

# Natural Light Therapy to Lower Agitation and Sleep Disturbance of Dementia Patients in Semarang

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**Abstract---** Agitation is the mismatch of verbal, vocal, and motor activities that are not based on clear or confused needs. This disorder is a common and challenging symptom affecting dementia patients and impacting on sleep quality. This study aims to describe the effect of light therapy on agitation and sleep disturbance experienced by dementia patients in Semarang. The study used a quasi-experimental with one group design pre and posttest. The research samples were 83 respondents using a purposive sampling technique. The respondents received a daily routine of light therapy over a seven day period. Pre and posttest data were obtained from the Pittsburgh Agitation Scale to obtain agitation level and sleep pattern observation sheet to observe sleep disturbance. For the empirical investigation, 32 men and 51 women were recruited (mean age 67.35 years). Of these, 100% of respondents suffered a moderate level of agitation and 34.9% had sleep disturbance observed from sleep hours in a day. A Wilcoxon test was conducted to compare the agitation levels and sleep disturbance before and after light therapy. Findings showed that agitation level and sleep disturbance decreased with the light therapy ( $z = (-8.11)$ ,  $p < 0.05$ ;  $z = (-8.08)$ ,  $p < 0.05$ ). These findings suggested that light therapy confers benefits in terms of agitation and sleep disturbance in dementia patients, as well as cost-effectiveness in an intervention that can readily be implemented in nursing homes.

**Keywords---** Light Therapy; Agitation; Sleep Disorder; Dementia; Mental Illness

## I. INTRODUCTION

Dementia is a neurodegenerative syndrome caused by a chronic and progressive disorder accompanied by decreased brain function that affects emotions, memory and decision-making. Dementia is a neurodegenerative syndrome caused by a chronic and progressive disorder accompanied by decreased brain function that affects emotions, memory, decision-making, behavior and other brain functions that interfere with daily activities. These changes make various life activities—including interactions with other persons—increasingly difficult [1], [2]. Dementia is characterized by progressive cognitive disability, a high prevalence of neuropsychiatric symptoms such as agitation, depression, and psychosis, and reduced quality of life [1], [3].

Today, 47 million people live with dementia worldwide, and it is projected to increase to more than 131 million by 2050, as populations age [4]. Indonesia is the world's fourth most populated country. Its large population (over 257 million people in 2015) is relatively young compared to other countries in South East Asia. However, even with the relatively low proportion of older people compared to other countries, Indonesia is still ranked eighth in the world in terms of the overall number of older people. There are no locally generated estimates of the prevalence of dementia in Indonesia so far. Using data from comparable countries, the World Alzheimer Report 2015 estimated that, in 2015, there were just over 556,000 people with dementia in Indonesia. The prevalence of dementia increases by 1% at the age of 60

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years and doubles every 5 years, reaching 30% -50% by the age of 85 years (Soni et al., 2014). Much of the increase will take place in low and middle-income countries, 58% in 2015, rising to 63% in 2030 and 68% in 2050. The prevalence of dementia in Indonesia reached 1.2 million cases in 2015 and will continue to increase to 4 million in 2050[5].

People living with dementia often have sleep disturbances including difficulty falling asleep, nighttime awakening and wandering, and excessive daytime sleepiness. An investigation showed that over 60% of persons with neurodegenerative dementias, vascular dementia or mild cognitive impairment (MCI) had one or more sleep disturbances. These almost invariably associated one to another without any evident and specific pattern of co-occurrence. Other study stated that as many as 70% of patients in early-stage dementia have sleep disturbances. Sleep disturbance in people with dementia is predictive of poorer outcomes, including more severe cognitive and neuropsychiatric symptoms, and poorer quality of life. Among institutionalized dementia patients, sleep-wake cycles can be so disrupted that they are neither continuously awake nor asleep for a full hour for 24 hours [6]. Sleep disorders are related to Alzheimer's disease and begin in the prodromal phase of the disease; this may reflect an ongoing neurodegenerative process [7], [8]. Sleep disturbances not only exacerbate the patients' discomforts, but also impact family caregivers, who report that being woken during the night is the most distressing sleep disturbance [9].

Sleep disturbance is an important factor likely to contribute to the expression of agitated behaviors. Poor sleep is known to lead to poor mood, increased irritation, and lower threshold to pain in the general population. A study found that less night-time sleep of patients with dementia correlated.

Agitation is a nonspecific concept that broadly encompasses specific activity disturbances. It is the mismatch of verbal, vocal, and motor activities that are not based on clear or confused needs. Agitation includes aggressive and non-aggressive behavior or physical and verbal or vocal behavior. Verbal agitation was reported to be more common than physical agitation [10], [11]. Inappropriate verbal agitation refers to verbally non-aggressive behavior such as repetitive questions, complaining and attention-seeking behavior, and verbally aggressive behavior such as cursing and screaming [12]. Agitation may cause trouble for family members, caregivers, and other service users. Likewise, agitation in one resident may trigger agitation in the other residents [11].

Agitation, being one of the most commonly observed neuropsychiatric symptoms, is reported to be found in up to 70% of dementia patients [11]. Some conditions are more likely to contribute to agitated behaviors in patients with underlying dementia, partly because such persons have an impaired ability to obtain help for pain or discomfort through coherent conversation [11]–[13].

There is a high prevalence of dementia and disruption on sleep quality caused by dementia, as well as the impact of agitated behavior, so it is important to develop effective interventions for those with dementia. The treatment of sleep disturbance and agitation encompasses a multidisciplinary model that uses nonpharmacological and pharmacological/somatic approaches. Management of dementia using antipsychotic drugs causes side effects. The American (including the American Associations for Geriatric Psychiatry), British and Canadian Geriatrics Societies recommend non-pharmacological interventions as the first-choice approach in managing dementia-related agitation [11]. Nonpharmacological interventions are often effective for managing agitated behaviors to develop an appropriately stimulating environment, remove or limit exposure to noxious stimuli, and provide the patients with basic nutritional and personal needs. Various nonpharmacological therapies have been developed as an appropriate stimulus for patients to manage the settings and minimize events that can trigger agitation, one of which is light therapy[14]–[16].

Light therapy has been used to treat disruptive behaviors in dementia patients with variable short-term success, and it may be more effective in those with milder dementia [14]. Bright light therapy seems to be useful to reduce sleeping problems in dementia [14], [17]. Light therapy is an, environment-based treatment that was noted by Florence Nightingale as an important point in the healing process [14]. Research shows that daytime light exposure can consolidate sleep at night and improve nighttime sleep efficiency while increasing daytime wake-up and reducing night

agitation [15], [16]. This study aims to analyze the effectiveness of light therapy on agitation and sleep disturbance in the elderly with dementia in Semarang.

## II. METHODS

The study was a quasi-experimental design with one pre and posttest group. It was conducted between July 2019 and September 2019. A total of 115 residents in nursing homes in Semarang City were contacted for sample selection and all agreed to participate. Each participant was informed about the study nature, purpose, and benefits, the right to refuse or withdraw at any time, as well as the obtained data confidentiality.

The study was conducted with 83 respondents who met the inclusion criteria (Figure 1). Participants were selected based on inclusion criteria: (1) 60-80 years old, (2) MMSE score was lower than 24. Respondents in temporary respite care and those who had recent hospitalization were excluded as they were likely to be readjusting to the nursing home setting and this may affect their sleep patterns. The director of the nursing home compiled a list of eligible residents based on the criteria. Information on the capacity to give informed consent was also provided during this process. Once consent was obtained, the MMSE (Mini-Mental State Examination) was conducted with a nursing staff having three years experience who knew the participants well and signed an informed consent from the researcher. Demographic details were collected from the participant. The reasons for exclusion from this study were being younger than 60 years or older than 80 years, did not have dementia symptoms from Mini-Mental State Examination Score, having a diagnosis of major depression, and consuming medication that affected their sleep pattern.

- Interventions

The day before giving the first light therapy, the respondents' agitation level was observed by Pittsburgh Agitation Scale and respondents' sleep duration was observed using a table that contains the hours of sleep during the morning, afternoon, and night. Respondents were also explained about the light therapy procedure using a light therapy guideline book.

Light therapy was conducted by taking the respondents to the open field of the nursing home for exposure to natural, bright sunlight at 8am, assisted by facilitators. It was taken for one week (7 days) for 30 minutes. Respondents should not be looking at the light directly because it is potentially damaging to the eyes. They were also advised to use sunblock to prevent sunburn. Respondents' agitation level and sleep disturbance were then observed the day after this therapy for being posttest.

- Instruments

Respondents' agitation level prior and after the intervention was assessed through the Pittsburgh Agitation Scale (PAS), which is an easy-to-use instrument, based on direct observations of the patients and was developed to monitor the severity of agitation associated with dementia. Interrater reliability and measures of validity have been established with clinical staff on a busy psychogeriatric inpatient unit and with research personnel in a nursing home setting [18]. The scale focuses on four behavior groups: aberrant vocalizations, motor agitation, aggressiveness and resisting care. An intensity score, on a scale of 0 (not present) to 4 (highly present), is assigned to each behavior group. The ratings across the four behavior groups are summed to give the total score, with higher score indicating greater agitation.

Respondents' sleep disturbance was measured through the recapitulation of respondents' sleep duration observed using a table that contains the hours of sleep during the morning, afternoon and night. Sleep duration during the 24-h day was positively correlated with the severity of dementia in nursing home patients. Demented older adults exhibit significant sleep disturbance and degenerate sleep patterns, including shorter sleep duration and fragmented sleep [19].

All analyses were computed using IBM SPSS Version 23. Before the final analysis, data were screened for normality assumption. The normality test of data using the Shapiro-Wilk test revealed that the data were not normally distributed for the level of agitation and sleep disturbance. The demographic characteristics of the respondents are

reported as numbers and percentage distributions. Wilcoxon test was used to analyze the effect of light therapy on agitation and sleep disturbance. The study was declared to have passed the ethical review by the Research Ethics Committee Karya Husada Semarang College No.60/KH.KEPK/KT/I/2020.

### III. RESULTS

Eighty-three home care residents with dementia signs and symptoms were recruited to the study. Demographic characteristics by age, sex, education level, and religion are presented in Table 1, and demographic characteristics by agitation level and sleep disturbance are presented in Table 2.

Table 1. Demographic characteristic by agitation level and sleep disturbance

Variable	Level of Pittsburgh Agitation Scale (PAS)				Sleep Disturbance	
	No	Mild	Moderate	Severe	Sleep well	Sleep not well
Sex						
Male	0	0	32 (38.55%)	0	10 (26.5%)	22 (12.0%)
Female	0	0	51 (61.45%)	0	10 (12%)	41 (49.4%)
Total	0		83 (100%)		20 (38.5%)	63 (61.4%)
Age						
Pre-Elderly	0	0	25 (30.12%)	0	8 (9.6%)	17 (20.5%)
Early Elderly	0	0	50 (60.24%)	0	8 (9.6%)	42 (50.6%)
Late Elderly	0	0	8 (9.64%)	0	4 (4.8%)	4 (4.8%)
Total	0	0	83 (100%)	0	20 (24%)	63 (76%)

The observation of the agitation level found that all respondents (100%) had a moderate level of agitation, which is the level of PAS by age showing that 50% were early elderly respondents, while 38.5% of respondents slept well and 61.4% of respondents did not sleep well, which is 50.6% of early elderly respondents found as not sleeping well.

The table of descriptive statistics showed that mean, standard deviation, minimum, and a maximum score of agitation level decreased after light therapy. On the contrary, the sleep disturbance considered from respondents' duration of sleep in a day increased after light therapy (Table 3). These results were also indicated from the Wilcoxon Signed Rank Test (Table 4).

Table 2. Descriptive statistics for dependent variables

Variables	Pre therapy	Post therapy
Score of agitation (PAS)		
Minimum	15	7
Maximum	28	14
Mean	20.95	10.37
Std. Deviation	4.254	2.908
Sleep disturbance		
Minimum	3	4
Maximum	6	8
Mean	4.69	7.24
Std. Deviation	1.058	1.206

Statistical analysis using the Wilcoxon test indicated that there was a significant difference in agitation level ( $Z = -8.114$  based on positive ranks) and sleep disturbance ( $Z = -8.081$  based on negative ranks) pre- and post-light therapy (Asymp. Sig 2 tailed  $<0.05$ ) (Table 3).

Table 3. Wilcoxon Test Statistics for all dependent variables

Agitation Score Post - Pre	Sleep Disturbance
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Z	-8.114	-8.081
Asymp. Sig. (2-tailed)	.000	.000

#### IV. DISCUSSION

This study involved 60.24% early elderly who had signs and symptoms in MMSE detecting dementia in the elderly, while 30.12% were still pre-elderly and 9.64% were late elderly. The older age means a higher risk of dementia. Dementia mainly affects older people, although there is a growing awareness of cases that start before the age of 65. Population aging is having a profound impact on the emergence of the global dementia epidemic. A negative effect of the rapid aging of the population is the increase in the number of people with dementia. Although dementia mainly affects older people, it is not a normal part of aging. According to different estimates, between 2% and 10% of all cases of dementia start before the age of 65. The prevalence doubles with every five-year increment in age after 65.

The 76% of elderly with dementia are not sleeping well, of whom 67% of them are early elderly and 6% of them are late elderly. Sleep disorders are common in aging and increase with advancing age. Furthermore, sleep disturbance is impaired possibly due to an ongoing neurodegenerative process, and in cognitive healthy controls poor sleep is associated with poor episodic memory and executive functioning [7]. As humans age, sleep patterns change, most commonly, with advancing age, persons have difficulty falling back to sleep. Severe sleep disturbance may lead to depression and cognitive impairments. Lack of sleep can impair memory, disrupt metabolism, and hasten death.

Light plays an important role in the secretion of melatonin, as well as serotonin (Lindquist, 2013). Melatonin is a natural hormone produced by the pineal gland located at the center of the brain. Melatonin is used to induce a person's sleep so that someone will easily start sleeping, reduce the frequency of waking up at night and prevent waking up too early. The melatonin of the elderly who have not been exposed to enough sunlight is decreased. This causes the body of the elderly to be unable to distinguish day and night, resulting in insomnia in people with dementia. This factor disrupts the body's biological clock so that a person will be more difficult to sleep soundly (Nakamura et al., 2013). Therefore, melatonin is needed for good sleep patterns.

Light therapy for the treatment of sleep problems in older adults has been suggested by several studies [9], [15]–[17], [20], [21]. Light therapy has shown promise as a nonpharmacological treatment, noninvasive therapy, and preliminary studies demonstrate that timed light exposure can consolidate and improve nighttime sleep efficiency, increase daytime wakefulness and reduce evening agitation without the adverse effects of pharmacological solutions. It also has been suggested that light therapy may be an effective therapy for improving sleep patterns of individuals with dementia. The present study showed that, for the elderly with dementia, sunlight therapy significantly increases sleep quantity for up to seven days of treatment. The total sleep time average before sunlight exposure was 4.69 and 7.24 after therapy. Moreover, there was a significant difference in sleep quantity score averages pre- and posttest natural light therapy ( $p < 0.005$ ). These results are consistent with other studies that revealed that light therapy improved the quantity of sleep [14], [17], [22].

A study in geriatric units on 66 older adults with dementia suggested that bright light had a modest but measurable salutary effect on sleep. Further, the investigators concluded that ambient light might be preferable to stationary devices, such as light boxes, for older people with dementia in long-term care settings. However, the impact of bright light on sleep and behavior in dementia patients is inconclusive.

Light therapy is effective in additional older populations. Seniors living in long-term-care facilities had improved cognitive function indicators as well as improvement in anxiety scores when receiving light therapy. Further, 89 patients over the age of 60 with major depressive disorders demonstrated improved mood, increased sleep efficiency, and a

steeper rise of evening melatonin when exposed to three weeks of bright light therapy. Light therapy can relieve behavior disorders, improve sleep quality, and alleviate symptoms of depression for cognitively impaired persons.

Results from other studies indicated that 5-days exposure to natural sunlight for older adults has a positive effect on sleep quality, particularly for those with chronic disease and those with long-term nursing home stays ( $p < .001$ ). Natural sunlight exposure was recommended for the elderly with sleep problems and no allergies. The exposure to direct sunlight was between 8am and 10am for five days [21]. The time of day is also an important consideration in light therapy. The study concluded that early-morning exposure was more effective in reducing depression than when administered at other times of the day. Morning light therapy significantly increased total and nocturnal sleep time and significantly decreased daytime sleep time. Thus, morning bright light is a powerful synchronizer that can normalize disturbed sleep and substantially reduce the frequency of behavior disorders in elderly people with dementia.

Reducing sleep disturbance was also related to circadian rhythms that are known to be entrained by light exposure. When circadian rhythms are well-entrained, the suprachiasmatic nucleus (SCN) oscillates in time with the external day-night cycle, and all other body tissues and organs are synchronized by the SCN's rhythmic signal [22]. A previous study found evidence of small but statistically and clinically significant improvements in sleep continuity disruption, self-reported sleep disturbance, and sleep timing that can be achieved through altering light exposure patterns in some groups. Thus, the findings support the use of morning light exposure to advance sleep timing and hasten sleep onset in delayed sleep phase disorder. The other study showed that five consecutive days of 30-min exposure to sunlight, increased physical activity and structured bedtime and control of light and noise at night resulted in a significant decrease in daytime sleeping in intervention participants compared with controls. Light therapy was found to exhibit more consolidated sleep at night, as measured by the average length of maximum nocturnal sleep bouts [15], [16].

This current study showed that there is a relationship between light therapy and the quantity of sleep ( $p < 0.05$ ) based on negative ranks test. But, changes to mean total sleep time are difficult to interpret without individual patient data or sub-grouping by baseline sleep duration. Results from other studies also recommended that studies of light schedule interventions consider stratifying participants by baseline total sleep time. A future review of this topic might examine this outcome using individual patient data [22].

Study analysis showed that mean, standard deviation, minimum, and the maximum score of agitation level decreased after light therapy (mean of agitation level pre-therapy = 20.95, post-therapy = 10.37). Agitation, being one of the most commonly observed neuropsychiatric symptoms, is reported to be found in up to 70% of dementia patients [11]. Within the last decade alone, numerous studies have been published describing the effectiveness of the non-pharmacologic interventions in the prevention and treatment of dementia-related agitation.

Natural light exposure was associated with a reduced risk of agitation episodes [23]. Sunlight induces a positive mood as follows. Morning sunlight contains serotonin that eliminates bad mood, stress, and acute to chronic depression. The non-visual effects of sunlight through the retinohypothalamic tract (RHT) are known to influence both the limbic and endocrine systems, thus influencing mood and cognition. The dominant wavelength of sunlight (477 nanometers) through the retinal pathway modulates suprachiasmatic nuclei (SCN), which, in turn, regulates hormonal systems, blood pressure, and cognitive functioning. SCN affects pineal glands and restricts the conversion of serotonin to melatonin. Serotonin, the "feel good" hormone, is associated with happiness, contentment, and relaxation, whereas melatonin, a derivative of serotonin, or the "wonder hormone", affects sleep patterns and acts as an antioxidant [24].

Short-term benefits from higher daily light exposures indicated significantly reduced agitated behavior in demented patients. Disturbances of circadian rest-activity rhythms in demented patients often culminate in the clinical problem of an evening and nighttime agitation [22]. Meanwhile, as agitation in dementia patients may be due to other causes, focusing to alleviate sleep disorders problems may markedly help the management of behavioral symptoms related to dementia. Likewise, dealing with hypothesized unmet needs of dementia patients plays a remarkable role in managing

agitation-related symptoms in dementia [11]. Thus, light therapy intervention programs that aim to address unmet needs related to sleep disturbance likely reduce agitation in dementia patients.

Based on the above discussion, we propose a possible pathway to explain the effectiveness of sunlight therapy to decrease the agitation level and improve sleep quantity. Increasing intensity of sunlight affects SCN functioning, which increases serotonin levels and limits the conversion of serotonin to melatonin, thus increasing an individual's total levels of happiness, contentment, and relaxation. These also associated with positive mood influences sleep quality and also personal behaviors such as agitation.

## V. CONCLUSIONS

Natural light therapy for 30 minutes for seven days decreases the agitation level of patients with dementia. This intervention also increases the quantity of sleep. Future study needs to assess if light therapy can also improve sleep quality. Finally, when assessing the effect of light on agitation and sleep disturbance in the elderly with dementia, it is important to also consider other environmental factors and comorbidities and other therapies impacting sleep and behavior in the elderly with dementia. Future studies should investigate whether light can be more effective at treating agitation and sleep disturbance if combined with some of these other therapies.

## CONFLICT OF INTEREST

The authors do not have any conflicts of interest to disclose.

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