general public in extreme conditions and 15% to 20% in moderate form. (Damien Leger, 2011). According to patients, the most serious issue

with sleep problems is not the lack of sleep but the impact on daily productivity and the aggravation of other chronic diseases (Damien Leger, 2011). Previous research has shown that office environment illumination during work hours can influence circadian behaviour biology, with blue-enriched artificial lighting systems competing with natural sunshine as an entertainer. Given that entertainer hours occur during physiologically typical daylight hours, we expect that exposure to light in the office setting will affect sleep, and hence health and well-being through sleep and other reasons (Mohamed Boubekri, 2014).

The study aims to understand the effects of daylight exposure on the sleep quality of occupants of different workspaces and how daylight affects their performance and their mood in the indoor environment. (Javiera Morales-Bravo, 2022). This will be done by examining and comparing the existing literature and experiments done by multiple researchers and scholars. The biological clock and the cycle of sleep and wakefulness are both well synchronized by light. Those who are blind have greater sleep interruptions than those who are healthy-sighted. However, it has never been investigated if visually capable individuals who are not exposed to intense natural light experience sleep-waking. (Francine Harb, 2015).

REVIEW OF LITERATURE

Indoor Spaces and Daylight Exposure:

Light from the sun is another form of visible electromagnetic radiation. Although there are electric light sources that can perfectly replicate the spectrum of daylight, none have been created to mimic the variations in the spectrum that occur with daylight at various times of the day, seasons, and weather conditions (Peter Boyce, 2003). The performance of activities that are constrained by visibility is determined by the stimuli that the task presents to the visual system and by the state of that system's activity. Natural light and artificial light are not inherently preferable when evaluating either of these factors (Shah et al., 2023). However, daylight has a greater chance of enhancing visual performance than other types of electric lighting since it is delivered in large amounts and has a spectrum that offers excellent colouring. (Peter Boyce, 2003).

The process of using windows and skylights to let light into a building's envelope is known as natural lighting. Additionally, the definition of the daylight factor is the proportion of horizontal interior to outside illumination provided by daylight under conditions of continuously overcast skies. (Mohamed Boubekri, 2014). Interior daylight brightness is affected by several factors, including location, direction, day and time, sky cover, room geometry, window size, and the presence of shadow. It is hard to make adjustments after the fact, so making the right decisions regarding room geometry and window size, in particular, becomes crucial during the early design process. Building daylighting is governed by regulations in several buildings (Amirazar, 2021). These standards may be set up in several buildings on the amount of light, the size of the window, and the daylight factor. The planet's population accomplished a significant milestone in 2008 when more than half of its inhabitants relocated to urban areas. Even while this trend will continue until 2050, when urban regions will house 80% of the world's population, this transition has undoubtedly contributed to the unprecedented increase in our urbanization. As civilizations become increasingly more urban, people spend an increasing amount of time indoors, frequently spending 90% of their time indoors. (Francesco P Cappuccio, 2010). Daylight is a key element of how we perceive our internal surroundings throughout the day, making it a great choice for affecting our psychological reaction when we are at home. According to some studies, several characteristics of indoor lighting have an impact on how people perceive interior spaces and how they feel when using them. (KÖSE, 2019). The majority of buildings have facade openings that let in air, daylight, and views. Even though a total glass façade cannot provide the best daylighting, the occupants' comfort and energy efficiency must be taken into account. Especially on the side. Especially making up the bulk of rooms with daylighting, daylighting solutions may need to be developed to maximize the day. (KÖSE, 2019).

According to Odabasioglu & Olguntürk 2015, varying colours of illumination alter individuals' perceptions of relaxation, including white and green-lit environments perceived as giving much greater satisfaction to interior settings than red-lit

places. Daylight is an important factor of design, with Le Corbusier acknowledging that architectural factors impact the daylighting qualities of the interior of the building (Javiera Morales-Bravo, 2022).

Human health, comfort, performance, and well-being are all influenced by light, which is a crucial component of architectural design. Over millions of years, the daily rhythms of human behaviour and physiology—such as wake behaviour and sleep—have developed in response to the cycles of natural light and darkness. Today, we are exposed to less light during the day and more light at night since we spend a lot of time in the constructed environment. (Amirazar, 2021). During the night, we are given longer hours than we would have ordinarily had during the day. Also, this natural cycle can be adversely affected by inappropriate and insufficient personal light exposure throughout the day and at night, which is linked to many psychological, and behavioural health problems. (Amirazar, 2021).

This natural cycle can be adversely affected by inappropriate and insufficient personal light exposure throughout the day and at night, which is linked to several psychological, physical, and health problems. The time of the behavioural clock is synchronized by light, which has an impact on our health and sense of well-being in addition to being necessary for clear and efficient vision. (Christine Blume, 2019). The structure serves as a vehicle to encourage comfort, productivity, and health in relation to light. The discovery of the impacts of light and the resurgence of interest in the idea of human-centric lighting during the past 20 years have fundamentally altered how people live and work. (Amirazar, 2021). Lighting that is "dedicated to increasing human performance, comfort, health, and well-being, singly or in some combination" is referred to as "human-centric lighting."

Effect of Day Light Exposure on Mood and Sleep Quality:

Since humans are now exposed to less natural light during the day, the introduction of electric lighting has substantially changed the pattern of light exposure during the last few decades. Even still, nighttime electric light exposure to humans is excessive. Natural light-dark cycles have caused regular human rhythms in behaviour and

physiology, such as wake behaviour and sleep patterns, to evolve over millions of years. (Amirazar, 2021). A number of psychological, physical, several health issues are associated with behaviour and insufficient personal light exposure throughout the day and at night, which can disturb this natural cycle. Subjective wellness refers to a person's body's cognitive and emotional evaluations. Being content with life and enjoying all of its components, including employment, family, leisure, health, and financial stability, as well as being content with oneself and with one's connections with others, is characterized as the cognitive side of well-being. The affective component, of well-being as emotional subjective well-being, is concerned with how people's well-being including their levels of happiness, sadness, and fear is affected. (Javiera Morales-Bravo, 2022).

The human individual is an inherently visual organism, with one-third of our cortical neurons dedicated to accessing visual information, exceeding any other sensation. We interpret light stimuli differently based on their origin, frequency, dosage length, and kind of illumination (Javiera Morales-Bravo, 2022). The sun's luminous cycle has a massive effect on the circadian greatly affect entireness. Your body's circadian clock responds to light as a wake-up signal and darkness as a signal to sleep. Increase your light exposure during the day to become more attentive. To sleep better at night, darken your bedroom. (Christine Blume, 2019). The affective scale developed by Bradburn suggests effective are of two categories of emotional variations: positive and negative (Javiera Morales-Bravo, 2022). It has been explored and evident from previous studies that any major negative emotion in the form of sorrow, anxiety, wrath or even stress, has been associated with the feeling of utter discontent or even discomfort based on the response to a single or a set of stimuli as well as circumstances. However, it has also been reported that a positive emotion or its variants such as pleasure, joy, enthusiasm, euphoria, pride or even adoration, can be easily related or viewed as the true reflection associated with the feeling of satisfaction based on the defined stimuli or circumstances based on a certain defined scenario (Francesco P Cappuccio, 2010). It is the job of the human circadian system to teach the circadian rhythms to synchronize with

an approximately 24-hour daily cycle. After-sunset light exposure can cause the circadian rhythm to alter, a phenomenon known as phase shifting. People who work at night, such as nurses and shift workers, or who travel across time zones, have been most likely to experience phase-shifting. (S. Hubalek, 2010).

As a result, it is clear that irregular light-dark exposure affects the circadian rhythm and negatively impacts human health and well-being. The five aspects of light that impact circadian entrainment, according to current research, are

- Intensity
- Spectrum
- Timing
- Duration
- History of light exposure.

As previously stated, these five light qualities, as well as geographical distribution and age, must be addressed to successfully analyze the non-visual effects of the indoor environment. Another crucial health indicator is sleeping quality, which can influence and interact with mood, brain ability, and health consequences including hyperglycemia and some other disorders. Investigating daylight's impacts is vital because it could offer a significant approach to boosting occupants of office workers' health and productivity in addition to protecting the neighbourhoods where they work and reside. (Damien Leger, 2011).

Lighting indoors has monoamine neurons, resulting in sad behavioural traits. It is well-accepted that exposure to natural light behaviour directly to seasonal affective disorder in humans. Multiple studies have found that intense light—both natural and artificial—especially in the morning may drastically improve health outcomes such as sorrow and agitation. (Mohamed Boubekri, 2014). Understanding the influence of light on human biology requires knowledge of light. In a word, light is electromagnetic radiation within a specific wavelength range. This is best and maybe most completely characterized by its spectral distribution, which measures the amount of energy (or particles) as a function of the wavelength (with visible light having wavelengths spanning from 380 to 780 nm). Ambient illumination at maximum efforts, such as that seen in outdoor structures, has previously:

- Advance sleep scheduling to earlier hours
- Alter sleep duration

- Increase sleep quality.

Mood alterations have been discovered to be influenced by a complex and non-additive interaction between the circadian phase and prior wakefulness. In particular, adjustments to the sleep-wake cycle's timing can have a profound impact on mood. (Abdou, 1997). In addition to directly altering the availability of neurotransmitters like serotonin, which is important in mood regulation, illumination may also affect emotions in several other ways. It can also synchronize and maintain rhythm, so addressing circadian resynchronization and sleep problems, which are prevalent in patients with mental illnesses. (Christian Cajochen, 2000). To treat mood and other mental illnesses, light therapy. They cogently gained acceptance over the past few decades. Light affects our circadian rhythms, sleep, and mood in addition to enabling us to sense high resolution and tone, and, enabling therapy can be used as a treatment for mental and other health issues, exposure to light at the wrong time might harm circadian rhythms and sleep. (Christine Blume, 2019).

RESEARCH METHODOLOGY

Selection Criteria for Data Collection:

Criteria on which articles were included:

- Articles reporting study findings including subject answers,
- Controlling for daylighting, illumination, or window view evaluations (Predictors).
- Criteria on which articles were exempted:
- Publications out of objective.
- Investigations engaging with some other interior environmental characteristics.
- Identical publications.

Framework for Analysis:

The number of studies determined the basic structure of the assessment. A thorough examination of the outcomes was influenced by the number of documents inside the research. Numerous kinds of research, for example, provided well over one goal, concept, and methodology conducted well over one trial or used different methods for collecting information relating to a similar result type. The overall total quantity of predictors and results from either publication specifies the number of items in this

analysis.

- Examination of the used methodology in the literature

Main Elements of the Study:

The major characteristics are the article's kind and purpose and the sunlight situation under investigation. Based on the practical arrangements for the collection of data, it is classified that the investigations are done into three different types:

- Micro and Macro level view of literature
- Examination of the Data Set

DATA COLLECTION & ANALYSIS

Macro level view of literature:

In the existing literature, there are multiple types of research from multiple working environments that are going to be discussed further in this chapter. Following is the brief table depicting the priorities, impact and relevance of the literature studied during the research.

Research Material used in the literature review

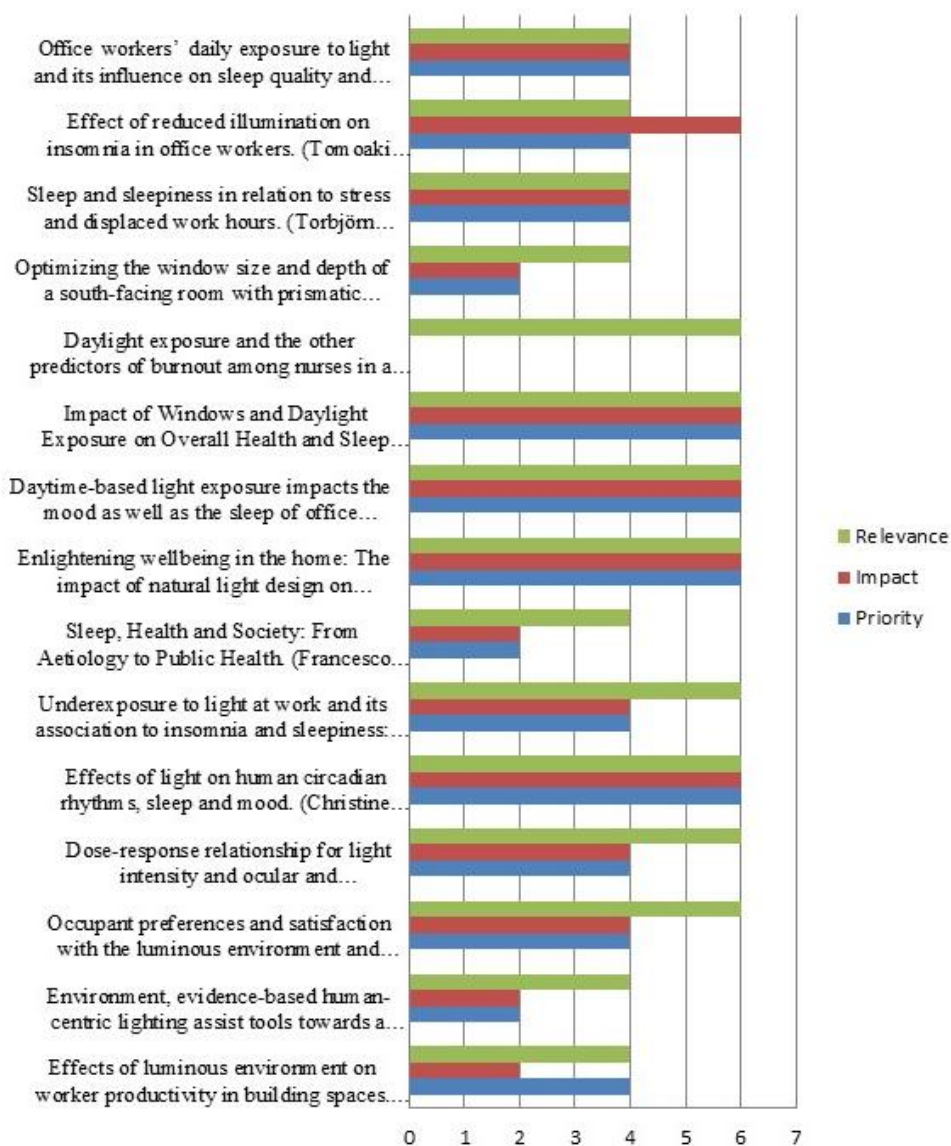


Figure 01: Research Material used in the literature review

Parameters of high, medium and low are used to evaluate the relevance, impact and priorities of the research materials. Articles having high in all three

parameters are the most prominent and used for extensive literature review.

Micro-level view of literature:

There is research done by Mariana G. Figueiro and colleagues (2017) on the impact of daylight on sleep and the mood of office workers. In the research, there was a total of 109 participants of which 81 took part in the research in summer and winter. (Mariana Figueiro, 2017). The research aimed to measure self-reported mood and sleep in terms of circadian effective light and rhythms for 7 days. The participants were given multiple questionnaires to fill out regarding their exposure to light from 8:00 am to 5:00 am in summers and winters. The purpose of this study was to see if exposure to excessive circadian effective illumination in the workspace throughout the day, especially in the morning, was related to significant alterations in circadian entrainment. Numerous conclusions stand out. Firstly, as predicted, increased circadian stimulus exposure in the morning was related to a quicker sleep start delay than a less circadian stimulus dose in the morning. (Mariana Figueiro, 2017). This link was greater during the winter season when the chance of receiving sunlight before entering the off was limited to the delayed emergence of sunrise. This current research is different in that this was the first to employ a sensor designed to assess circadian effective light to quantify individual circadian illumination exposures, in-office employees. It is the first study to link circadian-effective lighting to emotion, anxiety, and sleep outcomes. (Anca D. Galasiu, 2006). These current findings could be viewed as the first stage in encouraging the use of novel, more relevant measurements for fieldwork, offering sleep investigators innovative methods for measuring and quantifying circadian effective illumination (Figueiro, M. G., Steverson, 2017).

A new study found by Kozaki, T and et al (2012) that respondents who operated underground (metro and trains) had a higher incidence of sleeplessness and daytime drowsiness than those

who worked above ground (buses and trams). These findings imply that a lack of light throughout the day may cause sleeplessness (Tomoaki Kozaki, 2012).

The daily light pattern has a significant impact on all species on Earth. Unfortunately, contemporary civilization has altered this life-governing cycle by emphasizing maximal output and paying little consideration to ecological integrity and human metabolic equilibrium. This disrupts our other circadian rhythms, leading to progressively serious pathologies such as oxidative stress, inflammation, and, as a result, hormonal problems, and metabolic disorders such as metabolic syndrome, diabetes, neurodegenerative illnesses, and cancers. This condition is known as Chrono disruption in the medical language. Night-shift work is another example of Chrono disruption. Night shift workers may sleep intermittently or reverse their sleep habits; in any case, they are subjected to artificial light more often than day shift employees. (Tomoaki Kozaki, 2012)

There is another research done on nurses working in a university hospital by Mustafa Kemal Alimoglu. The survey's goal was to look at the potential immediate or indirect impacts of direct sunlight on exhaustion. The survey comprised 139 nurses from the Akdeniz University Hospital located in Antalya, Turkey. (Mustafa Kemal Alimoglu, 2005). Most nurses were informed well about the trial, and their signed permission was acquired. In conjunction with an individual survey questionnaire, all attendees were requested to complete the Maslach Burnout Inventory (MBI), the Workplace Relevant Strain Inventory (WRSI), as well as the Work Satisfaction Questionnaire (WSQ). Between March 18 and March 25, 2003, 141 nurses out of 149 fulfilled all four forms correctly. The remaining 8 nurses were disqualified because they filled out the applications incorrectly. Their overall rate of response was 94.6%. The authors developed an individual data-collecting questionnaire with constrained options and open-ended sections to gather details concerning demographic, economic, private, and work-related factors that were believed to possess an impact on WRSI, WSQ, and MBI ratings. The answer to the inquiry "How many hours (considering mealtime, break periods,

etc.) are you confronted with broad sunlight throughout a regular working day?" was one of three options: under one hour, one to 3 hours, and 3 hours or over. Hardly six respondents indicated being introduced to sunlight in less than one hour. Somewhat as a result, we divided the sample into two categories for quantitative analysis: those exposed to sunlight for less than three hours each day (group A) as well as those exposed for at least 3 hours per day (group B). As a result of this research, it was determined that access to sunlight for a minimum of three hours each day seemed to lower occupational stress and unhappiness in the study. (Mustafa Kemal Alimoglu, 2005). The researcher also anticipated seeing a result indicating that sunlight access had a therapeutic efficacy on exhaustion markers, as there have been several research indicating that sunlight has a positive influence on depressive disorders (Mustafa Kemal Alimoglu, 2005). Office workers who receive low concentrations of circadian-effective light from the sun, obtaining elevated amounts in the early hours are associated with decreased rem sleep latency (especially in the winter) and increased phase shift magnitudes (an amount of circadian entrainment), as well as improved sleep quality. High amounts of circadian-effective light throughout the day are also linked to higher phase magnitudes, lower depression, and better sleep quality. (Christian Cajochen, 2000).

As you can determine from some of the above-mentioned examples in the literature review all the research done is on daylight exposure on occupants of different workspaces and by further comparison of data, we can understand the effects of daylight exposure on the sleep quality of the occupants. Regarding the above-mentioned literature analysis, it is evident that insufficient daylight exposure to natural light causes various diseases and sleep deprivation in occupants working in multiple workspaces worldwide. There is a lack of comparative research on the topic which needs to be filled by comparing multiple data from different research papers, articles and

experiments done by past researchers to fully understand this topic and create an ease for the readers to understand this issue better.

Examination of the Data Set:

Although it is generally documented that interior surroundings are important for our emotional health, little is known about the precise features of residential indoor spaces that influence both happy and negative emotions. The techniques or tactics used to discover, select, process, and analyze material on a topic are referred to as research methodology. The methods section of a research paper assists the reader in objectively examining the overall validity and reliability of the study. The methods of several papers will be evaluated and analyzed in this section. Mariana G. Figueiro and colleagues (2017) investigated the influence of sunlight on the sleep and mood of office workers. Participants were chosen via a questionnaire and interviews throughout their research. (Mariana Figueiro, 2017). Participants answered five surveys about their mood and behaviour. After the conclusion of the study, sleep patterns were examined. The process was divided into 2 seasons. (Summer and winter). Participants were instructed to wear the Daysimeter as a necklace for 7 days in a row throughout two data-collecting periods. They were told to keep the gadget exposed at all times (Mariana Figueiro, 2017). The participants were requested to wear the Daysimeter on their wrists while sleeping to allow tracking of their sleep-wake activity patterns. Users were requested to keep a sleep record of bedtime and waking time, sleep latency, quality of sleep, and any naps taken throughout the 7-day data collecting period. The purpose of this study was to see if exposure to high circadian-effective light in the workplace during the day, especially in the morning, was related to substantial alterations in circadian rhythms (Mariana Figueiro, 2017). For example, the authors of "The Impact of daytime light exposures on Sleep and Mood in office workers", used 5 different types of questionnaires during their study:

<u>QUESTIONNAIRE NAME</u>	<u>DEFINITION</u>
The Center for Epidemiologic Studies Depression Scale (CES-D) questionnaire.	The Center for Epidemiologic Studies Depression Scale (CES-D) questionnaire is designed to measure depressive symptoms
Perceived Stress Scale (PSS-10) questionnaire.	The Perceived Stress Scale (PSS-10) questionnaire assesses participants' thoughts and feelings over the past month by posing 10 questions concerning how often they have thought or felt a specific way
The Pittsburgh Sleep Quality Index (PSQI) questionnaire	The Pittsburgh Sleep Quality Index (PSQI) questionnaire is a subjective measure of sleep quality and patterns experienced for the majority of days and nights over the past month
Positive and Negative Affect Schedule (PANAS) questionnaire	In the Positive and Negative Affect Schedule (PANAS) questionnaire, subjective feelings about 10 positive affects (i.e., interested, excited, strong, enthusiastic, proud, alert, inspired, determined, attentive, and active) and 10 negative effects (i.e., distressed, upset, guilty, scared, hostile, irritable, ashamed, Nervous, jittery, and afraid) are rated by participants on a scale ranging from 1 to 5
The Patient-Reported Outcomes Measurement Information System (PROMIS) Sleep Disturbance-Short Form 8a questionnaires	The Patient-Reported Outcomes Measurement Information System (PROMIS) Sleep Disturbance-Short Form 8a questionnaire requests responses to 8 statements regarding sleep quality

Figure 02 Explaining the questionnaires and scale used in the study. (Mariana Figueiro, 2017)

The authors of the article “Effect of Reduced Illumination on Insomnia in office workers” investigated the effect of reduced lighting in the workplace on sleeplessness among office personnel. (Tomoaki Kozaki, 2012). During their course of study, the method of questionnaires and interviews were used to gather participants. In July 2009 and July 2010, 72 office employees completed the Athens Insomnia Scale (AIS). A worker who often works outside the office may only sometimes be exposed to the lighting conditions within an office, therefore the workers were separated into three groups based on how often they worked outside the office:

- indoor workers (IWs)
- semi-outdoor workers (SWs)
- outdoor workers (OWs)

Employees who worked indoors seldom left the office and were only exposed to indoor office light during the day. As a result, the patient’s lack of exposure to light may have contributed to their sleeplessness. To maximize work-related amounts

of light exposure, a unique lighting environment is necessary. (Tomoaki Kozaki, 2012).

The authors of the article “Dose-response relationship for light intensity and ocular and electroencephalographic correlates of human alertness” research into the connection between light intensity and human alertness. (Christian Cajochen, 2000). During their course of study, the research subjects were hand-picked from a large pool by different methods. A newspaper ad and a poster were used to find potential participants. Potential individuals completed the various screening questions and provided informed permission after passing a telephone screening interview. A physical examination, standard blood and urine chemistries, and a 12-lead electrocardiogram were planned for a few members of the staff. A qualified psychologist conducted a screening interview with them as well. The final step was to choose potential volunteers. After the conclusion of the study, 23 young, healthy volunteers between the ages of 18 and 44 took part in a nine-day research project. (Christian Cajochen, 2000). To verify compliance with an 8-hour sleep episode, subjects were instructed to call the lab immediately before their planned bedtimes

and shortly after their scheduled waking hours. Wake times established at their stated usual timings are needed to collect the necessary data. (Christian Cajochen, 2000).

The study sought to determine whether exposure to sunshine while working may be one of the factors that predict job burnout. 141 nurses from the Akdeniz University Hospital in Antalya,

Turkey, made up the sample. (Mustafa Kemal Alimoglu, 2005). To gather information about each participant's levels of burnout, stress level, and job happiness in addition to personal characteristics, they were each requested to complete the fill-out questionnaires and interviews.

<u>QUESTIONNAIRE NAME</u>	<u>DEFINITION</u>
Maslach Burnout Inventory	The Maslach Burnout Inventory (MBI) is a psychological assessment instrument comprising 22 symptom items about occupational burnout.
The Work-Related Strain Inventory	Work-Related Strain Inventory is a 4-point Likert-type self-report. Scale with 18 items developed to determine work-related. Stress in HPs. It is scored between 1 and 4 points.
The Work Satisfaction Quest Work	The Work Satisfaction Quest Work is a questionnaire used to evaluate nine dimensions of job satisfaction related to overall satisfaction.

Figure 03 Explaining the questionnaires and scale used in the study. (Mustafa Kemal Alimoglu, 2005)

Relating the above research has shown that spending at least 3 hours each day outside reduces stress and increases job satisfaction. Younger age, having health issues relating to one's employment, being less educated, and having sleep difficulties have all been demonstrated to have full or partial direct effects on burnout. Working in inpatient care, night hours, and unhappiness with yearly income may all contribute to burnout through work-related stress. While linking a number of already-existing stress variables, this study provided a previously unexplored area. Exposure

to sunshine may lessen workplace burnout. (Mustafa Kemal Alimoglu, 2005)

A cross-sectional, environment-controlled epidemiological study was done. (Damien Leger, 2011). 13,296 French employees from a single transportation company made up the survey's representative sample. During working hours, 4635 people (34.9%) were not exposed to any light, whereas 8661 other people were either totally or partially exposed to natural light (Damien Leger, 2011). With the use of this questionnaire:

<u>QUESTIONNAIRE NAME</u>	<u>DEFINITION</u>
The Sleep Disorders Questionnaire-French version (SDQFV)	This questionnaire is a screening tool for physicians to assist in their clinical evaluation of insomnia. It can be used to screen for a sleep disorder.
The Epworth Sleepiness Scale	The Epworth sleepiness scale (ESS) is a self-administered questionnaire that's routinely used by doctors to assess daytime sleepiness. The person filling in the questionnaire rates how likely they are to doze off during the day in different situations.

Figure 04 Explaining the questionnaires and scale used in the study. (Damien Leger, 2011)

The evaluation of subjective drowsiness, sleep disturbance, and quality of sleep measurements. Light exposure was determined using the workers' schedules and objective measurements of light intensity. The study's findings suggest that persons who do not have access to natural light at work may experience substantially worse sleep and waking troubles, according to the study's conclusion. There is a limited body of literature on the issue of the relationship between interior-built environments and people's emotions. (Damien Leger, 2011). According to several studies, adding plants to interior spaces has been shown to improve people's E-SWB in locations including waiting rooms, schools, and offices. According to Bower ET's meta-analysis of studies on indoor built environments, only a small number of studies have looked at how different architectural design elements affect neurophysiological responses related to human emotions. Curved surroundings outperform linear ones, according to Baenei et al evaluations of enjoyment and excitement as well as the physiological and psychological states of attention and stimulus-response. (Damien Leger, 2011).

Examination of the used methodology in the literature:

When it comes to clinical illnesses, whether they be sleep, mental, or physical, screening is often employed most extensively. This field still lacks established protocols and standards. However, in the aforementioned study, several tools, including sleep diaries and questionnaires, are being used in conjunction with objective assessments to ensure that normal sleepers are identified and descriptive data for control subjects are offered. Group

differences in the study may be generated by normal sleepers and participants rather than the sick group if they are not accurately described and chosen.

Additionally, consistency in the way sleepers are defined is essential for comparing findings among studies. The choice of normal sleepers or controls in sleep research generally is affected significantly by these findings. An analysis of the aforementioned data set shows that volunteers and study participants are often hand-selected or put through some sort of screening process. Most of the publications included in the analysis employed questionnaires and interview techniques to identify participants. Physical and psychological evaluations, as well as medical histories, are crucial components in the selection of participants for this research since sleep length and quality are connected to each participant's psychology. In other instances, psychologists were even utilized to conduct participant interviews and choose the ideal candidate for the study. The most common approach for these studies, as mentioned above, is questionnaires, however, the design and content of these questionnaires rely on the question and the limitations established by the researchers of various study articles. The use of several measures and surveys aims to illustrate how individual differences in sleep quality exist. Additionally, the bulk of earlier experiments were conducted under well controlled conditions with ongoing electric lighting. Because of this, there is not only a dearth of knowledge on the variation in non-visual effects of light in actual surroundings across different geographical places, but also an absence of helpful features for tracking and measuring one's lighting circumstances during a 24-hour day

and providing advice on how to make that particular lighting conditions better

No.	Article Name	Types of Methodologies					
		Questionnaires	Interviews	Surveys	Observations	Focus Group	Records and Documents
1.	The impact of daytime light exposures on sleep and mood in office workers. (Mariana Figueiro, 2017)	●	●	●	●	●	●
2.	Effect of reduced illumination on insomnia in office workers. (Tomoaki Kozaki, 2012)	●	●	●			
3.	Dose-response relationship for light intensity and ocular and electroencephalographic correlates of human alertness (Christian Cajochen, 2000)	●		●			
4.	Daylight exposure and the other predictors of burnout among nurses in a University Hospital. (Mustafa Kemal Alimoglu, 2005)	●	●	●	●		●
5.	Underexposure to light at work and its association to insomnia and sleepiness: A cross-sectional study of 13 296 workers of one transportation company. (Damien Leger, 2011)	●		●			

Table 5 Methods used to gather data in different research studies

DISCUSSION & ANALYSIS

The key issue raised by conducting the study was the absence of broad standardization of many metrics and processes for comparing the findings in various research articles. The outcomes of several studies undertaken in the past on how daylight exposure affects sleep

quality show a wide range of results. We reside in a dystopian society, which is the cause of this. Since Earth orbits the Sun in a certain way, the amount of daylight from the Sun, which is a natural phenomenon change. The length of daylight exposure varies depending on the region. Individual light environments should be

thoroughly studied since the effects of light on health vary from person to person and because human movement and activity make it difficult to anticipate non-visual reactions to light. In the recent time, with the help of modern-day technology, new techniques and processes have been evolved which can help measure the light which has the capability to stimulate the non-visual system as well as how it may affect the health and the wellness of the tenant. Unfortunately, these devices neither can be easily purchased from the market as they are not commercially available nor they are affordable at the moment. Another major issue with these devices mainly is the lack of capability to engage and measure Spectral Power Distribution (SPD) in the form of monitoring it as light exposure towards any form of exploration or conclusions. Another major drawback is their in-ability to opt for real time monitoring based on the real time data though they might be able to record and take on a continuous data set based on a person's exposure to light and how he or she has responded to it through activity level or engagement over hours as well as days. The sole cause of seasons like summer and winter is the movement of the sun. Those seasons have different day lengths. Researchers had to divide their study into two phases, just like in "Effect of reduced light on sleeplessness in-office employees." A summertime one and a wintertime one. Both seasons' outcomes were very different from one another.

The lack of criteria for establishing the sleep cycle is mostly because sleeping patterns and the circadian cycle are tied to human psychology and are also influenced by one's background and way of life for each personnel. Also, the perception of good sleep quality varies from individual to individual. It's really hard for researchers to find participants with similar parameters to conduct their research. As above stated, the screening process of finding perfect participants is a difficult and prolonged process. Many participants are hesitant to discuss this as it is considered personal information.

There should be precise processes in place for conducting these inquiries. Though it is hard to state with certainty whether it can help one

achieve perfect sleep quality or not, daytime exposure does affect the quality of sleep. Even without the proper steps and conditions, daytime exposure can still be caused. We may conclude from the literature review of the aforementioned studies that daylight exposure has a substantial influence on how the circadian cycle of people who utilize workplaces operates, even if more extensive research is required to fully understand the topic. To enhance human health and well-being in the built environment, new associated support systems must be developed by continuously monitoring numerous external and internal environmental impacts from the sun and users. A growing number of researchers from various domains have been drawn to investigate the non-visual effects of light and its applications in lighting design. These researchers are striving to develop new tools and methodologies.

CONCLUSIONS

We can conclude that natural light significantly affects the quantity and quality of human sleep after reviewing the literature and studies in the field. Especially those who spend a lot of time working inside in enclosed spaces. The amount and timing of daily sunshine exposure have an impact on a person's circadian rhythm. We can all agree that spending a lot of time indoors and not receiving enough sunshine may have an impact on people's health and mood, which lowers productivity and creates an uncomfortable work environment. In summary, it can be said that exposure to sunshine improves human sleep quality but deprivation has a detrimental impact as well.

Also, it can be concluded there is a dire need for protocols and sets of previously defined rules for understanding the effects of daylight exposure on the occupants of different spaces. But it can only be done if those rules and protocols are changed and vary from location to location according to the following factors:

- Region
- Sun Paths and Seasons
- User History

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