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REVIEW ARTICLE

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"SLEEP UNVEILED: EXPLORING THE VITAL ROLE OF ENVIRONMENTAL CONDITIONS IN SLEEP HEALTH - A COMPREHENSIVE REVIEW"

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Abstract:
Sleep quality and overall well-being are intimately linked, with environmental conditions playing a pivotal role in shaping the restorative nature of sleep. This review article synthesizes current research to explore the multifaceted relationship between environmental factors and sleep health. By analyzing a diverse range of studies, we highlight the significant impact of ambient noise, light exposure, temperature, air quality, and comfort on sleep patterns and sleep-related disorders. Homelessness often exposes individuals to suboptimal sleeping environments, characterized by excessive noise, exposure to harsh weather, and lack of safety. This vulnerable population's sleep health can be severely compromised, contributing to physical and mental health issues. Addressing the environmental influences on sleep quality within the homeless community is not only a matter of health equity but also underscores the broader significance of creating safe and conducive sleeping spaces for marginalized individuals.

INTRODUCTION

Sleep is an essential component of human health. During sleep, most of the body's systems are in an anabolic state, helping to restore the nervous, muscular and immune systems. Sleep has not been given its due importance in health as compared to nutrition or exercise. The environment in which one sleeps influences the amount and quality of sleep obtained. Various external environmental conditions (e.g., light, noise, temperature, safety issues, bad weather and mosquitoes) and internal conditions (e.g., fatigue, body weight, anxiety, hunger) can influence various parameters of sleep health.

There is scarcity of literature regarding influences of environmental factors on sleep variables. Hence, present paper explored the multifaceted relationship between environmental factors and sleep health.

INFLUENCE OF ENVIRONMENTAL CONDITIONS ON SLEEP HEALTH

Mizuno et al, 2016 examined the association between sleep and environmental conditions using actigraphy, sleep diaries and monitored noise, light, temperature, and humidity in temporary shelter for 7 days and perceived difficulties during sleep. Sleep disturbance causes were reported as noise being the largest (66.7%), uncomfortable sleeping conditions (26%), 26.7% light, Hot ambient temperature 20% and uncomfortable pillows 13%. These sleep disturbances showed delayed bedtime and early risetime which led to reduced time in bed and total sleep time. (1)

Housing and sleep

The quality and quantity of sleep can vary significantly depending on the type of housing individuals have access to. Housing types in the general population encompass a broad spectrum, ranging from stable and secure homes to temporary or inadequate living conditions. Simonelli et al, 2013 did intervention-based study in which participants were moved from low quality house to basic prefabricated $18m^2$ modular house. Sleep quality was assessed using PSQI which showed significant improvement. ($z= -6.57$, $p<0.001$) Overall dissatisfaction with housing conditions, (predominantly rain or dampness problem) were reduced from 78.7% to 2.6%. ($\chi2= 58.07$, $p<0.001$) 76.7% had PSQI >5 which after housing reduced to 30%. ($\chi2= 26.44$, $p<0.001$) Significant decreased sleep latency ($p=0.018$), increased sleep duration ($p= 0.002$), improved sleep efficiency ($p=0.014$), less sleep disturbances ($p<0.001$) and less daytime dysfunction ($p<0.001$) after housing was observed. (2)

Impact of Light on sleep

Exposure to natural light during the day and darkness at night helps regulate the circadian rhythm, which is responsible for our sleep-wake patterns. A cooler room temperature can aid in this synchronization, as it mimics the drop in temperature that naturally occurs in the evening as the body prepares for sleep. Conversely, higher temperatures can disrupt sleep and lead to sleep fragmentation. Studies have shown that, in healthy adults, one night of moderate (100 lx) light exposure during sleep increases nighttime heart rate, decreases heart rate variability (higher sympatho-vagal balance), and increases next-morning insulin resistance when compared to sleep in a dimly lit (<3 lx) environment. In circadian rhythm sleep disorders, the sleep-wake cycle becomes misaligned with the circadian system or the external environment, resulting in insomnia, fatigue, and deterioration in performance and alertness. Studies have shown that appropriately-timed exposure to bright light can reset the timing of sleep and wake to the desired times, and improve sleep quality and daytime alertness, hence shown implication in treating circadian rhythm disorders.(3,4)

Smit et al, studied and compared the impact of evening light exposure on sleep characteristics including sleep onset, duration, total sleep time and sleep quality in villages with and without light facility. Result showed compared to the other group, the population with light facility found significantly delayed sleep onset (23 min), less sleep duration (28 min), 10% more sleep fragmentation, 3% less sleep efficiency. Breastfeeding females in village with light exposure showed significantly less sleep duration (65 min) & total sleep time as compared to other group.(5) Moreno et al, revealed that workers with electric light at home went to sleep significantly later (21:01 h) than those without electric light (20:21 h, $p < 0.01$) and showed significant difference in sleep duration between the two groups on workdays ($p < 0.01$), those with electric light at home having significantly shorter sleep (30 min/day less) based on actigraphy and sleep diaries. Analysis showed a significant delay in the timing of melatonin onset in workers with electric light (19:28 h, $n = 13$) compared to those without electric light (19:06 h, $n = 20$), revealing a main effect of electric lighting at home ($p < 0.01$).(6,7)

Sleep and Neighbourhood

Chambers et al, examined the association of adverse housing and neighbourhood conditions with sleep disturbances, sleep quality, duration, and latency in a housing unit with low income and poor

neighbourhood conditions. (8) Household crowding was measured using government standard included various parameters like number of individuals per room, trashes on sidewalks or streets, inadequate police protection, loud noises, assaults, drinking in public places etc. Results showed 30% population reported average sleep duration of less than 6.5 hours, 35.3% perceived trouble sleeping in 3 days/ week and 31.5% perceived the quality of their sleep to be poor. Average sleep latency was 36.88 minutes Adverse housing & neighbourhood were found to be significantly associated with poor sleep quality.(8)

Benson et al, examined the association of sleep quality with loneliness and social isolation using wrist actigraphy, survey questions and sleep diaries. Results showed social isolation and loneliness was associated with worse Actigraphy score and disrupted sleep- WASO (wake after sleep onset). Increased loneliness was strongly associated with more insomnia symptoms and shorter sleep duration but not social isolation.(8)

Sleep and lifestyle/ schedule

Hgghighi et al, studied sleep quality of long-haul drivers. Mean PSQI score was 5.75±2.75 (62% showed poor sleep quality). Among the population, 88.03% of night shift drivers showed poor sleep quality which was found to be positively associated with working hours. Multivariate logistic regression showed that smoking, job satisfaction, accident risk, shift duty and working hours were important risk factors for poor sleep quality.(9) .

Alshoballi et al., studied association of mobile usage with sleep quality and found that that employees who use their smartphones more at bedtime have more risk of being poor sleepers. (10) Sleep is not merely a state of rest; it is a vital biological process that allows our bodies and minds to rejuvenate and heal. However, many individuals find themselves trapped in a vicious cycle of sleep deprivation, perpetuated by irregular schedules and unhealthy lifestyle choices. Our bodies thrive on routine, and having a regular sleep-wake cycle can help regulate our internal clock, known as the circadian rhythm. By going to bed and waking up at the same time every day, even on weekends, we align ourselves with our body's natural rhythm, making it easier to fall asleep and wake up refreshed. This gets disturbed because of work schedule and digitalization in morning and late evening/ night, hence influenced our sleep wake cycle (10)

Sleep and temperature

Temperature plays a significant role in our sleep patterns and overall sleep quality. Both the ambient temperature of our sleeping environment and our body temperature can impact the different stages of sleep and our ability to fall asleep and stay asleep. The onset of sleep is often associated with a drop in body temperature, which helps initiate and promote sleep. Cooler room temperatures can aid in this process, as they help lower core body temperature. Conversely, higher room temperatures may interfere with the body's natural cooling process, making it harder to fall asleep. Extreme temperatures, either too hot or too cold, can disrupt sleep. During the sleep onset period, sleep is more likely to occur when the core body temperature (Tcore) decreases. This decrease in Tcore is influenced by the peripheral skin temperature (Tsk), which regulates blood flow to the skin. Increased peripheral Tsk allows heated blood from the core to flow to the skin, facilitating heat loss and promoting sleep. The dilation of distal skin regions and the release of melatonin are associated with this process. Cardiac autonomic activity and changes in body temperature are also linked to the onset of sleep. The recommended bed climate temperature for normal sleep is typically maintained between 32°C to 34°C, with a relative humidity of 40% to 60%. These values align with the comfort bed climate range suggested by Yanase. Several studies have shown that a cooler bedroom temperature promotes faster sleep onset and helps maintain sleep throughout the night. Research indicates that higher temperatures, especially when they exceed the comfort range, can disrupt sleep and reduce sleep efficiency. Individuals may experience more awakenings and lighter sleep stages in warmer environments. (11,12)

Sleep and Noise

Sleep is an important modulator of hormonal release, glucose regulation and cardiovascular function. Slow-wave sleep, the most restorative sleep stage, was associated with decreased heart rate, blood pressure, sympathetic nervous activity. The presence of nighttime environmental noise might cause detectable disruptions in metabolic and endocrine functions, such as increased secretion of adrenaline, noradrenaline, and cortisol, leading to elevated heart rate, arterial pressure, and increased bodily movement which might cause sleep disruptions. Nocturnal noise has been shown to fragment sleep, and as a consequence lead to a redistribution of time spent in the different sleep stages, typically increasing wake and stage 1 sleep and decreasing slow wave sleep and REM sleep. Nocturnal air traffic causes nocturnal awakenings at levels as low as 48 dB, and physiological reactions in the form of increased vegetative hormonal secretions, cortical arousals and body movements at even lower levels, probably around 33 dB. (13–17)

Frei et al, investigated effects of noise on subjective and objective sleep quality using sleep diary, sleep disturbance questionnaire and actigraphy and found that self-reported sleep quality was strongly related with noise annoyance ($p<0.001$).(18)

Sleep and weather

Extreme weather can negatively impact sleep due to factors like discomfort, noise disturbances, and temperature fluctuations. High temperatures during heatwaves make it difficult to cool down and sleep comfortably, while cold temperatures can cause discomfort and difficulty staying warm. Storms and severe weather can disrupt sleep with loud noises and heightened anxiety. Additionally, poor air quality from events like wildfires can lead to respiratory issues.

Mattingly et al., studied seasonal effects on sleep patterns measuring sleep habits over 4 seasons over one year using objective and continuous measure of sleep and local weather and observed strongest seasonal effect for wake time (early) and sleep duration (decreased) during spring season compared to winter. Between winter and summer, bedtime and wake time tend to be slightly later as temperature increased during day and sleep duration decreased as daylength increased.(19)

Suzuki et al., investigated the effects of seasonal changes on sleep duration and sleep problems in Japanese community residents at four time points (spring, summer, fall, and winter). Seasonal changes in sleep duration were found, with the longest in winter and the shortest in summer (winter-summer difference: 0.19 h). The seasonality of sleep duration was influenced by age, sex, and residential area.(20)

Sleep and hygiene

Reduced hygiene-related self-care among homeless individuals in high-income nations has been linked to several outcomes related to communicable and non-communicable diseases. In a study conducted in Europe, people suffering homelessness were more likely to have body lice, fleas, head lice, and scabies infestations when they had less showers and did not regularly wash their clothes. The increasing frequency of scabies and body lice has been linked specifically to sleeping outside. Yersinia pestis, Bartonella quintana are just a few of the vector-borne infectious agents that some ectoparasites, most notably body lice, can spread. These illnesses have been linked to urban homelessness and may have long-term health effects for some people. (21,22)

Persons experiencing homelessness in the United States experience significant barriers to self-care and personal hygiene, including limited access to clean showers, laundry and hand washing facilities. While the obstacles to personal hygiene associated with homelessness may increase risk of infectious disease, hygiene-related behaviours among people experiencing homelessness have received limited attention. (21–24)

Leibler et al., conducted a cross sectional study to explore the hygiene status and facilities of homeless in US and found that persons who engaged in heavy drinking were significantly less likely to take a daily shower compared to individuals who did not drink heavily. Injection drug use was associated with a number of reduced hygiene-related outcomes, including not showering daily,

infrequent handwashing, sharing clothing or bedding and laundering clothing in the sink. For some individuals, shared living areas and sanitation facilities feel unsafe and uncomfortable, which in turn may drive these persons to sleep outdoors. The role of access and utilization of sanitation facilities as a risk factor for street sleeping is an important area.(25–27)
Personal hygiene has also been identified as a positive contributor to mental health among persons experiencing homelessness. Rosengard et al., stated that 66% of homeless individuals reported bathing. In a study of risk factors for negative physical and mental health in homeless men with HIV, reduced access to bathrooms was identified as a significant risk factor for poor physical and mental health. (25–28)

Sleep and homelessness

Homeless individuals are among the most vulnerable populations when it comes to experiencing sleep deprivation. Sleep deprivation refers to insufficient or poor-quality sleep that can have detrimental effects on physical, mental, and emotional well-being. Sleeping on the streets, in makeshift shelters, or crowded emergency shelters often exposes them to harsh environmental conditions, noise, and increased risk of theft or violence. These factors make it extremely difficult to obtain adequate, uninterrupted sleep.
Chang et al**,** examined sleep quality and duration in homeless population and reported an average of 11.58±10.73 days (over the past 30 days) of inadequate rest or sleep 6.93±2.04 hours of sleep over an average 24-hour period) and 6.13± 8.63 days (over the past 30 days) of unintentionally falling asleep during the day. Among those, 39.8% of the participants showed incidence of snoring.(29)
Léger et al, studied sleep duration and incidence of insomnia in homeless population and reported significantly shorter total sleep time in homeless (6 hours 31 minutes) compared to the general population (7 hours 9 minutes). Among the population, 41% reported incidence of insomnia and 25% of the total population used drugs to help sleep. (30)
Gonzalez et al, assessed sleep disturbance and awareness about sleep importance in American homeless adults and reported average sleep duration of 5.29 hours with 75% having less than 7 hours sleep. 90% believed that sleep affects their daily health while 92.7% agreed for sleep interventions when asked. (31) Reitzel et al, assessed sleep inadequacy in homeless population taken from shelter providing agencies and reported an average of 13.0±11.4 days over the past 30 days of inadequate sleep, average sleep duration was 6.6±2.2 hours over 24-hour period, and 4.7±7.9 days of unintentionally falling asleep over the past month.(32)
Kim et al., 2021 assessed sleep quality in Korean construction workers using PSQI and reported 62.6% of poor sleepers among the population. Poor sleep quality was significantly related with longer sleep latency, shorter sleep duration, worse sleep efficiency, more sleep disturbances and daytime dysfunction with higher use of sleep medication($p<0.001$)(33). T Lallukka et al, 2017 explored the association of sleep quality with sleep duration for weekdays and weekends. Strong association were found for people who reported poor sleep quality with shorter sleep duration (OR-3.15, 95% CI (2.76-3.61). (34) Hgghighi et al, studied sleep quality of long-haul drivers. Mean PSQI score was 5.75±2.75 (62% showed poor sleep quality). Among the population, 88.03% of night shift drivers showed poor sleep quality which was found to be positively associated with working hours.(9)

Sleep and Physical Health of homeless population

Wen et al, studied homeless workers and reported 40% population exceeded threshold of BP, BMI, cholesterol and showed 41% incidence of musculoskeletal disorders. Kling et al, found that Trouble sleeping (not sleep duration) was significantly associated with work related injuries in homeless construction workers. Odds of work injury was elevated for women who slept 5-6 hours/ night compared to women who slept 7-9 hours (OR 1.59, 95% CI-1.15,2).(35) Powell & Copping, studied sleep quality of homeless construction workers and association of poor sleep with risk for injuries during work. It was found that only 16% met recommended guidelines of 8 hours sleep and 10% reported fall in mental efficiency during work and 9% more accidental risk associated with inadequate

sleep. 60% injuries occurred in age under 40 who slept less as compared to over 40 Kim et al, also reported that poor sleep quality was found to be associated with high level of fatigue and depression**.**(36)

Oh et al, explored the relationship of sleep quality and insomnia severity with the risk of anxiety and depression and found incidence of depression with insomnia (25.9%) was more as compared to without insomnia (1.7%). Therefore, significant association of insomnia and psychological comorbidity was found. Lee et al, 2012 used PSQI and studied the association of sleep with quality of life using SF-36 questionnaire in community dwelling individuals. This study found a strong negative association between sleep deprivation (poor sleep quality (PSQI<5, short duration (<5.5 hours)) and health-related quality of life.(37) Myung et al.,2019 reported that presence of insomnia increases the risk for anxiety (OR 9.8, 95%CI-7.7,13.1) and depression (OR 19.7, 95% CI -13.1, 29.6) compared to the population without insomnia.(37–39)

Homelessness is often accompanied by high rates of mental health illness, including major depression. In the Los Angeles study, unsheltered women had much greater odds of being in poor mental health (OR=12.69; 95% CI=6.68, 24.13; p=0.001) than sheltered homeless women.

Hwang et al, 2013 compared healthcare utilization of homeless with matched controls and reported more ambulatory care encounters (RR 1.76, 95% CI, 1.58-1.96), emergency cases (RR 8.48, 95% CI, 6.7-10.7), medical or surgical hospitalization (RR 4.22, 95% CI, 2.9-5.9), psychiatric illnesses (RR 9.27, 95% CI, 4.42-19.43) compared to the matched controls.(40–42)

CONCLUSION

Summarizing review of literature, studies on sleep health is lacking despite the higher rates of health issues experienced by this population. Most importantly, there is no study available about sleep health in Indian homeless population. The awareness level of this population about importance of sleep in physical and mental functioning and consequences of poor sleep health is not reported in literature. Without this understanding, sleep hygiene strategies could not be implicated.

Therefore, there is need to explore their sleep health and related sleep disorders of Indian homeless population.

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