

# The effect of light therapy on the sleep quality of the elderly: an intervention study

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## KEYWORDS

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## ABSTRACT

### Objective

The study was conducted to determine the effect of light therapy on the sleep quality of older adults.

### Design

This interventional study was conducted with a single group pre-test, post-test model.

### Setting

The study was conducted in a nursing home in Ankara, Turkey.

### Subjects

Twenty-four older adults with poor sleep quality were included in the study.

### Intervention

During the study procedure, a 10,000 Lux light was administered continuously for a half-hour duration in the morning over a one-month period.

### Main outcome measures

The main outcome measures included global and subcomponents of sleep quality, which were assessed by the Pittsburgh Sleep Quality Index, and were repeatedly measured at the baseline, pre-intervention (four weeks at baseline), post-intervention (at the end of intervention/eight weeks at baseline), and follow-up (four weeks at intervention).

### Results

At the end of light therapy intervention and during the four-week follow-up period, the global sleep quality scores were found to be higher compared with pre-intervention and baseline scores ( $p < 0.001$ ). The 'daytime dysfunction' and 'sleep latency' sub-scores were found to be the most positively changed, whereas the change in 'duration of sleep' sub-score was less.

### Conclusion

Light therapy has been shown to be effective non-pharmacological therapy for improving sleep quality among healthy elders.

## INTRODUCTION

Sleep problems are frequently observed among older adults. While the prevalence of sleep disorders is 20–40% for the population in general, this rate rises to 50% in people who are 65 years and older (Mathews et al 2004). Sleep problems are characterised by reduction in the duration, quality, or efficiency of sleep. Problems among older people may involve sleeping early, waking up early, a decrease in sleep duration, taking longer to fall asleep, frequently waking up at night, and sleeping in the daytime (Voyer et al 2006; Zee and Bloom 2006; Van Someren 2000).

Different factors can influence the sleep pattern of elderly people, for example, changes in physiological, psychological, emotional, cognitive, and social status; chronic disorders and treatments; economic and physical deficiencies; and changes of place (Vitiello 2006; Zee and Bloom 2006). Furthermore, it is generally acknowledged that sleep disorders in the elderly usually emerge due to the disturbance of the circadian rhythm, which is regulated on a 24-h basis with light intake during daytime, meal hours, physical activity, and social interactions (Aminoff 2008; Kryger et al 2000; Van Someren 2000).

Conditions such as living in institutions, physical handicaps, and a decrease in retinal sensitivity prevent the elderly from receiving enough light and may lead to problems in circadian rhythm regulation (Figueiro et al 2008; Alessi et al 2005; Hood et al 2004). Shochat et al's (2000) study reported that the elderly who are independent in their daily activities receive light for an hour during the day; however, this light intake is reduced to 10 minute for those living in institutions.

Circadian rhythm disorders are regulated by means of light therapy. The main principle of light therapy is circadian rhythm and melatonin secretion regulation (Sloane et al 2007; Terman 2007; Chesson et al 1999). The light received in the daytime stimulates photoreceptors and the suprachiasmatic nucleus through the retina and forces melatonin secretion in the pituitary gland to take place at night (Wu and Swaab 2007; Montgomery and Dennis 2002; Mishima et al 2001).

Research about light therapy mostly focused on sleep-wake disturbances such as jet lag and shift-work adaptation, depression, and managing behavioral disturbances and other nocturnal sleep disruptions in the elderly (Gammack 2008; Montgomery and Dennis 2002). Many studies proved that light therapy effectively improves the sleep quantity in the elderly (Montgomery and Dennis 2002). For the treatment of sleep problems, light should be used with a volume of 2,500–10,000 Lux for 30 minutes to 2 hours in the morning or in the evening (Montgomery and Dennis 2002; Chesson et al 1999).

Considering the problems it causes, inadequate and low-quality sleep is a very serious issue for the elderly. Since nurses are key members of the health team and are likely to be the first to detect problems in patients, influence drug decisions, and actively implement non-pharmacological treatments, their role is particularly important in monitoring and treating sleep problems (Hoffman 2003). It is also very important for nurses to remain up-to-date regarding the latest non-pharmacological approaches available to help the elderly improve their duration and quality of sleep.

## AIM

The study determines the effect of light therapy on the elderly living in nursing homes.

## METHODOLOGY

### Sampling

The study was conducted as an intervention study to determine the effect of light therapy on the elderly living in nursing homes. The number of the elderly to be included in the sample was calculated as at least 12

using the Number Cruncher Statistical System and the Power Analysis and Sample Size program in repeated measures variance analysis ( $\alpha$ : 0.05). Taking into consideration possible losses during the study, 24 literate individuals 65 years and older participated. Individuals were eligible if they were suffering from poor sleep quality (Pittsburgh Sleep Quality Index (PSQI) score higher than 5), were independent in daily activities, and were not using hypnotic drugs or drugs that might influence sleep<sup>1</sup>. All subjects diagnosed with Parkinson's disease, depression, psychiatric disorders, cognitive disorders, active disorders that might influence sleep quality, and communication problems were not included in the study.

### Data collection

Data were collected via a general questionnaire, weekly follow-up form, and the PSQI. The general questionnaire collected socio-demographic data and clinical and sleep features. The clinical and sleep features investigated the elderly's chronic diseases, medications, exercise, participation in institutional activities, light intake during daytime, lighting of room and noise exposure during sleep, smoking/alcohol consumption, and sleep problems.

The weekly follow-up form gathered information related to changes in health condition, treatment, and conditions (such as experience of loss and mourning) leading to intensive stress.

The PSQI measured sleep quality. The PSQI is a self-administered questionnaire with 19 questions and 7 components: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction. Global score is calculated as 0–21, with higher scores indicating lower-quality sleep. This study used the Turkish validated version of the PSQI (Agargün et al 1996), and the subcomponent 'use of sleep medication' was not included in the evaluation due to inclusion criteria.

### Intervention

This single-group pretest/posttest model (before trial test model) intervention study was carried out in three stages: pre-intervention, intervention, and post-intervention. In the four weeks prior to light therapy, the elderly were visited once a week and were monitored using a weekly follow-up form. At the beginning and end of this stage, the sleep quality was measured via the PSQI. At the intervention stage, which was based on the guideline given in the Cochrane database, groups of 2–6 participants were exposed to light with a volume of 10,000 Lux for 30 minutes every morning for 30 days. The light therapy was arranged so that the equipment was at eye level at least 30 centimetres from the individual. The participants were asked not to look directly at the light (Chesson et al 1999). Light was administered with a specially designed light box (Britelite6 Box, Apollo Health), sized 7.1 × 11.0 × 17.4 cm, with cool-white fluorescents and full spectrum and 10,000 Lux light intensity. During the intervention period, the elderly were also assessed using a weekly follow-up form, while the PSQI was administered at the end of the light therapy. At the last, post-intervention stage, which was four weeks following the light therapy, the participants were readministered the PSQI.

### Data analysis

All analyses were conducted with SPSS 11.5. Friedman's test and Wilcoxon's Paired Sample Test with Bonferroni adjustment used in data assessment. The study participants' sleep quality was measured at the beginning, prior to light therapy, at the end of light therapy, and one month later. The gradual change in sleep quality was analysed using Friedman's Test; the changing group was identified using the Wilcoxon Paired Samples Test with Bonferroni adjustment. The between-group differences were calculated using the Mann-Whitney U Test.

<sup>1</sup> Drugs That Might Influence Sleep: central nervous system medications (benzodiazepines, melatonin, antiepileptic agents, antidepressants, central nervous system stimulants), atypical antipsychotic agents, anticholinergics, cardiac medications (beta adrenergic blockers, alpha adrenergic agonists, diuretics), pulmonary medications (methylxanthines, corticosteroids) (Kamel and Gammack 2006; Zee and Bloom 2006).

## ETHICAL CONSIDERATIONS

The University's Research Ethics Committee approved the study protocol (LUT 09/19-15). Written consents from the institution and the elderly were obtained prior to the study.

## FINDINGS

Study participants had a mean age of 79.95 ( $\pm 3.49$ ) years and received daylight for 75.41 ( $\pm 68.46$ ) mean minutes; the majority were female (66.7%) and single (83.3%) (table 1). Of the elderly, 41.7% never participated in institutional activities; 45.8% went out of the institution weekly, 70.8% exercised; 66.7% slept in a lighted/dim place; 70.8% were not exposed to noise; and 87.5% had at least one chronic disorder and used medications (table 1). In addition, 79.2% stated that they experienced sleep problems. Self-reported sleep problems were early and frequent awakening, unrefreshing sleep, and trouble falling asleep.

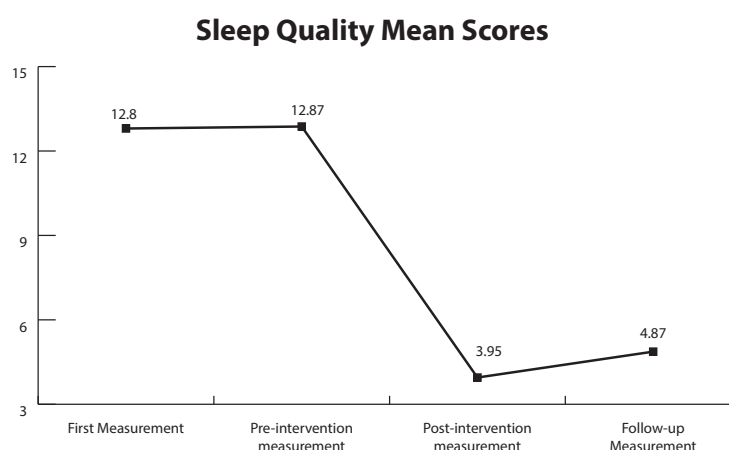
**Table 1: Basic Socio-Demographic, Clinical and Sleep Characteristics of Patients (n:24)**

| Characteristics                               | n (%)             |
|-----------------------------------------------|-------------------|
| Age, years (mean, SD)                         | 79.95 $\pm$ 3.49  |
| Institutional stay, years (mean, SD)          | 4.89 $\pm$ 2.03   |
| Female                                        | 16 (66.7)         |
| Male                                          | 8 (33.3)          |
| Primary School                                | 7 (29.2)          |
| Secondary School                              | 14 (58.3)         |
| University                                    | 3 (12.5)          |
| Single/Widow                                  | 20 (83.3)         |
| Married                                       | 4 (16.7)          |
| Having Diseases                               | 21 (87.5)         |
| Not Having Diseases                           | 3 (12.5)          |
| Exercising                                    | 17 (70.8)         |
| Not Exercising                                | 7 (29.2)          |
| Participating in Institutional Activities     | 14 (58.3)         |
| Not Participating in Institutional Activities | 10 (41.7)         |
| Light Intake During Day, Minutes (mean, SD)   | 75.41 $\pm$ 68.46 |
| Sleeping in Dark Place                        | 8 (33.3)          |
| Sleeping in Lighted/Dim Place                 | 16 (66.7)         |
| Exposed to Noise During Sleep                 | 7 (29.2)          |
| Not Exposed to Noise During Sleep             | 17 (70.8)         |

In the weekly follow-ups with the elderly, change was observed in four (16.6%) individuals' general health and in two (8.3%) individuals' treatment; three (12.5%) people experienced a stress-induced condition and one individual (4.2%) experienced a loss.

The global sleep quality mean scores in our study were 12.80 for the first measurement, 12.87 at the beginning of light therapy, 3.95 after therapy, and 4.87 one month after therapy. The difference between the scores shows that sleep quality increased with light therapy (figure 1).

**Figure 1: Global Sleep Quality Scores in Repeated Measurements**



**Table 2: Pittsburgh Sleep Quality Index Scores in Repeated Measurements (n:24)**

| PSQI Subcomponents       | Pre-intervention Measurement | Post-intervention Measurement | Follow-up Measurement | Significance   |        |
|--------------------------|------------------------------|-------------------------------|-----------------------|----------------|--------|
|                          | X±SS                         | X±SS                          | X±SS                  | X <sup>2</sup> | p      |
| Subjective Sleep Quality | 1.75±0.60                    | 0.50±0.51                     | 0.66±0.48             | 39.970         | <0.001 |
| Sleep Latency            | 1.54±1.06                    | 0.33±0.48                     | 0.37±0.49             | 36.105         | <0.001 |
| Sleep Duration           | 2.29±0.95                    | 1.04±0.62                     | 1.08±0.58             | 39.377         | <0.001 |
| Sleep Efficiency         | 1.91±1.13                    | 0.75±0.44                     | 0.87±0.61             | 27.382         | <0.001 |
| Sleep Disturbance        | 2.16±0.63                    | 1.16±1.00                     | 1.50±0.97             | 43.053         | <0.001 |
| Daytime Dysfunction      | 1.20±1.31                    | 0.16±0.38                     | 0.37±0.49             | 18.681         | <0.001 |
| Global Sleep Quality     | 12.87±4.26                   | 3.95±1.75                     | 4.87±1.96             | 44.571         | <0.001 |

Light therapy had an effect on all subcomponents of the PSQI except 'daytime dysfunction' when comparing pre-intervention mean score with post-intervention mean score ( $p < 0.001$ ), whereas the comparison of pre-intervention and post-intervention scores with follow-up scores showed no significant differences (table 2). In the 'daytime dysfunction' subcomponent, pre-intervention and post-intervention mean scores were found to be significant compared with follow-up scores ( $p < 0.001$ ) (table 2).

Although not shown in the table, according to the percentage calculation of mean score changes between measurements of sleep quality subcomponents, the most change was found in 'daytime dysfunction' (84.5%) and 'sleep latency' (82.4%) subcomponents, and the least was found in the 'sleep duration' (53.8%) component.

The between-group differences were not found to be statistically significant in terms of the person's age, sex, educational status, and length of stay in the institution ( $p > 0.05$ ).

The within-groups' change in pre-intervention and post-intervention mean scores resulted from the 80–86 and 74–79 age groups, males, and in those who were diagnosed with an illness and who used drugs ( $p < 0.001$ ). Change in pre-intervention and follow-up mean scores resulted in the female elderly with secondary school education ( $p < 0.001$ ).

All groups' pre-intervention, post-intervention, and follow-up mean scores regarding features that might influence sleep decreased; the change in all groups' mean global scores was found to be statistically significant ( $p < 0.05$ ). However, those who received daylight for 30–60 minute and who did not go out of the institution had significantly different 'subjective sleep quality' subcomponent mean scores ( $p < 0.05$ ), whereas a gradual change in 'sleep efficiency' and 'daytime dysfunction' mean scores was found to be significant in the group receiving daylight for two to four hours ( $p < 0.05$ ).

Further statistical analysis found differences among 'subjective sleep quality', 'sleep duration', 'sleep disturbance', 'sleep latency', and 'sleep efficiency' subcomponents pre-intervention, post-intervention, and follow-up mean scores to be significant in the group that slept in lighted/dim environments at night ( $p < 0.001$ ). In the same group, the difference between the 'daytime dysfunction' subcomponent's pre-intervention and post-intervention mean scores was also found to be statistically significant ( $p < 0.001$ ).

## DISCUSSION

The present study showed that, for elderly people, light therapy could significantly improve sleep quality and its subcomponents for up to one month after therapy. This study found the 'daytime dysfunction' and 'sleep latency' sub-scores to be the most positively changed, whereas the change in the 'duration of sleep' sub-score was less significant.

In previous studies conducted in Turkey, sleep quality scores of the elderly varied between 7.4 and 13.14, similar to this study (Fadiloglu et al 2006; Demirli 2005; Agargün et al 1996).

In Figueiro et al (2008) study, there was a five-point decrease in sleep quality scores following light therapy. Fetveit and Bjorvatn (2004), in their study on 11 nursing home residents exposed to light therapy with a volume of 8,000 Lux (two weeks, two hours), observed an improvement in sleep efficiency, decrease in sleep latency, and increased total period of wakefulness after the therapy. Fetveit and Bjorvatn also found that a change in sleep efficiency was preserved in the fourth week follow-up post-treatment.

In this study, elderly's subjective quality, duration, efficiency and latency of sleep and also daytime function were improved. Light therapy was found to increase subjective sleep quality in Ho et al (2002) study, sleep duration in Sloane et al (2007) study on the therapy's effect on sleep and activity, and time spent in bed and melatonin secretion (from  $7.5 \pm 2.6$  pg/mL to  $13.3 \pm 9.2$  pg/mL) in Wakamura and Tokura's (2001) study.

In contrast to the previous studies, this study shows that daytime dysfunction improves in the long term. This may be related to the decrease in daytime naps and the time spent falling asleep, and an increase in uninterrupted sleep, and the fact that they feel more rested because they have slept for longer periods. In addition, the good health status of the majority of the individuals in the sample may account for this result. The elderly who slept better were perhaps more able to carry out their daily activities more easily (Young 2009). In this study, the 'sleep duration' subcomponent changed the least. Decrease in sleep latency is expected to increase sleep duration, while in the present study, the low amount of change in sleep duration might stem from the subjective assessment of sleep duration. This result might also be related to the fact that the elderly may have felt rested with little sleep due to increased sleep quality.

Kabayashi et al (1999) study of ten elderly women exposed to light therapy with a volume of 8,000 Lux found that continuity of sleep improved with therapy, while waking up during sleep and naps in the daytime decreased. Kokhasa et al (2000) study on the male elderly revealed that time spent in bed and the frequency of waking up at night decreased after treatment. In the present study, it was found that the effectiveness of light therapy continued one month later in women ( $p < 0.001$ ).

Research showed that the effectiveness of the treatment continued after the follow-up even in individuals who did not participate in institutional activities ( $p < 0.001$ ). This effect lasted longer in the group that exercised and received daylight for 30–60 minutes. Hood et al (2004) state that light and activity influence sleep quality independently from other factors. Montgomery and Dennis (2003) state that an exercise program including a 30–40-minute walk leads to a decrease of 3.4 in the sleep quality score. King et al (2008) illustrated specific improvement in sleep duration, sleep disturbance, and daytime dysfunction; while Singh et al (1997) demonstrated improvement in all subcomponents of sleep quality. Alessi et al (2005) state that non-pharmacological interventions carried out in the daytime (exercise, social activity, etc.) decrease naps in the daytime, improve quality of life, and thus lead to improvement in sleep quality. The findings of those studies, together with those of the present study, reveal that participation in social activities increases social interaction, feeling of wellness, and level of life satisfaction. Furthermore, going out of the institution increases physical activity and benefits from the daylight, thus leading to continuity of sleep quality for a longer time.

Results from the one-month follow-up of the present study indicated that treatment effectiveness (global score, subjective sleep quality, sleep duration, sleep disturbances, sleep latency, and sleep efficiency scores) remained in the elderly who slept in lighted/dim environments ( $p < 0.001$ ). Decrease in light intake leads to changes in the time and amount of melatonin secretion. Figueiro et al (2008) state that regular daylight intake in the daytime and decreasing light intake at night is essential for regulating melatonin secretion. In this research, it is thought that light therapy applied in the daytime may increase melatonin secretion in earlier hours and thus maintain longer periods of more optimal sleep quality.

## CONCLUSION

Based on results, this study adds evidence to the hypothesis that light therapy has, after continuous four-week half-hour 10,000 Lux interventions and at a four-week follow-up, an impact on the global sleep quality and its subcomponents, in particular the participants' 'daytime dysfunction' and 'sleep latency' subcomponents. Also, those effects are beneficial and recommended for seniors, females, and those with diseases.

## RECOMMENDATIONS

For nurses, activities such as assessment of sleep problems and encouraging the elderly who live in institutions to benefit from daylight are recommended. Further studies are needed with various groups to generate intervention results.

## LIMITATIONS

Several limitations should be considered when interpreting the findings of this study. The healthy independent sample of the study, and self-reported sleep quality, duration, and depth may not be truly representative. The other limitations are the small sample size, institutionalised elderly, and the implementation period. The study was done during summer. This may have an altering effect on the improvement of sleep quality. Therefore, this study's results cannot be generalised to all elderly population.

## REFERENCES

- Agargün, M.Y., Kara, H., Anlar, Ö. 1996. Validation and reliability of Pittsburgh sleep quality index. *Turkish Journal of Psychiatry*, 7(2)107-115.
- Alessi, C.A., Martin, J.L., Webber, A.P., Kim, C.E., Harker, J.O., Josephson, K.R. 2005. Randomized, controlled trial of a non-pharmacological intervention to improve abnormal sleep/wake patterns in nursing home residents. *Journal of American Geriatrics Society*, 53(5)803-810.
- Aminoff, M.J. 2008. *Neurology and General Medicine*. Fourth edition. Churchill Livingstone Elsevier Inc. China.
- Chesson, A.L., Littner, M., Anderson, M.W., Grigg-Damberger, M., Hartse, K., Johnson, S., Wise, M. 1999. Practice parameters for the use light therapy in the treatment of sleep disorders. *Sleep*, 22(5)641-660.
- Demirli, F. 2005. Determination of sleep qualities of elderly people living in nursing homes. Gaziantep University Health Sciences Institute Master's Thesis. Gaziantep, Turkey.
- Fadıloglu, Ç., İlkbay, Y., Yıldırım, Y.K. 2006. Sleep quality of elderly living in nursing homes. *Turkish Journal of Geriatrics*, 9(3)165-169.
- Fetveit, A., Bjorvatn, B. 2004. The effects of bright-light therapy on actigraphical measured sleep last for several weeks post-treatment. a study in a nursing home population. *Journal of Sleep Research*, 13(2)153-158.
- Figueiro, M., Saldo, E., Cunningham, J. 2008. Developing architectural lighting designs to improve the health and well-being of older adults. AIA Report on University Research. 3, 3-26.
- Gammack, J.K. 2008. Light therapy for insomnia in older adults. *Clinics in Geriatric Medicine*, 24(1)134-149.
- Ho, S.C., Wong, T.K.S., Tang, P.L., Pang, S.M.C. 2002. Nonpharmacologic sleep promotion: Bright light exposure. *Complementary Therapies in Nursing and Midwifery*, 8(3)130-135.
- Hoffman, S. 2003. Sleep in older adult: Implications for nurses. *Geriatric Nursing*, 24(4)210-216.
- Hood, B., Bruck, D., Kennedy, G. 2004. Determinants of sleep quality in the healthy aged: the role of physical, psychological, circadian and naturalistic light variables. *Age and Ageing*, 33(2)159-165.
- Kabayashi, R., Kokhasa, M., Fukuda, N., Sakakibara, S., Honma, H., Koyama, E. 1999. Effects of morning bright light on sleep in healthy elderly women. *Psychiatry and Clinical Neurosciences*, 53(2)237-238.
- Kamel, N.S., Gammack, J.K. 2006. Insomnia in the elderly: cause, approach, and treatment. *The American Journal of Medicine*, 119 (6)463-469.
- King, A.C., Pruitt, L.A., Woo, S., Castro, C.M., Ahn, D.K., Vitiello, M.V. 2008. Effects of moderate- intensity exercise on polysomnographic and subjective sleep quality in older adults with mild to moderate sleep complaints. *Journal of Gerontology*, 63(9)997-1004.
- Kokhasa, M., Fukuda, N., Kabayashi, R., Honma, H., Sakakibara, S., Koyama, E., Nakano, T., Matsubara, H. 2000. Effects of short duration morning bright light in elderly men: sleep structure. *Psychiatry and Clinical Neurosciences*, 54(3)367-368.
- Kryger, M.H., Roth, T., Dement, W.C. 2000. *Principles and practice of sleep medicine*. Third Edition. Saunders. Philadelphia.
- Mathews, M., Adetunji, B., Budur, K., Mathews, M., Ramachadran, S. 2004. An overview of sleep disorders in the older patients. *Clinical Geriatrics*, 12 (9)27-42.

- Mishima, K., Okawa, T., Shimizu, T., Hishikawa, Y. 2001. Diminished melatonin secretion in the elderly caused by insufficient environmental illumination. *Journal of Clinical Endocrinology and Metabolism*, 86(1)129-134.
- Montgomery, P., Dennis, J. 2002. Bright light therapy for sleep problems in adults aged 60+. *Cochrane Database of systematic Reviews*. Issue 2. Art. No:CD003403. DOI: 10.1002/14651858.CD003403.
- Montgomery, P., Dennis, J. 2003. Cognitive behavioral interventions for sleep problems in adults aged 60+. *Cochrane Database of systematic Reviews*. Issue 1. Art. No: CD003161. DOI: 10.1002/14651858.CD003161.
- Shochat, T., Martin, J., Marler, M., Anconi- Israel, S. 2000. Illumination levels in nursing home patients: effects on sleep and activity rhythms. *Journal of Sleep Research*, 9(4)373-379.
- Singh, N.A., Clements, K.M., Fiatarone, M.A. 1997. A randomized controlled trial of the effect of exercise on sleep. *Sleep*, 20(2)95-101.
- Sloane, P.D., Williams, S.C., Mithcell, C.M., Preisser, J.S., Wood, W., Barrick, L. 2007. High-intensity environmental light in dementia: Effect on sleep and activity. *Journal of American Geriatrics Society*, 55(10)1524-1533.
- Smeren, van EJW. 2000. Circadian and sleep disturbances in the elderly. *Experimental Gerontology*, 35(9-10)1229-1237.
- Terman, M. 2007. Evolving applications of light therapy. *Sleep Medicine Review*, 11(6)497-507.
- Vitiello, M.V. 2006. Sleep in normal aging. *Sleep Medicine Clinics*, 1(2)171-176.
- Voyer, P., Verreault, R., Mengue Nkogho, P., Morin, C.M. 2006. Prevalence of insomnia and its associated factors in elderly long-term care residents. *Archives of Gerontology and Geriatrics*, 42(1)1-20.
- Wakamura, T., Tokura, H. 2001. Influence of bright light during daytime on sleep parameters in hospitalized elderly patients. *Journal of Physiological Anthropology and Applied Human Society*, 20(6)345-351.
- Wu, YH., Swaab, DF. 2007. Disturbance and strategies for reactivation of the circadian rhythm system in aging and Alzheimer's disease. *Sleep Medicine*, 8(6)623-636.
- Young, C. 2009. Therapeutic lifestyle changes: A brief psycho-educational intervention for prevention of depression. University of Kansas Department of Psychology Doctorate Dissertation. Kansas, USA.
- Zee, P., Bloom, H. 2006. Understanding and resolving insomnia in elderly. *Geriatrics*, 61(5-Special Edition', 1-12.