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Effect of Natural Sunlight on Sleep Problems and Sleep Quality of the Elderly Staying in the Nursing Home

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This study was designed as an intervention study to determine the effect of light therapy on sleep problems and sleep quality of elderly people. The study sample was composed of a total of 61 elderly persons from Social Security Institution Narlıdere Municipal Nursing Home, 30 in the test group and 31 in the control group. Those 65 years and older, not diagnosed with major depression, not exercising regularly, not having sun allergy, not using sleeping pills, independent in activities of daily living, and having bad sleep quality were included in the study. The Pittsburgh Sleep Quality Index, the Demographic Data Form, and the Follow-up Form for Elderly were used for data collection, whereas the Pittsburgh Sleep Quality Index was used for sample selection. It was found that exposure to direct sunlight between 8 AM and 10 AM for 5 days seems to be effective in increasing the global sleep quality score ($P < .001$). In light of the findings in this study, it is suggested that allocating living places in the institution's architectural setting and providing social opportunities for elderly persons to get direct sunlight exposure can help increase the sleep quality of older adults. **KEY WORDS:** *elderly*, *light therapy*, *nursing home*, *sleep quality*

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Sleep problems occur in 20% to 40% of the population, while this rate reaches to 50% in people 65 years and older.[1] It has been reported that in the United States, 68% of individuals 50 years and older have sleep problems.[2] The frequency of sleep problems in Turkey is 43.5%, while the prevalence of having trouble falling asleep is 35% to 54% for those who reside in nursing homes where sleep problems are common.[3,4] In another study to determine the sleep patterns in nursing home residents, it was found that 58.3% of the older adults had woken up frequently after falling asleep, 56.1% did not feel rested after waking up, and 47.8% had difficulty falling asleep.[5] In another study conducted by Fadıloğlu et al[6] on individuals 60 years and older, it was found that 77% of them had poor quality of sleep.

Sleep disorders and sleep problems can be treated by pharmacological and/or nonpharmacological methods.[7] The pharmacological treatment methods involve hypnotic drugs, primarily benzodiazepines and nonbenzodiazepines, melatonin receptor antagonists, and antidepressants. The nonpharmacological methods include stimulus control, sleep hygiene education, sleep restriction, relaxation techniques, cognitive-behavioral therapy, and light therapy.[8,9] In addition to these methods, alternative therapies such as *tai chi*, aromatherapy, and massage are used to treat sleep disorders.[9] Nonpharmacological approaches have been proven to be sufficient for elderly individuals to avoid polypharmacy.[7] It is emphasized that pharmacological methods should be used in cases where nonpharmacological methods are not sufficient.[10]

One of the methods used to treat sleep problems in elderly people is light therapy. In light therapy (also known as phototherapy or heliotherapy), light is applied to the eyes of the elderly in the morning and in the evening for 30 to 120 minutes at an intensity of 2500 to 10 000 lux with the aid of a device.[11] However, there are practical problems in the application of light

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since it is difficult to get a device for every single patient because of its high cost and since the application of the light directly to the eyes of the older adults escalates eye diseases and eye sensitivity, which already increase at advanced age.[12] Furthermore, various studies have shown that natural sunlight is more effective than artificial light in treating seasonal depression,[13] in relieving the symptoms in Alzheimer disease, and in circadian rhythm correction.[14] For this reason, it is emphasized that the light needed by the elderly can also be taken directly from the sun.[12,14]

It is known that exposure to bright light affects the circadian rhythm phases. It has been reported that a light therapy involving 2500 lux of bright light applied for 2 hours between 6 AM and 9 AM for 1 week and avoiding bright light in the afternoon and evening hours helps falling asleep earlier.[15] In addition, studies have reported that there is a direct relationship between natural sunlight exposure and melatonin release.[14]

Light therapy is not frequently used for treating sleep problems in Turkey since the efficacy and effects of light therapy are not well-defined. The purpose of this study was to determine the sleep quality of the older adults and to investigate the effect of light therapy on sleep quality by applying bright light therapy as a nonpharmacological treatment to those with poor sleep quality.

MATERIALS AND METHODS

The study was conducted between May 2011 and September 2011 with 312 elderly people residing in the Social Security Institution Narlıdere Municipal Nursing Home. A total of 312 residents were contacted for sample selection; 290 individuals who agreed to participate completed the forms. The study was conducted with 70 individuals who met the inclusion criteria (Figure).

The reasons for exclusion from the study were being younger than 65 years, having a diagnosis of schizophrenia or major depression, being able to maintain daily activities independently, being in a cognitive state that will prevent communication, using sleeping pills, having an acute physical anomaly that prevents the participant from having sun exposure during the study, having sun allergy (photosensitivity), not giving consent to participate in the study, or having a sleep quality score below 5.

Power analysis, which is used to calculate the minimum sample size required for the study, indicated that the inclusion of 12 subjects was sufficient for this study. The study was carried out with a total of 61 subjects, 30 subjects in the experimental group and 31 in the control group. Those who agreed to take part in the study were first given the consent form to read and sign. Then, they were given the Elderly Individual Information Form, which includes demographic questions about the subject such as age, gender, height, weight, educational status, marital status, financial status, reason for staying at nursing home, length of stay, past sleep problems, chronic diseases, and use of sleeping pills. The Pittsburgh Sleep Quality Index (PSQI) was then administered to all subjects to determine their sleep quality.

The Pittsburgh Sleep Quality Index

The PSQI is an instrument that assesses sleep quality through use of a scale. It was developed in 1989 by Buysse et al and refined by Ağargün et al[16] in 1996, who studied the instrument's validity and reliability for a Turkish sample. Administering and scoring the test takes 5 minutes. There are 24 PSQI questions, 19 answered by the research subject and 5 answered by the partner or roommate. The 19th question answered by the research subject is about whether or not there is a partner or roommate. The last 5 questions answered by the partner/roommate are used only for clinical information and are not taken into account when PSQI scores are being determined. The 18 items included in the scoring are grouped into 7 component scores. Some of the components are represented by a single item, whereas others are obtained by grouping several items. Each item is graded from 0 to 3 points. The sum of 7 component scores gives the total PSQI score. The total score ranges from 0 to 21; the higher the score, the poorer the sleep quality.

RESEARCH APPLICATION PROCESS

The experimental and control groups were matched according to age, gender, educational background, and PSQI score.

Experimental group

Experimental group subjects were taken to the garden of the nursing home for exposure to natural, bright sunlight between 8 and 10 AM after their first meal for 5 days. Observations in this time period (first meal or

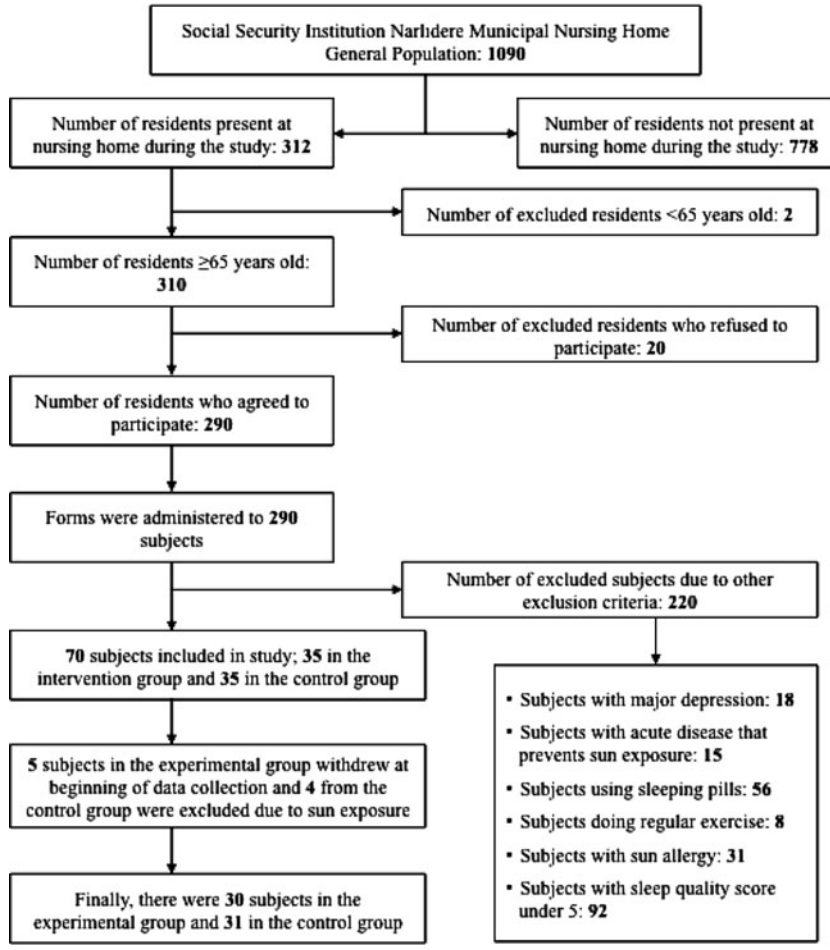

FIGURE. Flowchart describing the decision-making progress and the inclusion criteria for elderly people who participated in the sampling test.

not, hours of sun exposure, blood pressure, and pulse rates) were recorded in the Elderly Inspection Forms. Participants remained in the garden for 30 to 120 minutes. They were separated into 4 groups in terms of time periods: 30 to 60 minutes, 60 to 90 minutes, 90 to 120 minutes, and 120 minutes. The time spent in the garden was recorded for each subject for 5 days. The PSQI was readministered after the fifth day, and brochures on healthy sleep were distributed to subjects.

Control group and statistical analysis

The Elderly Identification Form was administered to control group subjects. The Consent Form was discussed and signed by all subjects. The PSQI was administered to control group subjects twice, the first time as a pretest measure and to establish a baseline with the experimental group and the second time after remaining in their rooms, in the canteen, or the nursing home living rooms while the experimental group spent time in direct sunlight. Brochures on healthy sleep were distributed to the control group after the administration of the second PSQI.

Evaluation of the data was conducted using Statistical Package for Social Sciences (SPSS 16.0). Sociodemographic characteristics of the patients are reported as number and percentage distributions. Chi-square test, correlation analysis, one-sample *t* test, one-way analysis of variance, and the Mann-Whitney *U* test were used to analyze the PSQI data.

FINDINGS

Subjects were 75 to 84 years of age; 63.3% were female, 53.3% were widowed, 56.5% ranged in height from 138 to 159 cm, and 47% ranged in weight from 50 to 65 kg. Furthermore, 56.7% were high school graduates, 86.6% had equal income-expense budgets, and 47.3% moved to the nursing home because of the inability to conduct self-care.

Subjects in the experimental group with chronic diseases had lower scores of global sleep quality. However, compared with the control group, the difference was not statistically significant. Furthermore, subjects who resided in the nursing home for more than 7 years had lower sleep quality scores. Among the combined experimental and control groups, diabetes mellitus and hypertension were the most frequently occurring diseases and those with at least one chronic disease used at least one medication (Table 1). There were no significant differences between the experimental and control groups in terms of sociodemographic characteristics.

For subjects in the experimental group, the duration of sunlight exposure ranged from 150 to 510 minutes at the end of the 5-day period (Table 2). On the fifth day of the intervention, the number of subjects who remained in the garden for 30 minutes decreased by 50%; however, those who remained in the garden from 30 to 60 minutes increased each day. No subjects appeared in the 90- to 120-minute exposure group during the first 2 days, but after the third day, a few subjects appeared in this group, indicating, at least for some, an increased tendency to get sun exposure (Table 3). There were no statistical differences in blood pressure and pulse rate averages in the experimental group before and after the sun exposure (Table 4).

Considerable statistical difference was found between the experimental and control groups in terms of subjective sleep quality (compound 1), sleep latency (compound 2), sleep duration (compound 3), sleep activity (compound 4), sleep disturbance (compound 5), and daytime dysfunction (compound 7) scores as measured at the first day and the fifth day ($P < .001$) (Table 5). There was also a statistical difference between the average sleep quality scores of the experimental and control groups. The average global sleep quality score improved from 10.45 ± 1.98 to 6.081 ± 2.45 after sunlight exposure ($P < .001$) (Table 6).

A strong positive relationship was found between sunlight exposure time and the components of sleep duration, regular sleep activity, and daylight sleep dysfunction (Table 7). There is also a strong relationship between sunlight exposure time and average sleep quality scores ($P < .001$). It should be noted that there was no difference in global sleep quality scores among subjects who remained in sunlight for at least 30 minutes daily compared with those remained for at least 100 minutes. It was observed that male subjects' global sleep scores improved more after the sunlight exposure than female subjects' scores, although this difference was not statistically significant.

DISCUSSION

Exposure to light-dark patterns is one of the main environmental cues for circadian rhythms that influence 24-hour biological, mental, and behavioral patterns such as sleep quality.[17-19] The present study showed that, for elderly people, natural sunlight therapy could significantly improve sleep quality and its subcomponents for up to 5 days after therapy. Fifty-nine percent of experimental and control subjects were high school graduates, in contrast with Çuhadar's[20] subjects who were primarily illiterate (35.7%), with only 10% having attended high school or college.[20] Current study findings revealed that 47.5% of subjects moved to nursing homes because of an inability to take care of themselves. Çuhadar's research revealed that 14.3% of subjects moved to nursing homes because of self-care deficits whereas 42.9% had been rejected by their families. Higher care expectations among the subjects of the current study could be related to higher education levels.

Sleep quality score average before sun exposure in the experimental group was 10.45 ± 1.98 compared with 9.48 ± 2.29 in the control group. Results from other studies on the sleep quality of the older adults as a function of sunlight exposure show similarities with the current study's findings; sleep quality scores reported by Ağargün et al[16] was 7.4, by Demirli[21] 10.21 ± 0.72; by Fadıloğlu et al[6] 8.02 ± 2.87, and by Akyar[3] 12.87 ± 4.2.

In the current study, there were significant decreases in global sleep quality averages and total subcomponent scores after the natural sunlight application in elderly subjects. Moreover, there were significant differences in sleep quality score averages pre- and posttest exposure to natural sunlight ($P < .001$). In a study by Wirz-Justice et al[22] and Benca,[23] elderly subjects who had direct exposure to sunlight in the early hours of a day slept more at night and took fewer naps in a day.

In a study conducted at 4 nursing homes in Los Angeles, Bloom et al[24] found that elderly subjects who had exposure to sunlight for 30 minutes a day slept more at night and less in daytime. These results are comparable with the results of other studies related to sunlight exposure.

TABLE 1. Demographic Information of Elderly Participants in the Experimental and Control Groups

Demographic Information	Experimental		Control		*P*
	n	%	n	%	
Age group ($X \pm$ SD = 78.96 ± 3.16 y; range, 75-84 y)	30	100	31	100	1.000
Gender					
Female	19	63.3	19	61.3	.387
Male	11	36.7	12	38.7	
Height					
138-159 cm	17	56.5	14	45.2	
160-181 cm	13	43.5	17	54.8	.205
Weight					
50-65 kg	14	46.7	15	48.4	
66-90 kg	14	46.7	15	48.4	.811
≥91 kg	2	6.6	1	3.2	
Marital status					
Married	9	30.0	5	16.1	.376
Single	2	6.7	6	19.4	
Widow	16	53.3	18	58.1	
Divorced	3	10.0	2	6.5	
Educational background					
Primary school	0	0.00	3	9.7	
Secondary school	13	43.3	8	25.8	.562
High school	17	56.7	19	61.3	
College	0	0.00	1	3.2	
Financial income					
Income < expense	2	6.7	2	6.5	
Income = expense	26	86.6	22	71.0	.773
Income > expense	2	6.7	7	22.5	
Institutional emplacement factors					
"Because I can't maintain my own care"	13	43.3	16	51.6	
"Because I am all alone"	9	30.0	7	22.6	.674
"Because my family do not accept me"	2	6.7	2	6.5	
"Because I don't want to be a burden to anybody"	6	20.0	6	19.4	
Duration of stay at the nursing home					
Less than a year	6	20.0	4	12.9	
1-3 y	5	16.7	6	19.4	.301
4-6 y	7	23.3	9	29.0	
>7 y	12	40.0	12	38.7	
Chronic illness situation					
Yes	26	86.7	26	83.9	1.000
No	4	13.3	5	16.1	
Chronic illness					
No chronic illness	4	13.3	5	16.1	
Hypertension	3	10.0	2	6.5	
Cardiac insufficiency	2	6.7	4	12.9	
DM	4	13.3	2	6.5	
Osteoporosis	4	13.3	2	6.5	.102
Asthma/COPD	2	6.7	5	16.1	
HT and DM	4	13.3	3	9.7	
KY and osteoporosis	2	6.7	4	12.9	
HT and asthma/COPD	3	10.0	4	12.9	
DM and asthma/COPD	2	6.7	. . .	. . .	
Total	30	100	31	100	

Abbreviations: CHF, chronic heart failure; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; HT, hypertension.

TABLE 2. Experimental Group Ranges of Time to Exposure to Natural Sunlight

	Total Minutes[a]										
	150 min	180 min	210 min	240 min	270 min	300 min	390 min	420 min	450 min	510 min	Total
Number of people	6	3	3	2	6	5	1	2	1	1	30
%	20	10	10	6.7	20	16.7	3.3	6.7	3.3	3.3	100

[a]Sun exposure durations of the experimental group after 5 days.

Wirz-Justice et al[22] demonstrated that 1-hour daily sun exposure significantly prevents sleep problems. When subjective sleep quality, sleep latency, sleep duration, sleep activity, sleep disturbance, and daytime dysfunction scores were considered, the current study revealed a positive difference between pre- and posttest measurements of sleep quality in experimental subjects compared with the control group, similar to the other studies in literature ($P < .001$).

Although all subcomponents improved after sun exposure, maximal changes were seen in daytime dysfunction and sleep latency and minimal changes in sleep activity scores and sleep disturbance. This suggests that the readjustment of circadian rhythms of subjects after sunlight exposure led to falling asleep earlier and easier. Furthermore, the elderly who sleep more at night, perform their daily activities more effectively.

Findings suggest that length of stay in the institution is the most important factor that may influence the positive effects of sunlight exposure.[25] In the current study, subjects with more than a 7-year stay had the best improvement in the global sleep quality scores. This finding is in line with that of Akyar's[3] study. This may be due to the fact that length of stay is associated with more chronic sleep problems in the elderly staying in nursing homes since they have less mobility and access to sunlight in that environment for a longer time.[25] It was also found that subjects with chronic diseases had more improvement in the global sleep quality scores. This may be related to more sleep

TABLE 3. Experimental Group Ranges of Sun Exposure Duration by Day

	1st Day	2nd Day	3rd Day	4th Day	5th Day
30 min	18	15	13	12	7
30-60 min	10	13	13	11	17
60-90 min	2	2	3	5	3
90-120 min	. . .	. . .	1	2	3
Total number of people	30	30	30	30	30

TABLE 4. Experimental Group's Measurements of Pulse and Blood Pressure Before and After Sun Exposure

	Blood Pressure, mm Hg								
	Systole			Diastole			Pulse, beats/min		
Days	$X \pm SD$	t	P	$X \pm SD$	t	P	$X \pm SD$	t	P
1st day[a]	118 ± 11.3	−0.14	.89	69 ± 6.90	−1.33	.18	81 ± 5.30	−1.21	.22
1st day[b]	118 ± 10.3			71 ± 6.20			80 ± 5.6		
2nd day[a]	119 ± 10.3	−2.44	.14	71 ± 7.70	−1.41	.15	81 ± 5.80	−0.90	.36
2nd day[b]	116 ± 9.4			72 ± 6.39			81 ± 6.63		
3rd day[a]	117 ± 12.0	−1.05	.29	72 ± 8.37	−1.46	.14	82 ± 6.09	−0.71	.94
3rd day[b]	118 ± 10.3			70 ± 6.95			82 ± 5.59		
4th day[a]	117 ± 10.1	−0.68	.49	71 ± 7.46	−1.33	.18	81 ± 5.34	−1.74	.08
4th day	117 ± 11.3			73 ± 9.7			83 ± 10.0		
5th day	117 ± 11.9	−0.20	.84	74 ± 12.6	−0.97	.33	84 ± 8.11	−1.81	.06
5th day	117 ± 13.3			75 ± 12.0			83 ± 7.26		

[a]First measurement before sun exposure.
[b]Last measurement after sun exposure.

TABLE 5. Global Sleep Quality Scores Before and After Natural Sunlight Exposure and Analysis of Pittsburgh Sleep Quality Index Subcomponent Score Averages

Sleep Quality Subcomponents	Experimental (n = 30)/ Control (n = 31)	1st Measure[a]			2nd Measure[b]			Difference Between 2 Measures, *P*
		X ± SD	*t*	*P*	*X* ± SD	*t*	*P*	
Subjective Sleep Quality score	Experimental	2.16 ± 0.37	−0.71	.47	1.33 ± 0.47	−1.17	.00	
	Control	2.09 ± 0.39			2.03 ± 0.40			**.00**
Sleep Latency score	Experimental	2.21 ± 0.70	−2.02	.43	1.36 ± 0.61	−3.84	.00	**.00**
	Control	1.87 ± 0.70			2.01 ± 0.53			
Sleep Latency score	Experimental	2.03 ± 0.55	−1.43	.15	1.50 ± 0.73	−1.72	.06	**.00**
	Control	1.77 ± 0.80			1.87 ± 0.76			
Sleep Latency score	Experimental	1.75 ± 0.39	−0.69	.49	1.40 ± 0.51	−2.77	.00	**.00**
	Control	1.68 ± 0.38			1.76 ± 0.43			
Sleep Disorder score	Experimental	0.76 ± 0.39	−1.5	.11	0.41 ± 0.21	−3.14	.07	**.00**
	Control	0.61 ± 0.35			0.69 ± 0.35			
Daytime Dysfunction score	Experimental	1.58 ± 0.64	−0.56	.57	0.81 ± 0.38	−0.56	.00	**.00**
	Control	1.46 ± 0.53			1.43 ± 0.57			
Global Sleep Quality score	Experimental	10.45 ± 1.98	1.95	.05	6.81 ± 2.45	−4.67	.00	**.00**
	Control	9.48 ± 2.29			9.79 ± 2.24			

[a]Before an exposure of natural sunlight.
[b]After an exposure of natural sunlight (after fifth day).

problems in the older adults due to the discomfort associated with chronic diseases. Although there was no intervention in the elderly in the control group, there is a slight increase in global sleep quality scores.

The fact that for the older adults in the experimental group, getting out to get sunlight every day for 5 days can be considered a social activity, which may explain the lessening of daytime dysfunction in this group. Other studies have found that interventions such as social activities reduce the daytime naps of elderly people and improve their quality of life.[3,24]

The relationship between the global sleep scores of the elderly individuals receiving minimum sunlight (average of 30 minutes per day for 5 days) and maximum sunlight (average of 100 minutes for 5 days) in the experiment group was examined. Although there is a relationship between the length of sunlight exposure and the subscales of Subjective Sleep Quality and Sleep Disorder, this difference was not statistically significant ($P > .05$). A weak negative correlation was found between the length of sunlight exposure and sleep latency, indicating that those getting more sunlight fell asleep faster; however, this relationship was also not statistically significant ($P > .05$).

Hanford and Figueiro[26] found that individuals with seasonal depression slept longer, woke up less through

TABLE 6. Analysis of PSQI Global Sleep Quality Scores of Experimental and Control Groups After Sun Exposure

Group	n	*X* ± SD	*t*	*P*
Experimental	30	3.64 ± 1.92	10.30	.000
Control	31	−0.3 ± 0.08	−1.69	.101

Abbreviation: PSQI, Pittsburgh Sleep Quality Index.

TABLE 7. Relationship Between Duration of Sun Exposure and Sleep Quality Averages and Sleep Quality Subcomponent of Experimental Group Subjects

	Total Minutes		
	Correlational Coefficient (*r*)	*P*	n
Subjective Sleep Quality (1st component)	0.31	.08	30
Sleep Latency (2nd component)	−0.22	.23	30
Sleep Duration (3rd component)	0.69	.00	30
Regular Sleep Activity (4th component)	0.55	.00	30
Sleep Disorder (5th component)	0.32	.07	30
Daytime Sleep Dysfunction (7th component)	0.61	.00	30
Average of Sleep Quality score	0.65	.00	30

the night, and experienced disease remission when exposed to natural sunlight during the day. A 1983 research study on the effect of natural sunlight on sleep documented changes in melatonin secretions in individuals periodically exposed to sunlight for 1 week and found that sun exposure affects the sleep cycle.[27,28] Research on nurses who work shifts at Akdeniz University Hospital revealed that those exposed to sunlight at least 3 hours per day were less stressed and exhausted. Concomitantly, those nurses who had sleep problems reported more exhaustion.[29] Wirz-Justice et al[22] found that individuals exposed to sunlight for 1 hour per day for 1 week spent less time awake in bed and slept more at night. In the current study, a statistically significant positive relationship was found between being exposed to sunlight and the sleep quality subcomponents of sleep duration, regular sleep activity, and daytime sleep dysfunction as well as average sleep quality scores. However, no significant difference was found between improvements in the global sleep quality scores of subjects who were exposed to sunlight for 30 or 100 minutes per day. This suggests that 30-minute sun exposure provides sufficient improvement and there is no more gain from longer sun exposure in terms of sleep quality.

CONCLUSION AND RECOMMENDATIONS

Findings of this study indicate that 5-day exposure to natural sunlight for older adults individuals has a positive effect on sleep quality, particularly for those with chronic disease and those with long-term nursing home stays. For the elderly with diagnosed sleep problems and no allergies to natural sunlight, natural sunlight exposure for 30 minutes per day is recommended.

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