Prevalence of Uncoupled Sleep and Dysfunctional Sleep Beliefs in a Sample of Community-Dwelling Older Adults in Western Australia: A Cross-Sectional Study

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Abstract

Objectives: Individuals who complain of insomnia may not always have objectively measured poor sleep, and vice versa, a phenomenon which is referred to as uncoupled sleepers. This study assessed the prevalence of uncoupled sleepers and levels of dysfunctional sleep beliefs in a sample of older adults in Western Australia.

Method: 80 adults aged 60-80 years (71 females, 89%) completed a questionnaire, sleep diary and actigraphy measurements. Sleep related dysfunctional beliefs and self-rated sleep quality were assessed using the Dysfunctional Beliefs and Attitudes about Sleep scale (DBAS-16). Objective sleep quality was measured using an Actigraph™ model wGT3X-BT activity monitor and subjective sleep quality was assessed using a modified version of the Consensus Sleep Diary.

Results: 52 of 80 participants (65%) were uncoupled sleepers. Individuals who complained of insomnia in the absence of objectively measured poor sleep showed worse self-reported sleep outcomes and higher dysfunctional beliefs, even though on actigraphy measurements there were no significant differences.

Discussion: Future research should examine subjective and objective sleep parameters in older individuals. Interindividual differences in the relationship between perceived and measured sleep quality could present a target for potential therapeutic intervention.

Trial Registration: Australian New Zealand Clinical Trials Registry (ANZCTR), ACTRN 12619001509156; http://www.anzctr.org.au/Trial/Registration/TrialReview.aspx?id=378451

Background

Around 10,000 days of a person's life is spent asleep (1). Disruptions to sleep can have a profound adverse impact on quality of life, together with increased fatigue, cognitive impairment, hypertension, and decreased blood glucose homeostasis and immune function (2). A recent Parliamentary inquiry into the sleep health awareness in Australia has now formally recognised the effect of poor sleep on the health of the nation (3).

Whilst poor sleep affects all areas of society, older adults in particular report a high number of sleep complaints. Nearly 60% of adults over the age of 60 describe at least one chronic sleep problem, with insomnia being particularly prevalent (4). Insomnia presents as difficulties with sleep initiation, sleep maintenance or early awakening, combined with a reduction in daytime functioning. It is considered chronic if it persists for at least three months, and if it occurs for a minimum of three nights a week (5). Furthermore, a diagnosis of insomnia consists of two components: objective poor sleep quality, and a subjective sleep complaint. One could assume that poor sleep quality and a sleep complaint occur in conjunction with each other, however, some individuals display an uncoupled sleep pattern and sleep appraisal (6). Uncoupled sleep and sleep complaint can manifest as paradoxical insomnia (7), where an individual complains about insomnia without the presence of objectively measurable poor sleep quality.
(also called a ‘complaining good sleeper’), or vice versa, where some individuals with objective poor sleep may not consider themselves as having sleep problems (‘non-complaining poor sleepers’). Complaining good sleepers and non-complaining poor sleepers fall outside the traditional insomnia definition, but some authors suggest that non-complaining poor sleepers may have levels of daytime impairment and anxiety that are comparable with those who sleep well (6).

Some studies have suggested that the uncoupling of sleep quality and sleep complaint may be widespread in older adults (8). Complaining good sleepers may display increased dysfunctional sleep beliefs, for example the conviction that one did not sleep all night and will therefore be unable to function the next day, even though the person does not report any daytime sleepiness. Dysfunctional sleep beliefs might be vital influences in determining how insomnia is developed and maintained (9–15) particularly in older adults (16).

This cross-sectional study, which forms part of a larger non-randomised trial, examined sleep quality in community-dwelling adults aged 60-80 years through assessment of both objective sleep (measured via wrist actigraphy) and subjective, self-reported sleep quality (measured via sleep diaries). Based on the measurements of objective and subjective sleep, the occurrence of complaining sleepers and non-complaining good and poor sleepers and the levels of dysfunctional beliefs about sleep in those groups were evaluated. It was anticipated that complaining good sleepers with negative sleep state perception (objective good sleep but perceived poor sleep) experience higher levels of dysfunctional sleep beliefs than non-complaining participants with poor sleep who display positive sleep state misperception (objective poor sleep but perceived good sleep). We will also investigate whether subjective and objective sleep parameters vary based on whether an individual identifies as having a sleep problem, and the relationship between subjective, self-reported sleep and actigraphy measured sleep.

Methods

Design

This study examined differences between non-complaining good sleepers, complaining good sleepers, complaining poor sleepers, and non-complaining poor sleepers in a sample of older adults regarding their objective sleep, their subjective sleep, the relationship between objective and subjective sleep appraisal in these groups, i.e. disparities between subjective sleep appraisal and objective sleep measures, and any potential differences in dysfunctional sleep beliefs in those four groups. Ethics approval was received from the institutional review board under reference 22000 KUTZER. All participants provided written consent.

Study participants were asked to complete an online questionnaire using Qualtrics software (Qualtrics XM Platform™ software, Qualtrics, Provo, UT, USA). Sleep related dysfunctional beliefs and self-rated sleep quality were assessed using the Dysfunctional Beliefs and Attitudes about Sleep scale (DBAS-16) (17). In addition, participants wore an actigraph and completed a sleep diary over 96 hours (72 hours plus an additional 24 hours to account for wear time non-adherence). Actigraphic sleep assessment examined
sleep-onset-latency, wake-after-sleep-onset, total sleep time, and number of night-time awakenings. The Actigraph™ model wGT3X-BT activity monitor (ActiGraph, Pensacola, FL, USA) was used, which has comparable accuracy for sleep-wake evaluation to lab-based, polysomnographic sleep assessment (18). Actigraphy is recognised by the American Academy of Sleep Medicine as an appropriate method to measure sleep-wake periods, despite its lower specificity in determining wake periods in individuals with low sleep quality (19). The actigraphy data was manually scored alongside using a sleep diary. The sleep diary utilised was a modified version of the Consensus Sleep Diary (CSD-Core) (20), which, in addition to the questions covered by the CSD-Core, recorded the total duration of all daytime naps, how many times the study participant got up, what time they had planned to wake up, and whether they took any sleep medication.

Based on their actigraphy results and sleep complaint status, participants were assigned to one of the four sleep groups: non-complaining good, complaining good, non-complaining poor, and complaining poor sleepers. Participants were considered poor sleepers if their sleep-onset-latency or wake-after-sleep-onset was ≥31min three times or more during the recording period (as per actigraph recording) and were considered complaining sleepers if they reported having had a sleep problem (e.g. trouble falling asleep) for a minimum of six months, as stipulated in their questionnaire responses. These criteria were based on previously established guidelines for the assessment of insomnia in research (21).

Procedure

Participants aged 60 to 80 years living in Western Australia were recruited between March 2020 and March 2021 using an advertisement on the website of an Australian not-for-profit health promotion charity, an advertisement in a university alumni newsletter, an advertisement on social media, via remote snowballing, using a poster in a local community hall, and using direct recruitment.

Most participants were recruited via social media using a targeted Facebook advert asking individuals whether they were interested in finding out more about their sleep pattern. Facebook was utilised for this study as previous research has demonstrated that this age group is the fastest growing user group for the social media platform (22). Participants clicked on the Facebook advert which directed them to a university intranet website listing all study requirements and contact details. Interested participants contacted the first author to express their interest. The lead researcher subsequently sent out additional study information (the consent form and the participant information sheet) and arranged an appointment for a screening call. During the screening call, which usually lasted between 15 and 30 minutes, potential participants were provided with an opportunity to ask questions about the study. Participant assessment included screening for exclusion criteria such as age <60 or >80 years, an existing diagnosis of a sleep disorder other than insomnia, an existing diagnosis of a psychiatric or cognitive disorder (e.g., bipolar disorder), current employment as a shift worker, and a diagnosis of epilepsy. Individuals were also screened for risk of falls using a brief, amended version of the STEADI (Stopping Elderly Accidents, Deaths, and Injuries) algorithm (23). In addition, participants were assessed for risk of obstructive sleep apnea (OSA) using the STOP-Bang questionnaire (24) and excluded if they were at high risk of
developing OSA or if they had an existing diagnosis of sleep apnea. Furthermore, individuals with an existing diagnosis of a psychiatric or cognitive disorder were assessed and excluded on a case-by-case basis following consultation with a clinical psychologist and were included if the diagnosis was not a current disorder or if the condition was managed well. Once individuals were confirmed eligible, they were asked to sign and return the consent form after carefully reading both the consent form and the participant information sheet via email or in the mail. Upon receipt of the consent form, participants were emailed a link to an online questionnaire.

Following completion of the online survey, participants were contacted again via email to arrange for an actigraph to be sent out to them. Actigraphs were usually dispatched via courier on a Monday and returned on a Friday, with the recording period (over four nights) mirroring this timeframe. The exception was one participant living in a rural area of Western Australia without street postal service. Participants wore the actigraph continuously, taking it off only for bathing, swimming, showering or any other activity that would submerge it in water. In addition, they were instructed to record the exact time when they removed the actigraph and subsequently when they reattached the actigraph to their wrist in their sleep diary. This allowed for accurate matching of the actigraph-estimated wear and non-wear times with the sleep diary.

**Results**

A total of 80 participants (71 females, 89%) completed the questionnaire and actigraphy measurement. The mean age of participants was 66.8 years (SD = 4.39). Nearly two thirds (65%) of participants were retired, 12.5% were in part-time employment, 8.8% in full-time employment, 7.5% self-employed, 2.5% were not employed and not currently looking for work, and 1.3% full-time carers, 'not employed and looking for work', and students, respectively. Only one participant was a smoker. Six participants (7.5%) consumed more than four standard drinks on any given drinking occasion.

Based on the classification of sleep groups, where participants were classed as poor sleepers if their sleep onset latency or WASO was \( \geq 31 \text{min} \) three times or more during the actigraphy recording period, and where participants were categorised as complaining sleepers if they had a self-reported sleep problem for at least six months, 22 participants were categorised as complaining-good (CG; 27.5%), 30 as complaining poor (CP; 37.5%), 14 as non-complaining good (NG; 17.5%) and 14 as non-complaining poor sleepers (NP; 17.5%). We used linear mixed modelling to conduct significance testing for the continuous outcome data: objective total sleep time (objTST), objective sleep onset latency (objSOL), objective wake after sleep onset (objWASO), and objective number of awakenings (obj#Awake), all of which were measured using actigraphy, and subjective total sleep time (subTST), subjective sleep onset latency (subSOL), subjective wake after sleep onset (subWASO), and subjective number of awakenings (sub#Awake), which were self-reported sleep measures we obtained from the participant sleep diaries, as well as scores on the DBAS16. We employed a Bonferroni correction to adjust for multiple comparisons. Restricted maximum likelihood was used to fit the model. We used ID as random effects, and as fixed effects included group, gender, alcohol consumption (more than four standard drinks per drinking occasion, etc.)
session), smoking status, employment status, age, and caffeine consumption. An overview of the outcome data is shown in Table 1.

Actigraphy measured objective total sleep time (objTST) showed no significant main effect between the four groups NG, CG, NP, and CP sleepers $F(3,76)=0.772, p=0.513$.

For objective sleep onset latency (objSOL), linear mixed modelling revealed that there was a significant main effect for group $F(3,63)=2.846, p=0.045$, although this was a weak effect (partial $\eta^2=0.05$). There was also an effect of smoking status $F(1,63)=5.719, p=0.02$. CP sleepers had significantly lower objective sleep onset latency compared with NP sleepers (between group mean difference $=-2.969, p=0.034$), but there was no statistically significant difference between the other groups.

There was a significant main effect for group for objective wake-after-sleep-onset (objWASO) $F(3,63)=28.966, p=0.000$; this was a large effect (partial $\eta^2=0.41$). CG sleepers had significantly lower WASO than CP sleepers (between group mean difference $=-37.06, p=0.000$), and NP (between group mean difference $=-23.55, p=0.000$) but not NG sleepers. CP sleepers had significantly higher WASO than NG sleepers (between group mean difference $=39.34, p=0.000$), whereas NG sleepers had significantly lower WASO than NP sleepers (between group mean difference $=-25.89, p=0.001$). There was no statistically significant difference between CP and NP sleepers.

Furthermore, analyses showed a significant main effect for group in objective number of awakenings (obj#Awake) $F(3,63)=20.73, p=0.000$, and this was a large effect size (partial $\eta^2=0.33$). There was also an effect of age $F(1,63)=5.86, p=0.018$. CG sleepers had a significantly lower number of objective awakenings than CP sleepers (between group mean difference $=-6.32, p=0.000$) and NP (between group mean difference $=-4.47, p=0.009$), but not NG sleepers (between group mean difference $=2.87, p=0.317$). CP sleepers’ (between group mean difference $=9.19, p=0.000$) and NP sleepers’ objective number of awakenings (between group mean difference $=7.34, p=0.000$) were significantly higher than those of NG sleepers, but there was no difference between CP and NP sleepers.

For subjective total sleep time (subTST), linear mixed modelling revealed that there was a significant main effect for group $F(3,63)=2.827, p=0.046$, and this was a medium effect size (partial $\eta^2=0.06$). CG sleepers displayed significantly lower self-reported subjective total sleep time than NP sleepers (between group mean difference $=-69.51, p=0.031$), but not compared with CP or NG sleepers. There were no significant differences between any of the other groups.

There were no significant differences between the groups in subjective sleep onset latency (subSOL) $F(3,64)=2.021, p=0.120$.

Subjective WASO (subWASO) displayed a significant main effect for group $F(3,62)=7.231, p=0.000$, showing a medium effect size (partial $\eta^2=0.095$), and an effect of age $F(1,63)=4.663, p=0.035$. CP displayed significantly higher self-reported subWASO than NG sleepers (between group mean
difference=45.34, p=0.004) and NP sleepers (between group mean difference=48.02, p=0.001), but not CG sleepers. There were no significant differences between the other groups.

There were no significant differences between the groups in subjective number of awakenings (sub#Awake) $F(3,64)=2.021, p=0.120$.

Levels of dysfunctional sleep beliefs (measured by the DBAS16) displayed a significant main effect for group $F(3,308)=10.740, p=0.000$, showing a medium effect size (partial $\eta^2=0.095$). CG displayed significantly higher levels of dysfunctional beliefs than NG sleepers (between group mean difference=0.94, p=0.002) and NP sleepers (between group mean difference=1.12, p=0.000), but not compared with CP sleepers. CP sleepers had significantly higher levels of dysfunctional beliefs than NG (between group mean difference=0.82, p=0.004) and NP (between group mean difference=1.00, p=0.000). There was no statistically significant difference between NG and NP sleepers.

**Discussion**

When comparing objective and subjective sleep parameter, objective total sleep time was not different between the sleep groups, but subjective, self-reported total sleep time was significantly lower in complaining-good sleepers, when compared to non-complaining poor sleepers. This may suggest that those with a sleep complaint, but without objectively measured poor sleep, perceived the total amount of sleep as lower than those without a sleep complaint but with actual, objectively measured poor sleep.

For objective sleep onset latency, non-complaining poor sleepers had higher sleep onset latency compared with complaining poor sleepers, but there was no difference between complaining-good sleepers and non-complaining good, or healthy, sleepers or any of the other groups. Subjective sleep onset latency in complaining-good sleepers was not statistically different from the other groups, and perceptions of sleep onset latency also did not show a significant difference between any of the other groups. This finding suggests that non-complaining poor sleepers may not perceive delayed sleep onset latency as problematic, even though it takes them longer to fall asleep than those with insomnia. In addition, these results demonstrated that it did not take complaining-good sleepers longer to fall asleep than healthy sleepers. However, these results must still be interpreted with caution, since actigraphy is known to have shown limited accuracy for sleep onset latency compared with polysomnography (25).

With regard to objective wake after sleep onset, in complaining-good sleepers this was significantly lower compared to the poor sleep groups, but there was no difference compared with healthy sleepers. Furthermore, the poor sleep groups (CP and NP) had higher objective wake after sleep onset than the healthy sleeper group. The non-complaining groups (NG and NP) had lower subjective wake after sleep onset compared to the complaining poor sleepers, those that fall within the classic definition of insomnia as having a sleep complaint as well as poor sleep, but there was no difference in complaining good sleepers subjective wake after sleep onset compared with any of the other groups. Complaining good sleepers might overestimate the time they spend awake at night since they had objective wake after sleep onset that was no different than healthy sleep group and lower than that of the insomnia group but rated
their subjective wake after sleep onset at levels comparable to those experienced by individuals with insomnia.

In addition, complaining good sleepers had a significantly lower number of objective awakenings than the groups with objective poor sleep, and there was no difference compared to the healthy sleepers (non-complaining good sleepers). There were no significant differences between the groups in subjective number of awakenings. This indicates that complaining good sleepers in this sample did not appear to wake more during the night than healthy sleepers, but also that there was no difference in how they rated the number of their nocturnal awakenings compared with the other groups.

Similarly, the assessment of dysfunctional beliefs in the four sleep groups showed that complaining sleepers had significantly higher dysfunctional sleep beliefs than the two non-complaining sleeper groups (NG and NP), but not the complaining poor sleepers. Complaining-poor sleepers also had significantly higher levels of dysfunctional beliefs than non-complaining good sleepers, but not compared with non-complaining poor sleepers. For the DBAS16, scores of 4 or above (or a rating higher than 6 on an individual item) indicate unrealistic expectations about sleep (17), and the mean scores for the complaining groups (CG and CP) showed scores over 4 whereas the in non-complaining groups they were below that threshold. Investigating the relationship between dysfunctional sleep beliefs and insomnia identity to elucidate to what extent maladaptive beliefs influence the one's perceptions of having sleep problems might be of interest for future research.

In summary, complaining – good sleepers appeared to report worse outcomes on several sleep parameters, even though on actigraphy measurements there were no significant differences in objective total sleep time, objective sleep onset latency, objective wake after sleep onset and objective number of awakenings than healthy sleepers (non-complaining good sleepers). In addition, the complaining-good sleeper group exhibited higher dysfunctional beliefs than healthy sleepers and non-complaining poor sleepers. Those that were complaining poor sleepers with ‘true’ insomnia also had higher dysfunctional beliefs than the healthy group, whereas there was no difference between the non-complaining poor sleepers and the healthy sleepers. These outcomes align with previous findings and raise the question whether insomnia might be a cognitive appraisal disorder and not a medical disorder, since individuals with a subjective sleep complaint report worse night-time sleep irrespective of how well they sleep (6). Consequently, insomnia might not arise from sleep deprivation, but might be associated with how sleep quality is perceived (26).

Cognitive behavioral therapy for insomnia, the gold standard treatment for insomnia, focuses heavily on cognitive components such as maladaptive beliefs. CBT-I has been proven to be an effective treatment for insomnia (27), but it remains unclear which factors influence its treatment outcomes. Several recent systematic reviews concluded that CBT-I is effective since it reduces dysfunctional beliefs about sleep long-term (28), and that there is sufficient evidence to show that dysfunctional beliefs do mediate the outcomes of CBT-I with regard to insomnia improvement (29). Furthermore, Sella et al. (30) highlighted that during the COVID-19 pandemic, changes in self-reported sleep quality particularly in older adults were
largely connected to changes in maladaptive sleep related beliefs. Therefore, for future research, we suggest that outcomes on sleep parameter prior and after CBT-I, including possible mediators such as dysfunctional sleep beliefs, should be investigated in older adults, using the above classification into non-complaining good, complaining good, complaining poor and non-complaining poor sleepers, to distinguish between individual discrepancies between sleep belief and objective sleep outcomes.

In addition, as we have demonstrated in this study, there may be substantial differences between self-reported and objectively measured sleep, and many studies only include self-reported questionnaire measures (31, 32). It would therefore be advisable in future investigations to record both subjective sleep perceptions and objectively measured sleep parameter, to encompass the full range of variability in sleep outcomes and sleep complaint, especially in those that fall outside the usual definition for insomnia, namely those that complain of poor sleep but sleep well objectively, and those that have objectively measured suboptimal sleep but do not complain of insomnia.

Conclusions

In this sample of community-dwelling older adults in Western Australia, we observed a similar prevalence of uncoupled sleep as had been proposed previously in other populations (6, 8). The classification of individuals into non-complaining good, complaining good, complaining poor and non-complaining poor sleepers might be a useful methodology to examine interindividual differences regarding subjective and objective sleep quality and could present a target for tailoring therapeutic interventions in the future.

Abbreviations

NG: non-complaining good sleeper, CG: complaining good sleeper, CP: complaining poor sleeper, NP: non-complaining poor sleeper, ObjTST=objective total sleep time, ObjSOL: objective sleep onset latency, ObjWASO: objective wake-after-sleep-onset, Obj#Awakenings: objective number of awakenings, SubTST: subjective total sleep time, SubSOL: subjective sleep onset latency, SubWASO: subjective wake-after-sleep-onset, Sub#Awakenings: subjective number of awakenings, DBAS16: Dysfunctional Beliefs and Attitudes about Sleep scale.

Declarations

Ethics approval and consent to participate: This study has received approval from the Edith Cowan University Ethics committee under reference 22000 KUTZER and was conducted in accordance with the Declaration of Helsinki. All participants provided written informed consent to participate.

Consent for publication: Not applicable

Availability of data and materials: The datasets analysed during the current study are available from the corresponding author on reasonable request.
Competing interests: none

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Authors’ contributions: YK: methodology, conceptualisation, project administration, investigation, data curation, formal analysis, writing – original draft preparation, writing – review and editing. LW: conceptualisation, writing – review and editing, project supervision. EQ: conceptualisation, validation, writing – review and editing, project supervision. SCF: resources, data curation, writing – review and editing. MS: conceptualisation, writing – review and editing, project supervision.

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Tables
Table 1: Estimated marginal means

| Group | CG (SE) | CP (SE) | NG (SE) | NP (SE) |
|-------|---------|---------|---------|---------|
| N (%) | 22 (27.5) | 50 (37.5) | 16 (17.5) | 14 (17.5) |
| Variable | EMM (SE) | EMM (SE) | EMM (SE) | EMM (SE) |
| ObjTST | 384.34 (35.73) | 399.20 (33.80) | 389.21 (37.32) | 400.53 (38.45) |
| ObjSOL | 7.62 (1.94) | 6.85 (1.34) | 8.57 (2.03) | 9.82 (2.09) |
| ObjWASO | 26.73 (10.30) | 85.79 (9.70) | 24.39 (10.71) | 50.28 (11.04) |
| Obj#Awakenings | 8.97 (2.47) | 13.29 (2.33) | 6.10 (2.38) | 13.44 (2.66) |
| SubTST | 349.73 (44.01) | 361.84 (41.64) | 380.36 (45.97) | 419.24 (47.37) |
| SubSOL | 10.91 (14.27) | 11.07 (13.49) | -3.07 (14.93) | -1.74 (15.37) |
| SubWASO | 9.28 (22.34) | 31.54 (20.94) | -9.80 (23.11) | -12.48 (23.87) |
| Sub#Awakenings | 1.01 (1.50) | 1.90 (1.15) | 0.67 (1.36) | 0.57 (1.46) |
| DBAS15 score | 4.14 (0.18) | 4.02 (0.14) | 5.20 (0.20) | 5.02 (0.20) |

Notes. Results are averaged over the levels of age, caffeine consumption. Results in indicated in minutes, except for DBAS15 scores.
EMM=Estimated Marginal Means
CG=complaining good sleepers
CP=complaining poor sleepers
NG=non-complaining good sleepers
NP=non-complaining poor sleepers
ObjTST=objective total sleep time
ObjSOL=objective sleep onset latency
ObjWASO=objective wake after sleep onset
Obj#Awakenings=objective number of awakenings
SubTST=subjective total sleep time
SubSOL=subjective sleep onset latency
SubWASO=subjective wake after sleep onset
Sub#Awakenings=subjective number of awakenings
DBAS6= Dysfunctional Beliefs and Attitudes about Sleep scale