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[Intervention Review]

Physical exercise for sleep problems in adults aged 60+

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ABSTRACT

Background

The prevalence of sleep problems in adulthood increases with age. While not all sleep changes are pathological in later life, severe disturbances may lead to depression, cognitive impairments, deterioration of quality of life, significant stresses for carers and increased healthcare costs. The most common treatment for sleep disorders (particularly insomnia) is pharmacological. The efficacy of non-drug interventions has been suggested to be slower than pharmacological methods, but with no risk of drug-related tolerance or dependency. Physical exercise, taken regularly, may promote relaxation and raise core body temperature in ways that are beneficial to initiating and maintaining sleep.

Objectives

To assess the efficacy of physical exercise amongst older adults (aged 60 and above).

Search methods

We searched: The Cochrane Library (Issue 1, 2002); MEDLINE (1966 to January 2002); EMBASE (1980 to January 2002); CINAHL (1982 to January 2002); PsycINFO (1887 to January 2002); National Research Register (Issue1, 2002). Bibliographies of existing reviews in the area, as well as of all trial reports obtained, were searched. Experts in the field were consulted.

Selection criteria

Randomised controlled trials of physical exercise for primary insomnia where 80% or more of participants were over the age of 60. Participants must have been screened to exclude those with dementia and/or depression.

Data collection and analysis

Abstracts of studies identified in searches of electronic databases were read and assessed to determine whether they might meet the inclusion criteria. Data were analysed separately depending on whether results had been obtained subjectively or objectively.

Main results

One trial, including 43 participants with insomnia, examined the effectiveness of exercise in a population within an elderly population. At post-treatment, sleep onset latency improved slightly for both men and women. Total sleep duration, sleep onset latency and scores on a scale of global sleep quality showed significant improvement. Improvements in sleep efficiency were not significant. In some cases improvements indicated falls to below what are usually considered pathological levels but the wide confidence intervals and small sample size indicate that these findings must be interpreted with caution.

Authors' conclusions

When the possible side-effects of standard treatment (hypnotics) are considered, there is an argument to be made for clinical use of alternative treatments in the elderly. Exercise, though not appropriate for all in this population, may enhance sleep and contribute to an increased quality of life. Research involving exercise programmes designed with the elderly in mind is needed.

PLAIN LANGUAGE SUMMARY**Physical exercise as a treatment for sleep problems in older people**

Sleep problems become more common with age, affect quality of life for individuals and their families, and can increase healthcare costs. Older people are often prescribed a range of drugs for their health problems (including with sleep) many of which have side effects. This review considered the effectiveness of a programme of physical exercise involving brisk walking and moderate resistance training tailored for the needs of the older adult. These reviewers report that evidence from one small trial is encouraging, and further research is needed.

BACKGROUND

Description of the condition

The incidence of sleep problems in adulthood increases with age (Brabbins 1993); National Commission on Sleep Disorders Research (NCSDR 1993; NCSDR 1993; Bliwise 1993; Foley 1995; Ford 1989). In the general population the most common types of sleep problems reported are insomnia (both in initiating and maintaining sleep) and early morning wakings with an inability to return to sleep. Older adults primarily report difficulty in maintaining sleep and while not all sleep changes are pathological in later life (Bliwise 1993; Morin 1989) severe sleep disturbances may lead to depression and cognitive impairments (Ford 1989). Night waking is very stressful for carers and is a common cause for demands that institutional living arrangements be made (Pollak 1990).

Prevalence rates of insomnia in people aged 65 and over range between 12 and 30%. There are reports that the impact of chronic sleep disturbance impairs waking functions (e.g. mood, energy, performance) and life quality (Borkovec 1982; Morin 1989). Evidence exists that sleep disturbances contribute significantly to healthcare costs (Stoller 1994; Simon 1997). Prevalence rates of insomnia are even higher when co-existing medical or psychiatric illness is taken into account (Ford 1989; Mellinger 1995). Lifestyle changes related to retirement, the increased incidence of health problems, and the use of medication, all place older people at increased risk of disrupted sleep (Morgan 1988).

Despite the high prevalence of sleep disorders and their negative impact, it is estimated that less than 15% of patients with chronic insomnia receive treatment (Mellinger 1995). This may be related to a lack of knowledge about sleep and its disorders amongst health professionals. It is reported that the median amount of time spent on sleep in medical training in the UK is five minutes (Stores 1998) and that in clinical psychology it is no better (Wiggs 1996).

Description of the intervention

The most common treatment for sleep disorders is pharmacological, particularly for insomnia (Hohagen 1994; Morin 1999b; Kupfer 1997). Lack of knowledge about non-drug treatment and limited access to other forms of professional help are cited by physicians as the main reason for prescribing sleeping pills (Baillargeon 1996). However the long-term efficacy of this approach, which typically involves the administration of hypnotics such as benzodiazepines and zolpidem, is not certain. Two consensus conferences sponsored by the National Institute of Health (NIH 1983; NIH 1990) concluded that short-term use of hypnotic medications may be useful for acute and situational insomnia, but long-term use remains controversial because of the potential risk of tolerance and dependency. The consensus statements produced by these NIH conferences indicate that the drug of choice for the symptomatic treatment of insomnia is the benzodiazepine receptor agonist (e.g. temazepam, zolpidem etc). Nowell et al (Nowell 1997) found that these drugs do improve sleep latency (the time between going to bed and going to sleep), number of awakenings, total sleep time and total sleep quality. However, follow-up was only considered in the one or two nights following discontinuation of the drug's administration. It has been reported that older people are more likely to be affected by daytime residual effects of these sorts of drugs (Prinz 1990; Morgan 1988) and that these drugs may increase the likelihood of

patients developing sleep apnoea (Kripke 1983) and are associated with increased mortality (Kripke 1998). The efficacy of non-drug interventions has been suggested to be slower but more durable than pharmacological methods (Hauri 1997; McClusky 1991; Milby 1993). In view of the frequently high numbers of drugs that older people may be taking, an evidence-based non-drug approach is of interest.

How the intervention might work

It has been reported that exercise programmes designed with the older adult in mind may help these individuals to prevent and treat sleep disorders when such disorders have been specifically linked to depression (Singh 1997a; Singh 1997b; Singh 2001). Much has been written discussing the benefits of exercise for depression in younger populations (Byrne 1993; Artal 1998). However, research on the benefits of exercise for improving sleep in an older, non-depressed population is scant.

To date, generalisability of the results of studies of sleep and exercise are limited by the fact that they have tended to focus on good sleepers and/or young sleepers, leaving little scope for the measurement of improvement (ceiling effect) (Youngstedt 2002). Whilst it is generally believed that exercise has a beneficial effect on the quality of sleep, researchers have suggested that empirical evidence is limited (Driver 2000). The mechanisms of the effect on sleep are argued to be so complex that to "expect a straightforward answer is an oversimplification of a complex set of activities that may be physiologically and psychologically beneficial but may also stress the body" (Driver 2000). Traditionally, three main theories have been postulated to account for the connection between exercise and sleep including (1) thermoregulation, (2) body restoration, and (3) energy conservation. Firstly, the thermoregulatory theory posits that raising temperature (through, for example, exercise or passive body heating before bedtime can activate heat loss and the associated sleep mechanisms (Horne 1983; Van Someren 2000). Currently less influential, the body restoration theory predicts that "conditions for anabolic activity during sleep will be favoured by high catabolic activity during wakefulness", whilst the energy conservation theory contends that an energy budget exists and must be balanced; and so, greater energy expenditure will require greater rest. (Driver 2000; Adam 1983). Recent research contains hypotheses that exercise has benefits for sleep through its anxiolytic (anti-anxiety) and antidepressant effects, its circadian phase-shifting effects and its tendency to raise levels of adenosine (Youngstedt 2000).

A few studies have considered the existence of a link between sleep and core body temperature, on which exercise has a significant effect. Zepelin and McDonald (Zepelin 1987) found a significant negative correlation between timing of wakings after the onset of sleep (WASO) and body temperature in both young and elderly non-sleep-disturbed individuals. Using multiple regression analyses they found that the timing of the temperature nadir and age together accounted for 57% of the variance in (WASO). These findings are further supported by the work of Haimov et al (Haimov 1994) again in both young and elderly populations this time both with and without sleep disturbance. Scott and Murphy, studying middle aged and elderly people found that not only was the timing of the minimum core body temperature correlated negatively with age, but that the earlier the temperature nadir, the more disturbed and shorter was a person's sleep. The hypothesis these studies tested was that declines in sleep quality would be

associated with age-related alterations in the circadian rhythm of body temperature, particularly with a phase advance in the timing of the temperature minimum. The disputed mechanisms by which exercise affects sleep has a special importance with regard to an older population, as specific limitations on activities on the part of older people as the ageing process continues and co-morbid conditions (e.g. arthritis, heart disease) multiply may increase the demand for sleep aids which do not make unfeasible physical demands on participants. Therefore, a question related to exercise therapy for sleep problems in older adults is whether or not it can effectively be combined or substituted with passive heat treatments, e.g. the bathing as investigated by the non-randomised trial undertaken by Dorsey et al (Dorsey 1996).

Why it is important to do this review

For the purposes of this review we will concern ourselves only with the effects on sleep of active participation in exercise programmes designed for older populations. We set out to investigate the area of non-drug treatments for sleep problems in the older adult by undertaking three separate reviews to cover cognitive behavioural treatments (for which some evidence of effectiveness exists) (Montgomery 2003), bright light therapy (for which no relevant studies have been identified) (Montgomery 2002), and physical exercise (this review). A summary review will set out the evidence for a range of non-drug treatments in an effort to answer the clinical question "What alternatives to medication exist for sleep problems in the older adult?".

OBJECTIVES

To assess the efficacy of physical exercise in improving sleep quality, duration and timing amongst older adults (aged 60 upward).

METHODS

Criteria for considering studies for this review

Types of studies

All relevant randomised controlled trials in which participants had been randomly allocated to an intervention group and a control group.

Types of participants

In determining a cut-off point in age for this review, the age of 60 was chosen as being most clinically relevant, following consultation (DPOA 2000). Trials whose focus was explicitly on the older adult were included when 80% or more of participants were recorded as being over the age of 60. Participants must have been diagnosed with sleep problems via standardised measures (e.g. the PSQI [PSQI 1989]), objective measures in sleep laboratory (e.g. polysomnography, actigraphy) or by reports/diaries kept by partners or by nursing staff. Participants must also have been screened to exclude those with dementia and/or depression by the use of a psychometrically sound measure such as the Mini Mental State Examination (MMSE [Folstein 1975]) or comparable instrument. This is to avoid the confounding effects of these conditions.

Sleep problems addressed in this series of reviews will include:

Primary insomnia:

- * difficulties in initiating and maintaining sleep
- * sleep efficiency
- * sleep latency
- * delayed or advanced sleep phase problems
- * parasomnias
- * impaired daytime functioning

As sleep apnoea is primarily treated as a respiratory condition, trials whose participants who have been diagnosed as having sleep apnoea will be excluded. Those with secondary insomnia or sleep disturbance caused by a psychiatric or medical disorder will also be excluded.

Subgroup analysis are planned in the event that clinically relevant differences between subject groups are found or suspected, e.g. between domestic and nursing home settings, or between primary outcomes e.g. sleep latency and daytime functioning.

Types of interventions

Exercise programmes designed for the older adult were considered within this review.

Types of outcome measures

Outcomes measures of interest to the review question include:

- Sleep onset latency
- Wake after sleep onset (WASO)
- Total wake-time
- Sleep duration (total)
- Early morning waking (defined by the trialist)
- Sleep efficiency (ratio of time asleep / over time in bed)
- Self-report of sleep satisfaction
- Scales related to sleep, e.g.. the Pittsburgh Sleep Quality Index (PSQI [PSQI 1989])
- Daytime functioning (as measured by attentional tasks tests, self-report using a standardised measure, e.g. the Stanford Sleepiness Scale [Hoddes 1973], the Epworth Sleepiness Scale [Johns 1991])

Outcomes were divided, where possible, into immediate post-treatment, medium term (3-12 months), and long term (more than 12 months).

Search methods for identification of studies

Electronic searches

The following electronic databases were searched: The Cochrane Controlled Trials Register (The Cochrane Library, Issue 1, 2002), MEDLINE (1966 to January 2002); EMBASE (1980 to January 2002); CINAHL (1982 to January 2002); PsycINFO Journal Articles and Chapter/Books (1887 to 2002); National Research Register (NRR) (Issue 1, 2002) ; and the sleep bibliography available at www.websciences.org/bibliosleep/ (1991 to 2002).

Terms were used to isolate controlled trials as appropriate to each database. The search terms in [Appendix 1](#) were used to search the Cochrane Library and were modified as necessary for other databases.

Searching other resources

Reference lists of articles identified through database searches were examined to identify further relevant studies. Bibliographies of systematic and non-systematic review articles were also

examined to identify relevant studies and experts in the field were consulted.

Data collection and analysis

Assessment of methodological quality

Amongst other aspects of methodological quality, the reviewers allocated trials to quality categories as per the Cochrane Collaboration Handbook. Uncertainty was resolved by consensus correspondence with trialists. The Cochrane Collaboration Handbook criteria are based on the evidence of a strong relationship between the potential for bias in the results and the allocation concealment and is defined as below:

- A. Low risk of bias (adequate allocation concealment)
- B. Moderate risk of bias (some doubt about the results)
- C. High risk of bias (inadequate allocation concealment)

For the purpose of the analysis in this review, trials were included if they met the criteria A or B of the Handbook.

All included studies were critically appraised with consideration of the following questions:

- Was the assignment to treatment groups really random?
- Was allocation adequately concealed?
- How complete was follow-up?
- How were the outcomes of people who withdrew considered?
- Were those assessing outcomes blind to the treatment allocation?

Selection of studies

All reports of studies identified as above were inspected independently by the two reviewers. Disagreements regarding relevance were resolved by acquisition of the full article and discussion. All selected articles were assessed independently on the basis of the inclusion criteria and disagreements were resolved by consensus. The reviewers were not blinded to the names of the authors, institutions or journal of publication.

Data extraction and management

Data were extracted independently by each reviewer, and compared using data extraction sheets. Where it was not possible to extract any data because they were not available or further information was needed, the first author was contacted for clarification.

Other methods

Meta-analysis was not possible with just one study included within the review. Should further trials be identified at a later date, these will be analysed using the methods specified in [Appendix 2](#).

RESULTS

Description of studies

Included studies

Only one trial met the criteria for inclusion in this review ([King 1997](#)). This involved a trial of 48 older people living in the community (mean age of 62). 43 participants completed the study (90%). Severity of sleep problems at baseline was measured by participants' sleep diaries (used for two weeks before the trials). Objective measures of sleep stage or duration (polysomnography)

were not used prior to or during the trial. Trialists reported screening participants for dementia, depression, sleep apnoea and other potential causes of secondary insomnia, via interviews and administration of psychiatric tests (e.g. the MMSE [[Folstein 1975](#)]). Exercise adherence rates over the 16 week period were high (93.6%). No follow-up data were sought. Please see [Characteristics of included studies](#).

Excluded studies

Please see [Characteristics of excluded studies](#).

Risk of bias in included studies

The one trial included within this review used the Efron system for randomisation, using a computerised 'biased coin design'. This was given a score of "B" as per the Cochrane Reviewers' Handbook ([Clarke 2001](#)). While blinding of participants or trainers was not possible, the first author reported that all outcome assessors were blinded to which arm of the treatment participants had been allocated to (personal communication). The drop-out rate of the trial was 5 out of 48 (10%) and thus fell well within the inclusion criteria stated within our protocol. Trialists did not report the consideration of outcomes of participants who withdrew from the study between post-treatment and follow-up separately.

There was no reason to think that there was a particular problem with publication bias, merely that studies dealing with the effects of exercise in an older population are relatively rare.

Effects of interventions

Only one trial met the inclusion criteria for this review and data given below are as supplied in the published paper ([King 1997](#)). The intervention in this trial consisted of 16 weeks of moderate-intensity, community-based exercise training (4 x 30-40 minutes' endurance training [low impact aerobics; brisk walking] per week). The control group remained on a wait-list for the intervention. The author has supplied means and SDs for all outcomes (separately, for men and women) which can be analysed in the event that further relevant trials are identified and a meta-analysis undertaken.

Sleep onset latency (SOL)

In the one trial on exercise included within this review, King et al. (n = 43, 14 men and 29 women) used the PSQI measure for sleep onset latency. They found exercise improved (reduced) SOL by an average of 11.5 minutes (p=0.007) ([King 1997](#)).

Wake after sleep onset (WASO)

WASO (whether measured subjectively by sleep diaries or objectively by PSG) was not used in the one trial included within this review ([King 1997](#)).

Total wake-time (in minutes)

Total wake time (whether measured subjectively by sleep diaries or objectively by PSG) was not used in the one trial included within this review ([King 1997](#)).

Sleep duration (in minutes)

In the one trial on exercise included within this review, King et al. (n = 43, 14 men and 29 women) used the PSQI measure for sleep duration (or 'total sleep time'). They found exercise improved sleep duration by an average of 42 minutes (p=0.05) ([King 1997](#))

Early morning wakening

Early morning wakening was not measured in the one trial included within this review (King 1997).

Sleep efficiency

In the one trial on exercise included within this review, King et al. (n = 43, 14 men and 29 women) used both the PSQI score for 'habitual sleep efficiency' and sleep diaries to measure sleep efficiency (a proportion of time spent in bed asleep to total time spent in bed). Overall there was no significant improvement (King 1997).

PSQI

King et al. used a standardised scale, the Pittsburgh Sleep Quality Index, at post-treatment (King 1997). This global measure used is a subjective measure of sleep quality, ranging from 0 to 21. Any score above five is considered indicative of sleep disturbance. King et al reported that PSQI global scores improved (reduced) significantly for those participating in the exercise programme used in their trial (mean post-test difference between conditions = 3.4) (p < .001, 95% CI = 1.9 - 5.4;) (King 1997).

No objective data and no follow-up data were sought for any measure.

DISCUSSION

Sleep problems amongst the elderly are a serious problem that appears to receive inadequate attention despite the negative effects resulting from them; however, this review suggests that there is very little evidence for the use of physical exercise upon which to make clear recommendations for clinicians. Further investigations into the effectiveness of exercise, given the promising nature of results from the trial by King et al., seems justifiable, particularly in view of the negative consequences of pharmacological treatments. This contention may be supported by a prospective study examining 5-year mortality among hypnotic drug users and respondents with subjective insomnia identified in a longitudinal study of health, activity, and lifestyle (Nottingham Longitudinal Study of Activity and Ageing) which involved 1042 survey respondents, aged over 65 years, concluded that the mortality rate of participants was significantly greater among those taking some form of medication for sleep than for those not taking sleep medication (Rumble 1992).

The results of the one small trial on exercise which fit the inclusion criteria for this review (King 1997) do appear encouraging. Whilst sleep efficiency improved only slightly for both sexes, sleep duration, sleep onset latency and the PSQI scores improved significantly for all. These results cannot be generalised due to small sample size, but they provoke interesting hypotheses for further research. Other limitations to generalising from this small

study have to do with the possible confounding effects of daylight (if exercise is taken outside, as in King et al's trial) (King 1997, and comments) as well as disagreement regarding mechanisms for a connection between exercise and sleep (Driver 2000; Youngstedt 2002). Exercise's more established role in combatting depression may have a role in combating sub-clinical depression-related insomnia (Artal 1998) which may be highly relevant for this population.

Caveats remain such as that exercise of the type used by King et al. (brisk walking and moderate weight training) may be unsuitable for a large portion of older populations (King 1997). Some research suggests that for such populations passive body heating may increase slow wave sleep (a deeper form of sleep which older people often complain they lack) by causing a rise in body temperature (Horne 1981). It is hypothesised that heating could achieve similar results with chronically ill, disabled or unfit people and this would be of benefit to older people, particularly those for whom exercise is difficult or impossible (Dorsey 1996).

AUTHORS' CONCLUSIONS

Implications for practice

There is a lack of evidence from well-designed trials for the effectiveness of physical exercise for the treatment of sleep problems in "normal" older adults, although the intervention may be worthy of investigation.

Implications for research

New trials should feature both objective and subjective measures of sleep, as there is a large variation in the interpretation of many sleep variables (McGhie 1962). Cost-benefit analysis as regards exercise versus pharmacological treatments would be a particularly useful addition to this area of study. Nothing is currently known about whether or not exercise is likely to have a durable effect but the mechanism by which exercise is thought to operate would suggest that an exercise regime would have to be maintained if any beneficial effects were to be maintained. Future research into these sorts of interventions might consider the use of objective measurement such as actigraphy and polysomnography so that any changes could be corroborated.

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REFERENCES

References to studies included in this review

King 1997 *{published and unpublished data}*

King AC, Oman RF, Brassington GS, Bliwise DL, Haskell WL. Moderate-intensity exercise and self-rated quality of sleep in older adults. *JAMA* 1997;**277**(1):32-37.

References to studies excluded from this review

Singh 1997a *{published data only}*

Singh NA, Clements KM, Fiatarone MA. A randomized controlled trial of the effect of exercise on sleep. *Sleep* 1997;**20**(2):95-101.

Additional references

Adam 1983

Adam K, Oswald I. Protein synthesis, bodily renewal and the sleep-wake cycle. *Clinical Science* 1983;**65**:561-567.

Ancoli-Israel 1997

Ancoli-Israel S, Poceta JS, Stepnowsky C, Martin J, Gehrman P. Identification and treatment of sleep problems in the elderly. *Sleep Medicine Reviews* 1997;**1**(1):3-17.

Artal 1998

Artal M, Sherman C. Exercise Against Depression. *The Physician and Sportsmedicine* 1998;**26**(10):<http://www.physsportsmed.com/issues/1998/10Oct/artal.htm>.

Baillargeon 1996

Baillargeon L, Demers M, Gregoire JP, Pepin M. [Study on insomnia treatment by family physicians] [French] [Enquete sur le traitement de l'insomnie par les omnipraticiens]. *Canadian Family Physician* 1996;**42**:426-432. [MEDLINE: 96204188]

Benson 1975

Benson H. The relaxation response. New York: Avon Books, 1975.

Bliwise 1993

Bliwise DL. Sleep in normal aging and dementia. *Sleep* 1993;**16**(1):40-81. [MEDLINE: 93205961]

Bootzin 1991

Bootzin RR, Epstein D, Wood JM. Stimulus control instructions. In: Hauri P editor(s). *Case Studies in Insomnia*. New York, NY: Plenum Medical, 1991:19-23.

Borkovec 1978

Borkovec TD, Hennings BL. The role of physiological attention-focusing in the relaxation treatment of sleep disturbance, general tension, and specific stress reaction. *Behaviour Research and Therapy* 1978;**16**(1):7-19. [MEDLINE: 78210369]

Borkovec 1982

Borkovec TD. Insomnia. *Journal of Consulting and Clinical Psychology* 1982;**50**(6):880-95. [MEDLINE: 83083520]

Brabbins 1993

Brabbins CJ, Dewey ME, Copeland JR, Davidson IA, McWilliam C, Sunders P, Sharma VK, Sullivan C. Insomnia in the elderly: prevalence, gender differences and relationships with morbidity and mortality. *International Journal of Geriatric Psychiatry* 1993;**8**(6):473-480.

Byrne 1993

Byrne A, Byrne DG. The effect of exercise on depression, anxiety and other mood states: a review. *Journal of Psychosomatic Research* 1993;**37**(6):565-574.

Clarke 2001

Clarke M, Oxman AD. *Cochrane Reviewers Handbook 4.1.2*. Oxford: Update Software, 2001.

Dorsey 1996

Dorsey CM, Lukas SE, Teicher NH, Harper D, Winkelman JW, Cunningham SL, Satlin A. Effects of passive body heating on the sleep of older female insomniacs. *Journal of Geriatric Psychiatry and Neurology* 1996;**9**:83-90.

DPOA 2000

Wilkinson P (Consultant Psychiatrist at the Dept of the Psychiatry of Old Age, Oxfordshire Mental Healthcare Trust, UK). Personal communication 2000.

Driver 2000

Driver HS, Taylor SR. Exercise and sleep. *Sleep Medicine Reviews* 2000;**4**(4):387-402.

Efron 1971

Efron B. Forcing a sequential experiment to be balanced. *Biometrika* 1971;**58**:403-417.

Foley 1995

Foley DJ, Monjan AA, Brown SL, Simonsick EM, Wallace RB, Blazer DG. Sleep complaints among elderly persons: an epidemiologic study of three communities. *Sleep* 1995;**18**(6):425-432. [MEDLINE: 96066124]

Folstein 1975

Folstein MF, Folstein SE, McHugh PR. Mini-Mental State: A practical method for grading the state of patients for the clinician. *Journal of Psychiatric Research* 1975;**12**:189-198.

Ford 1989

Ford DE, Kamerow DB. Epidemiologic study of sleep disturbances and psychiatric disorders. *JAMA* 1989;**262**:1479-84. [MEDLINE: 89362755]

Haimov 1994

Haimov I, Laudon M, Zisapel N, et al. Sleep disorders and melatonin rhythms in elderly people. *BMJ* 1994;**309**:167.

Hauri 1991

Hauri PJ (Editor). *Case studies in insomnia*. New York: Plenum Medical Book Company, 1991. [ISBN 0306437910]

Hauri 1997

Hauri PJ. Can we mix behavioral therapy with hypnotics when treating insomniacs?. *Sleep* 1997;**20**(12):1111-8. [MEDLINE: 98152939]

Hoddes 1973

Hoddes E, Zarconi V, Smythe H, Phillips R, Dement WC. Quantification of sleepiness: a new approach. *Psychophysiology* 1973;**10**:431-436.

Hohagen 1994

Hohagen F, Kaeppler C, Schramm E, Rink K, et al. Prevalence of insomnia in elderly general practice attenders and the current treatment modalities. *Acta Psychiatrica Scandinavica* 1994;**90**(2):102-108.

Horne 1981

Horne JA. The effects of exercise upon sleep: a critical review. *Biological Psychology* 1981;**12**(4):241-290.

Horne 1983

Horne JA, Staff LHE. Exercise and sleep: body heating effects. *Sleep* 1983;**6**:36-46.

Johns 1991

Johns MW. A new method of measuring daytime sleepiness: the Epworth sleepiness scale. *Sleep* 1991;**14**(6):540-545.

Kripke 1983

Kripke DF. Why we need a tax on sleeping pills. *Southern Medical Journal* 1983;**76**(5):632-636. [MEDLINE: 83197654]

Kripke 1998

Kripke DF, Klauber MR, Wingard DL, Fell RL, Assmus JD, Garfinkel L. Mortality hazard associated with prescription hypnotics. *Biological Psychiatry* 1998;**43**:687-693.

Kupfer 1997

Kupfer DJ, Reynolds CF 3rd. Management of insomnia. *New England Journal of Medicine* 1997;**336**(5):341-346. [MEDLINE: 97156228]

McClusky 1991

McClusky HY, Milby JB, Switzer PK, Williams V, Wooten V. Efficacy of behavioral versus triazolam treatment in persistent sleep-onset insomnia. *American Journal of Psychiatry* 1991;**148**(1):121-6. [MEDLINE: 91083113]

McGhie 1962

McGhie A, Russell S. The subjective assessment of normal sleep patterns. *Journal of Mental Science* 1962;**108**:642-654.

Meeks 1991

Meeks S. Perceptions and selected physiological effects of slow stroke back massage in hospice clients. Austin, TX: University of Texas at Austin, 1991.

Mellinger 1995

Mellinger GD, Balter MB, Uhlenhuth EH. Insomnia and its treatment. *Archives of General Psychiatry* 1995;**42**:225-232.

Milby 1993

Milby JB, Williams V, Hall JN, Khuder S, McGill T, Wooten V. Effectiveness of combined triazolam-behavioral therapy for primary insomnia. *American Journal of Psychiatry* 1993;**150**(8):1259-60. [MEDLINE: 93318985]

Miles 1980

Miles LE, Dement WC. *Sleep and Aging*. New York: Raven, 1980.

Montgomery 2002

Montgomery P, Dennis J. Bright light therapy for sleep problems in adults aged 60+. *Cochrane Database of Systematic Reviews* 2002, Issue 2 Art. No.: CD003403. [DOI: [10.1002/14651858.CD003403](https://doi.org/10.1002/14651858.CD003403)]

Montgomery 2003

Montgomery P, Dennis J. Cognitive behavioural interventions for sleep problems in adults aged 60+.. *Cochrane Database of Systematic Reviews* 2003, Issue Issue 1. Art. No.: CD003161.

Morgan 1988

Morgan K, Dallosso H, Ebrahim S, Arie T, Fentem PH. Prevalence, frequency, and duration of hypnotic drug use among elderly living at home. *BMJ* 1988;**26**:601-602.

Morin 1989

Morin CM, Gramling SE. Sleep patterns and aging: comparison of older adults with and without insomnia complaints. *Psychology and Aging* 1989;**4**(3):290-294. [MEDLINE: 90027474]

Morin 1993

Morin CM. Dysfunctional beliefs and attitudes about sleep among older adults with and without insomnia complaints. *Psychology and Aging* 1993;**8**(3):463-7. [MEDLINE: 94030738]

Morin 1994

Morin CM, Culbert JP, Schwartz SM. Nonpharmacological interventions for insomnia: a meta-analysis of treatment efficacy. *American Journal of Psychiatry* 1994;**151**(8):1172-1180. [MEDLINE: 94311363]

Morin 1999b

Morin CM, Hauri PJ, Espie CA, Spielman AJ, Buysse DJ, Bootzin RR. Nonpharmacologic treatment of chronic insomnia. *Sleep* 1999;**22**(8):1134-1156.

Morin 1999c

Morin CM, Mimeault V, Gagne A. Nonpharmacological treatment of late-life insomnia. *Journal of Psychosomatic Research* 1999;**46**(2):103-116.

Murtagh 1995

Murtagh DRR, Greenwood KM. Identifying effective psychological treatments for insomnia: a meta-analysis. *Journal of Consulting and Clinical Psychology* 1995;**63**(1):79-89. [MEDLINE: 95204685]

NCSDR 1993

National Commission on Sleep Disorders Research (WC Dement, Chairman, National Commission). *Wake Up America: A National Sleep Alert*. Report of the National Commission on Sleep

Disorders Research. Washington DC: U.S. Department of Health and Human Services, 1993.

NIH 1983

National Institute of Health. Drugs and Insomnia: The Use of Medications to Promote Sleep. NIH Consensus Statement 1983 (Nov 15-17); Vol. 4, issue 10.

NIH 1990

National Institute of Health. The Treatment of Sleep Disorders of Older People. NIH Consensus Statement 1990 (Mar 26-28); Vol. 8, issue 3:1-22.

Nowell 1997

Nowell PD, Mazumdar S, Buysse DJ, Dew MA, Reynolds CF 3rd, Kupfer DJ. Benzodiazepines and zolpidem for chronic insomnia: a meta-analysis of treatment efficacy. *JAMA* 1997;**278**(24):2170-2177. [MEDLINE: 98077494]

Pallesen 1998

Pallesen S, Nordhus IH, Kvale G. Non-pharmacological interventions for insomnia in older adults: a meta-analysis of treatment efficacy. *Psychotherapy* 1998;**35**(4):472-481.

Phillips 2001

Phillips B, Ancoli-Israel S. Sleep disorders in the elderly. *Sleep Medicine* 2001;**2**:99-114.

Pollak 1990

Pollak CP, Perlick D, Linsner JP, Wenston J, Hsieh F. Sleep problems in the community elderly as predictors of death and nursing home placement. *Journal of Community Health* 1990;**15**(2):123-135. [MEDLINE: 90285337]

Pollak 1991

Pollak CP, Perlick D. Sleep problems and institutionalization of the elderly. *Journal of Geriatric Psychiatry and Neurology* 1991;**4**(4):204-210. [MEDLINE: 92162157]

Prinz 1990

Prinz PN, Vitiello MV, Raskind MA, Thorpy MJ. Geriatrics: sleep disorders and aging. *New England Journal of Medicine* 1990;**323**:520-526.

Prinz 1995

Prinz PN. Sleep and sleep disorders in older adults. *Journal of Clinical Neurophysiology* 1995;**12**(2):139-146. [MEDLINE: 95318234]

PSQI 1989

Buysse DJ, Reynolds III CF, Monk TH, Berman SB, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Research* 1989;**28**:193-213.

Richards 1993

Richards KC. The effect of a muscle relaxation, imagery, and relaxing music intervention and a back massage on the sleep and psychophysiological arousal of elderly males hospitalized in the critical care environment [dissertation]. Austin, TX: The University of Texas at Austin, 1993.

Rumble 1992

Rumble R, Morgan K. Journal of the American Geriatrics Society. *Hypnotics, sleep, and mortality in elderly people* 1992;**40**(8):787-791.

Schulz 1959

Schulz JH, Luther W. Autogenic training: psychophysiological approach in psychotherapy. New York: Grune and Stratton, 1959.

Sherrill 1998

Sherrill DL, Kotchou K, Quan SF. Association of physical activity and human sleep disorders. *Archives of Internal Medicine* 1998;**158**(17):1894-1898.

Simon 1997

Simon G, Von Korff M. Prevalence, burden and treatment of insomnia in primary care. *American Journal of Psychiatry* 1997;**154**:1417-1423.

Singh 1997b

Singh NA, Clements KM, Fiatorone MA. A randomized controlled trial of progressive resistance training in depressed elders. *Journals of Gerontology Series A-Biological Sciences & Medical Sciences* 1997;**52**(1):M27-M35.

Singh 2001

Singh NA, Clements KM, Singh MA. The efficacy of exercise as a long-term antidepressant in elderly subjects: a randomized, controlled trial. *Journals of Gerontology Series A-Biological Sciences & Medical Sciences* 2001;**56**(8):M497-M504.

Spielman 1987

Spielman AJ, Saskin P, Thorpy MJ. Treatment of chronic insomnia by restriction of time in bed. *Sleep* 1987;**10**:45-56.

Stoller 1994

Stoller MK. Economic effects of insomnia. *Clinical Therapeutics* 1994;**16**:873-897.

Stores 1998

Stores G, Crawford C. Medical student education in sleep and its disorders. *Journal of the Royal College of Physicians of London* 1998;**32**(2):149-153. [MEDLINE: 98259921]

Van Someren 2000

Van Someren EJ. More than a marker: interaction between the circadian regulation temperature and sleep, age-related changes, and treatment possibilities. *Chronobiology International* 2000;**17**:313-354.

Wiggs 1996

Wiggs L, Stores R. Sleep education in undergraduate psychology degree courses in the UK. *Psychology Teaching Review* 1996;**5**:40-46.

Woodward 1999

Woodward M. Insomnia in the elderly. *Australian Family Physician* 1999;**28**(7):653-658. [MEDLINE: 99360088]

Woolfolk 1983

Woolfolk RL, McNulty TF. Relaxation treatment for insomnia: a component analysis. *Journal of Consulting and Clinical Psychology* 1983;**51**(4):495-503. [MEDLINE: 84008655]

Youngstedt 2000

Youngstedt SD. The Exercise-Sleep Mystery. *International Journal of Sport Psychology* 2000;**30**:241-255.

Youngstedt 2002

Youngstedt SD. Ceiling and floor effects in sleep research (running title). *Sleep Medicine Reviews* 2002;**in press**.

Zepelin 1987

Zepelin H, McDonald C. Age differences in autonomic variables during sleep. *Journal of Gerontology* 1987;**42**:142-146.

CHARACTERISTICS OF STUDIES
Characteristics of included studies [ordered by study ID]

King 1997

Methods	Randomised controlled trial. Method of randomisation: Ephron system
Participants	48 older people living in the community (mean age of 62). 43 participants completed the study (90%).
Interventions	Treatment 1: 16 weeks of moderate-intensity community-based exercise training (4x 30-40 minutes endurance training [low impact aerobics; brisk walking] per week) (n = 24) Treatment 2: No treatment, wait-list control (n = 24)
Outcomes	Daily sleep participant diaries (including onset, latency, duration); Pittsburgh Sleep Quality Index
Notes	Assessors were blinded

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Singh 1997a	This RCT exclusively investigates the sleep of elderly subjects who have been diagnosed with depression

APPENDICES
Appendix 1. Cochrane Library search strategy

Cochrane Library searched Issue 1, 2002

- 1) SLEEP-DISORDERS*:ME
- 2) INSOMNIA*
- 3) WAKEFULNESS
- 4) SLEEP near DISORDER*
- 5) SLEEP near PROBLEM*
- 6) SLEEP near PATTERN*
- 7) SOMNAMBUL*

- 8) ((((((#1 or #2) or #3) or #4) or #5) or 6) or 7)
- 9) GERIATRICS*:ME
10) GERIATRIC*
11) AGED*:ME
12) ELDERLY
13) (OLD* next PERSON*)
14) (SENIOR next CITIZEN*)
15) (OLD* next PEOPLE)
- 16) ((((((#9 or #10) or #11) or #12) or #13) or #14) or #15)
- 17) (#8 and #16)

Appendix 2. Methods to be used in updates of the review

Assessment of heterogeneity

Statistical heterogeneity will be assessed using the Chi-squared test of heterogeneity along with visual inspection of the graph. A significance level of less than 0.10 will be interpreted as evidence of heterogeneity and in this case a random effects model will be used.

Assessment of reporting (publication) biases

In future, should sufficient numbers of trials be identified to justify addressing this issue, data from all identified and selected trials will be entered into a funnel graph where appropriate (trial effect vs. variance) in an attempt to investigate the likelihood of overt publication bias.

Data synthesis

Incomplete data

With the exception of the outcome of 'loss to follow up', it was decided that if at the end of the trial data on a particular outcome the attrition rate was greater than 30%, these data were not to be used.

Dichotomous (yes/no) data

For binary outcomes a standard estimation of the Relative Risk with the 95% confidence interval (CI) around this was performed.

Continuous (including scale) data

Rating scales: a range of instruments are available to measure sleep quality and the aspects of mental health which are associated with it. For outcome instruments some minimum standards were required: (i) the psychometric properties of the instrument should have been described in a book or peer-reviewed journal; (ii) the instrument should either be: (a) a self report, or (b) a report completed by an independent rater, bed-partner or relative/carer (not the therapist); and (iii) the instrument should be either a global assessment of an area of functioning or a specific feature of sleep quality, duration or timing.

Combining mean treatment effects is straightforward when all measurements are comparable and on the same scale. The fixed effect estimate of the overall treatment effect can be computed as the weighted mean of the individual study effects, where the weights are inversely proportional to the individual study specific variance estimates. On other occasions it is necessary to transform the mean effect from each study to a standardised value by dividing by the sample standard deviation within each study.

Normal data: to avoid the pitfall of applying parametric tests to non-normally distributed data the following standards were applied to all data before inclusion: (i) standard deviations and means had to be reported in the paper or are obtainable from the authors; (ii) when a scale started from a finite number (such as 0), the standard deviation had to be less than the mean (otherwise the mean was unlikely to be an appropriate measure of the centre of the distribution). Data which did not meet the second standard were not entered on RevMan software (which assumes a normal distribution). Future such data will, however, be reported in the 'Other data types' of the results section where they will be analysed using appropriate non-parametric tests

General

In all cases the data (should a meta-analysis become possible) will be entered into RevMan in such a way that the area to the left of the 'line of no effect' indicates a favourable outcome for the relevant behavioural intervention.

WHAT'S NEW

Date	Event	Description
18 July 2008	Amended	Converted to new review format.

HISTORY

Protocol first published: Issue 3, 2001

Review first published: Issue 4, 2002

Date	Event	Description
25 November 2002	New search has been performed	Minor update
12 August 2002	New citation required and conclusions have changed	Substantive amendment

CONTRIBUTIONS OF AUTHORS

Both reviewers contributed to the writing of the text of the protocol, all searches, trial selection, data entry, analysis and the writing of results.

DECLARATIONS OF INTEREST

None known.

NOTES

This review contains a change in title and protocol to the previously published "Physical treatments for sleep problems in adults aged 60+".

INDEX TERMS

Medical Subject Headings (MeSH)

*Exercise Therapy; Sleep Wake Disorders [*therapy]

MeSH check words

Aged; Female; Humans; Male; Middle Aged