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Effectiveness of Non-Pharmacological Intervention for Insomnia: A Systematic Review and Meta-Analysis

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Abstract

Objectives: As chronic sleep deprivation can have devastating effects, sleep disturbances in older adult warrants investigation. This study aims to evaluate the effectiveness of non-pharmacological interventions for insomnia. **Methods/Statistical Analysis**: A systematic literature review was used to examine the effectiveness of non-pharmacological therapies on sleep disturbance. We conducted a literature search of Korean and international electronic databases. We reviewed selected 343 publications, 37 studies were analyzed in the meta-analysis. Comprehensive Meta-Analysis software was used to analyze the effect size. **Findings**: The meta-analysis based on the random effect model showed that the applied interventions improved sleep in older adults (Z = 5.63; 95% CI: 0.55-1.15). Subgroup analysis revealed that exercise was the most effective (95% CI: 0.35-0.88, Z = 4.55), followed by music therapy (95% CI: 0.30-1.16, Z = 3.36). On the contrary, behavior, laughter, massage, and supplementary therapy were not effective. **Improvements/Applications**: These findings provide comprehensive evidence regarding the efficacy and use of non-pharmacological sleep interventions. Thus, these interventions are available to improve quality of sleep in older adults.

Keywords: Insomnia, Meta-Analysis, Non-Pharmacologic, Older Adults, Sleep

1. Introduction

People experience various physical and psychological challenges as they age, including sleeping disorders. Such disorders are commonly reported by older adults, who spend most of their time in bed[1]. In fact, around half of the elderly population reports problems with sleep initiation and/or maintenance[2]. Sleep disorders among older adults may result from declines in physical health[3], as well as chronic conditions[4]. Older people report diverse degrees of association between subjective complaints and objective measurement[5]. Thus, the sleep patterns of older adults warrant consideration. Chronic sleep deprivation has been linked to premature death[6]. In addition, sleeping disorders can lead to falls, cognitive disorders, or diminished bodily function, particularly among older adults[7]. Therefore, preventative interventions for sleep disorders are needed to reduce the morbidity rate of various diseases among sleep deprived older adults[8,9]. Pharmacological and non-pharmacological interventions are used to treat sleep disorders, with soporifics and anti-depressants most frequently prescribed for older adults. However, as pharmacokinetic changes occur with age, it can be difficult to determine the proper dosage of such drugs for older patients. Moreover, although short-term use of these medications may be effective, long-term use may lead to adverse side effects, such as excessive drowsiness, decreased motor coordination, and difficulties with spatial navigation, which may lead to accidental injuries. A variety of non-pharmacological interventions exist, such as cognitive behavioral therapy, circadian rhythm adjustment, melatonin administration, aromatherapy, massage, and acupressure[10–12]. A meta-analysis of the effects of non-pharmacological interventions on sleep

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improvement uncovered that interventions improve sleep patterns and subjective evaluation of sleep quality[13,14]. Regarding specific methodologies, Morin, Culbert, and In[13] reported that the most effective intervention were control of stimulation and sleep restriction, on the other hand, in[14] reported that no significant difference between the effects of various interventions. In additions, there has also been increasing interest in interventions that combine pharmacological and non-pharmacological methods. However, many interventional studies have limitation due to no control group, or a design that lacks evidentiary power, which limits the conclusions regarding the efficacy of the targeted intervention for sleep. That is, non-pharmacological interventions should be considered. However, as mentioned previously, no substantial data exist regarding the efficacy of sleep interventions, nor has there been any systematic analysis of the existing studies. Therefore, our study intends to comprehensively evaluate the effectiveness of non-pharmacological therapies for sleep among older adults.

2. Material and Method

2.1 Study Design

This study was adopted a systematic literature review to analyze the efficacy of non-pharmacological interventions for sleep among the older adults.

2.2 Literature Search Strategy

2.2.1 Key Questions

- Participants: Adults over 60 years of age.
- Interventions: All types of non-pharmacological sleep-improvement interventions.
- Comparisons: No-intervention control group.
- Outcomes: Sleep improvement (duration, efficiency, quality, and subject satisfaction).

2.2.2 Search Databases and Search Terms

A search of online electronic literature databases (DB) was conducted and additional searches were conducted in domestic DBs, including the Korea Education and Research Information Services (RISS), Korean studies Information Service System (KISS), Korea med, Korean Medical Database (KMbase), and the homepages of the eight societies affiliated with the Korean Society of Nursing Science (KSNS). Search engines, such as PubMed and CINAHL, were used for the international DB search.

- Older adults.
- Sleep disorder, insomnia, quality of sleep, satisfaction of sleep.

2.2.3 Study Selection

We selected studies based on inclusive and exclusive criteria. Inclusion criteria were as follows: 1. Presented after the year 2000, 2. Included subjects over the age of 60, 3. Applied a non-pharmacological intervention for sleep improvement, and 4. Evaluated at least one of the following sleep parameters: Quality, satisfaction, efficiency, or improvement. Our exclusion criteria were university-owned research, thesis papers, duplicate publications, animal studies, presentations, announcements, and literature reviews.

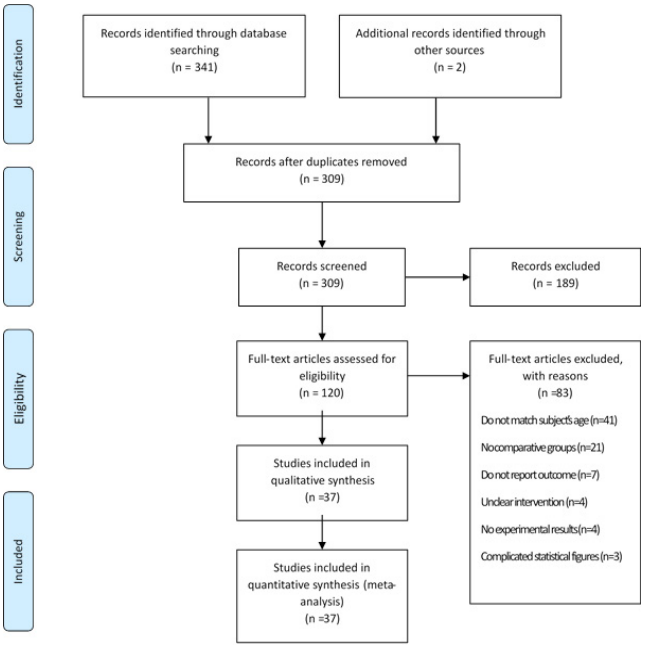


Figure 1. Flow chart of study selection

2.3 Literature Search Results

Using a combination of the search terms, titles from 343 journals were evaluated. After excluding duplicate results, 309 records were screened. We assessed 120 of full-text articles and 37 studies were selected for systematic review. Two researcher performed study selection procedure, and included three rounds of exclusions Figure 1.

2.4 Quality Assessment

Quality assessment of the literature was conducted using the assessment framework proposed in the quantitative study performed by the McMaster University Evidence-Based Practice Research Group[15,16]. This assessment consists of 8 sections: Research purpose, review of literature, research design, sample selection, results, intervention, conclusion, and clinical implications. Each section is evaluated as "yes," "no," or "not applicable." Based on the quality assessment, the two researchers selected acceptable studies by consensus.

2.5 Data Analysis

2.5.1 Systematic Literature Review

The characteristics of the 37 studies were analyzed and organized using a coding form, which included the study design, intervention, sample size, outcome variables, and statistical methods. Two researchers independently reviewed to maintain accurate process, and their results were crosschecked to ensure consistency.

2.5.2 Meta-Analysis

Comprehensive Meta-Analysis software version 2.2.064 (Biostat, Englewood, NJ, USA) was used to analyze the effect size across all 37 studies. As the studies used different scales, the standardized mean difference was used to convert to the effect size to a Z-score, thereby consolidating the measured values into a single unit. Higgins' I homogeneity test was used to statistically categorize the results of each study. Statistical heterogeneity was considered low if the I value was below 25%. Based on this analysis, the hypothesis of homogeneity was dismissed, and an effective size was consequently proposed according to the random effect model and a 95% CI. Furthermore,

Table 1. Characteristics of included studies

Year	Intervention	Categories	Design	SS	Variables
(2011)27	Aroma hand massage	Aroma massage	QE	66	Sleep Quality
(2011)28	Foot bath	Massage	QE	50	Sleep efficiency
(2011)29	Aroma hand massage	Aroma massage	QE	42	Sleep Quality
(2011)30	Aroma massage	Aroma massage	QE	42	Sleep Quality
(2005)31	Aroma foot massage	Aroma massage	QE	51	Sleep Quality
(2006)32	Aroma massage	Aroma massage	QE	60	Sleep Quality
(2009)33	Aroma hand massage	Aroma massage	QE	56	Sleep Quality
(2009)34	Education + Muscle relaxation	Behavioral	QE	32	Sleep Quality
(2009)35	Hand massage	Massage	QE	44	Sleep satisfaction
(2005)36	Foot massage	Massage	QE	38	Sleep Quality
(2005)37	Foot massage	Massage	QE	50	Sleep Quality
(2011)38	Aroma foot massage	Aroma massage	QE	62	Sleep Quality
(2011)39	Foot massage	Massage	QE	45	Sleep Quality
(2009)40	Aroma hand massage	Aroma massage	QE	72	Sleep Quality
(2013)41	Laughter therapy	Laugh	QE	87	Insomnia
(2009)42	Auricular acupressure therapy	Acupressure	QE	43	Sleep Quality
(2008)43	Auricular acupressure therapy	Acupressure	QE	56	Sleep Quality
(2011)44	Laughter therapy	Laugh	QE	40	Sleep Quality
(2010)45	Tai chi exercise	Exercise	QE	40	Sleep Quality
2009)46	Laughter therapy	Laugh	QE	109	PSQI
(2013)47	Yoga	Exercise	RCT	120	PSQI
(2012)48	Tai chi exercise	Exercise	RCT	96	PSQI

(2013)49	Sleep education program	Behavioral	RCT	47	Sleep efficiency
(2011)50	Tai chi exercise	Exercise	QE	56	PSQI
(2012)51	Traditional exercise program	Exercise	RCT	55	PSQI
(2011)52	Brief behavioral treatment	Behavioral	RCT	82	PSQI
(2011)53	Laughter therapy	Laugh	QE	109	PSQI
(2010)54	Music therapy	Music	RCT	42	PSQI
(2010)55	Silver yoga	Exercise	QE	55	PSQI
(2010)56	Acupressure	Acupressure	RCT	50	Insomnia
(2009)57	Melatonin application	Medication or diet	RCT	41	Sleep efficiency
(2006)58	Brief behavior treatment	Behavioral	RCT	35	PSQI
(2005)59	Behavioral therapy	Behavioral	RCT	118	Sleep efficiency
(2005)60	Music therapy	Music	RCT	60	PSQI
(2004)61	Tai chi exercise	Exercise	RCT	118	PSQI
(2012)62	Mg application	Medication or diet	RCT	46	Insomnia
(2011)63	Melatonin, Mg, Zinc application	Medication and diet	RCT	43	PSQI

SS, Sample Size; QE, Quasi-Experimental design.

Table 2. General characteristics of the studies

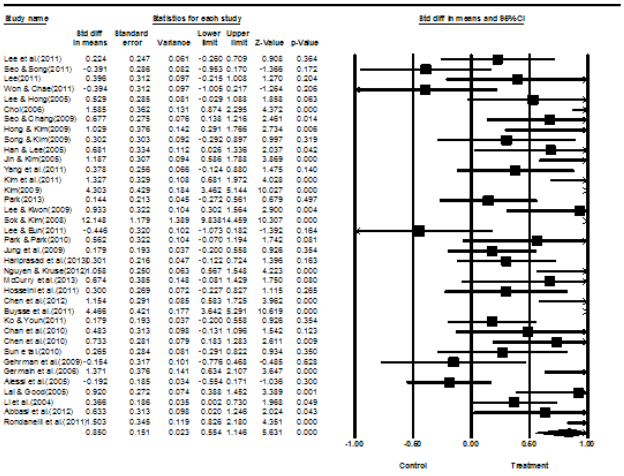
Variables	**Categories**		**n (%)**
Year	2004 2005 2006 2008 2009 2010 2011 2012 2013		1 (2.7) 5 (13.5) 2 (5.4) 1 (2.7) 7 (18.9) 4 (10.8) 11 (29.7) 3 (8.1) 3 (8.1)
Study design	Randomized Controlled Trial Before and After		13 (35.1) 24 (64.9)
Type of intervention	Aroma massage Exercise Massage Behavioral Laugh Acupressure Medication or diet Music	8 (21.6) 7 (18.9) 5 (13.5) 5 (13.5) 4 (10.8) 3 (8.1) 3 (8.1) 2 (5.4)	

sub-group analysis was performed for each categorical variable to determine mediator variables. To evaluate publication bias and verify the sensitivity of the selected studies, a funnel plot and Egger's linear regression asymmetry test[17] were used. Publication bias and sensitivity of the selected studies were analyzed using Egger's linear regression asymmetry test[17].

3. Results

3.1 Study Trends and Characteristics

The effects of the complementary and alternative sleep therapies that were included in this analysis are listed in Table 1. The sample size for all 37 studies ranged from 32-120 subjects. The majority of the studies were conducted in 5 years: 11 (29.7%) in 2011 and 7 (18.9%) in 2009 Table 2. Most studies (64.9%) adopted controlled pretest-posttest design. The most frequently used therapeutic interventions were aromatherapy massage (21.6%), exercise therapy (18.9%), and massage and behavior therapy (13.5%).



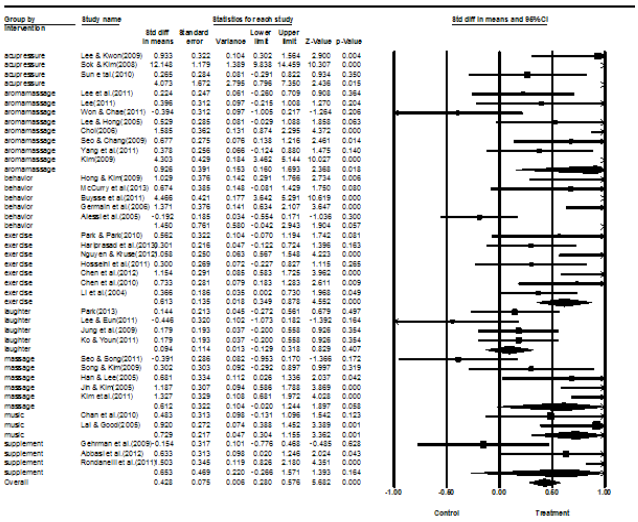
Heterogeneity: Tau^2=0.739, Q=373.685, df=36(p<.001), I^2=90.366%

Test for overall effect size Z=5.631, p<.001.

Figure 2. Effect size of therapeutic intervention related to sleep.

3.2 The Effect Size

The effect size for non-pharmacological interventions for sleep was also evaluated in the 37 studies. As homogeneity was not observed (I^2 = 90.37%, p < .001), the random effect model was used for the analysis. The effect size was Z = 5.63 (95% CI: 0.55–1.15, p < .001), indicating a significant improvement in sleep among the elderly through the use of therapeutic interventions Figure 2. Results of the meta-analysis on the mediating factor of the non-pharmacological interventions indicated that exercise therapy had the greatest effect size (95% CI: 0.35-0.88, Z = 4.55, p < .001). Other significant interventions were music therapy (95% CI: 0.30-1.16, Z = 3.36, p = .001), acupressure (95% CI: 0.80-7.35, Z = 2.44, p = .015), and aromatherapy massage (95% CI: 0.16-1.69, Z = 2.37, p = .018). However, behavioral intervention (95% CI: 0.04-2.94, Z = 1.90, p = .057), laughter therapy (95% CI: -0.13-0.35, Z = 0.83, p = .407), massage (95% CI: -0.02-1.24, Z = 1.90, p = .058), and supplementary (95% CI: -0.27-1.57, Z = 1.39, p = .164) did not have a statistically significant effect size Figure 3.



Subgroup acupressure Heterogeneity: Tau^2=7.904, Q=96.070, df=2(p<.001), I^2=97.918%.

Test for overall effect size Z=2.44, p=.015.

Subgroup aromamassage Heterogeneity: Tau^2=1126, Q=95.250, df=7(p<.001), I^2=92.651%.

Test for overall effect size Z=2.37 p=.018.

Subgroup behavior Heterogeneity: Tau^2=2.772, Q=107.345, df=4(p<.001), I^2=96.274%.

Test for overall effect size Z=1.90, p=.057.

Subgroup exercise Heterogeneity: Tau^2=0.062, Q=11.909, df=6(p=.064), I^2=49.620%.

Test for overall effect size Z=4.55, p<.001.

Subgroup laughter Heterogeneity: Tau^2=0.005, Q=3.283, df=3(p=.350), I^2=8.609%.

Test for overall effect size Z=0.83, p=.407.

Subgroup massage Heterogeneity: Tau^2=0.09, Q=8.04, df=4(p=.090), I^2=50.23%.

Test for overall effect size Z=1.90, p=.058.

Subgroup music Heterogeneity: Tau^2=0.010, Q=1.114, df=1(p=.291), I^2=10.250%.

Test for overall effect size Z=3.36, p=.001.

Subgroup supplement Heterogeneity: Tau^2=0.553, Q=12.477, df=2(p=.001), I^2=83.971%.

Test for overall effect size Z=1.39, p=.164.

Total Heterogeneity: Tau^2=0.739, Q=373.685, df=36(p<.001), I^2=90.366%.

Test for overall effect size Z=5.682, p<.001.

Figure 3. Subgroup analysis on the effect size of therapeutic intervention.

3.3 Publication Bias

The funnel plot indicated the possibility of publication bias, and the Egger's test results confirmed that a publication bias existed (p<.001). Even when the evidence is available, intervention contents and outcomes varied within each type of intervention, and some of the trials had small sample sizes. These conditions increase the potential bias and make it difficult to precise the analysis, draw a firm conclusion about interventions. Although these characteristics among the included trials may be considered as the limitations of the review, the interventions do reflect current non-pharmacological sleep intervention from a clinical perspective.

4. Discussion

The purpose of this study was comprehensively to evaluate the efficacy of non-pharmacological sleep interventions among older adults, with an emphasis on evidence-based nursing. Thus, non-pharmacological sleep interventions, and their associated effect sizes, were analyzed in these nursing studies. These primary studies provided evidence of the effect of non-pharmacological sleep intervention in older adults. Of the 37 studies selected for analysis, 28 (75.68%) were conducted in the past 5 years, 11 (29.75%) were conducted in 2011, and 7 (18.92%) were conducted in 2009. In a previous trend analysis of sleep disorder studies, a sudden increase was observed after 2000[18]. Similarly, studies regarding complementary and alternative therapies have increased since the latter half of the 1990s[19], with a dramatic increase occurring during the 2000s[20]. These reports indicate that the increased interest in sleep disorders is linked to the increasing number of studies examining various complementary and alternative therapies. Of the studies we reviewed, 13 (35.1%) were RCT, while 24 (64.9%) were controlled pretest-posttest studies. In contrast, the recent literature review of foot reflexology massage, conducted by[21], did not find a single RCT study. Therefore, our results indicate a recent increase in the number of RCT studies, which is driven by an increasing desire among nurses to choose evidence-based interventions for all subjects, including those with sleep disorders. We found that a collective effective size of the most commonly used non-pharmacological interventions was 5.63. This effect size was greater than the 2.89 reported in the meta-analysis of non-pharmacological interventions for hypertension[22]. Therefore, this study results confirm that non-pharmacological therapies more effectively improve quality of sleep in older adults. In addition, these interventions are associated with fewer adverse events compared to pharmacological interventions. Finally, complementary and alternative therapies were effective and might be used as independent nursing interventions. In our subgroup analysis, the effect sizes for exercise therapy, music therapy, acupressure, and aromatherapy massage were 4.55, 3.36, 2.44, and 2.37, respectively. These effects are consistent with the results of a previous study on the insomnia and alternative therapies[23]; in this study, Tai Chi and yoga dramatically improved sleep quality, and acupressure produced effect sizes ranging from 1.30 to 2.12. The present study also categorized Tai Chi and yoga as exercise therapy, which was revealed to improve sleep in the elderly. In addition, Tai Chi exercise has positive effect on cognitive function in older adults[24], and life-style habit including sleep is associated to health-related quality of life[25]. Therefore, therapeutic intervention for sleep disturbance is important to improve life quality for older people. Interestingly, the effect size of music therapy in this study was lower than that reported (4.24) in a previous study of adult subjects[26]. Nevertheless, music therapy produced the second largest effect in the present study, and therefore represents an effective intervention for elderly, bed-ridden, or hospitalized patients that may not be ideal candidates for pharmacological or exercise therapy. Meta-analysis, which combines the results of different studies, is used to increase the statistical power and accuracy of estimation by minimizing random errors and reducing bias. However, one limitation of this study is that it is not considered intervention duration or the actual period during which the intervention was conducted. Therefore, further systematic reviews are needed that consider the research design and specific intervention. For example, behavioral therapy, laughter therapy, massage, and drug treatments have all been reported as effective, although their effects were not statistically significant in the meta-analysis.

5. Conclusion

This study was performed to provide comprehensive evidence regarding to effectiveness and use of non-pharmacological sleep interventions. Among older adults, the most commonly used non-pharmacological sleep interventions were aromatherapy massage, exercise therapy, massage, and behavioral therapy; all of these interventions significantly improved sleep quality. When the effect size of each intervention was compared, it was found that exercise therapy, music therapy, acupressure, and aromatherapy massage were effective. However, as we were unable to reach a definitive conclusion regarding the effects of these interventions on sleep health due to restriction in specific interventions, further investigation is recommended.

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