This is a repository copy of *Subjective and objective sleep quality in individuals with osteoarthritis in Taiwan*.

White Rose Research Online URL for this paper:
http://eprints.whiterose.ac.uk/84898/

Version: Accepted Version

Article:

Subjective and Objective Sleep Quality in Individuals with Osteoarthritis in Taiwan

C-J. Chen[1] PhD, G.A McHugh[2*] PhD, Malcolm Campbell[2] PhD, Karen Luker[2] PhD

[1] Department of Nursing, China Medical University Hospital, 2 Yude Road, North

District, Taichung, Taiwan 404, R.O.C.

[2] School of Nursing, Midwifery and Social Work, The University of Manchester,

Manchester, UK

Short title: Sleep Quality in Osteoarthritis Patients in Taiwan

Correspondence
Dr Gretl McHugh, Senior Lecturer, School of Nursing, Midwifery & Social Work, Jean
McFarlane Building, Tel: +44 161 306 7772; email gretl.mchugh@manchester.ac.uk

Word Count: 4982

Abstract

Objectives. Negative effects of osteoarthritis (OA) like pain and depression interfere with an individual's sleep quality. The main objective of this study was to investigate the prevalence of poor quality of sleep in individuals with OA in Taiwan and identify potential predictors. A secondary objective was to examine agreement between objective and subjective measures of sleep quality.

Methods. In a cross-sectional survey, OA outpatients in Taiwan completed a self-administered questionnaire, incorporating validated measurements for assessing quality of sleep (the Pittsburgh Sleep Quality Index (PSQI)), pain and physical functioning, anxiety and depression, and health-related quality of life. In a nested feasibility study, a sub-sample of participants wore an Actigraph wrist monitor to measure sleep objectively over a three-day period.

Results. Of 192 individuals with OA who completed the survey, 30 completed the Actigraph study. The mean PSQI global score was 9.0 (SD 4.5); most participants (135, 70.3%) had poor quality of sleep (global PSQI >5). Key predictors of poor quality of sleep included role limitation due to poor physical functioning, poor social functioning, higher anxiety levels and higher pain levels. There were moderate correlations between subjective and objective measures of sleep quality, although participants underestimated their true sleeping time by two hours.

Conclusions. Health professionals need to discuss sleep issues with individuals with OA and include strategies for coping with sleep difficulties. For reduced night time pain which may interfere with sleep, additional and appropriate advice about medication is required.

Introduction

Osteoarthritis (OA) is a common musculoskeletal condition and as the population ages, it is becoming more prevalent (Arden & Nevitt 2006). Pain and reduced physical function are the main symptoms of OA (Hawker et al., 2008; McHugh et al., 2008). Evidence suggests psychological distress, including anxiety and depression is often increased due to pain from OA (He et al., 2008; Somers et al., 2009, Verter et al., 2008). There is also evidence that poor quality of sleep is also associated with frequency and duration of pain (Davis, 2003).

Following a review of the literature, few studies were identified investigating how quality of sleep is affected in individuals with OA, and those identified were conducted in Western countries. These studies show that sleep complaints are more common in those with higher pain from their OA (Fujita et al., 2006; Hawker et al., 2008; Woolhead et al., 2010) or poor physical functioning (Hawker et al., 2010). Sleep patterns in patients with OA pain are fragmented with more sleep disturbance (Taylor-Gjevre et al., 2011). Poor sleep quality appears to have an accumulative effect for patients with OA (Allen et al., 2008). Weekly changes in pain are associated with number of nights with sleep interference (Hutchings et al., 2007). Poor sleep also appears to have an association with anxiety (Woolhead et al., 2010) and depression (Hawker et al., 2010; Murphy et al., 2011; Wilcox et al., 2000). However, normal levels of anxiety and depression has also been found in OA patients with a higher level of pain and sleep disturbance (Stebbings et al., 2010). Poor mental health and health-related quality of life (HRQoL) are associated with poor quality of sleep in patients with OA (Taylor-Gjevre et al., 2011). Studies also show that mental health may worsen when the quality of sleep is poor (Somers et al., 2009; Veldhuijzen et al., 2008).

The study population of interest are Taiwanese and there have only been two studies in older Taiwanese people with OA which assessed pain, control beliefs, coping strategies (Tsai et al., 2008) and depressive tendencies (Tsai, 2007). These studies provide limited information on quality of sleep in individuals with OA. Therefore, the main objective of the study was to investigate the prevalence of poor quality of sleep and identify predictors of quality of sleep in individuals with OA in Taiwan, with a secondary objective to examine agreement between objective and subjective measures of sleep quality. The review of the literature indicated that OA patients with more pain, reduced physical functioning, poorer mental health

and poorer HRQoL were more likely to have sleep problems, so relevant measures of these outcomes were considered as potential predictors. As the study was to be carried out in a community setting, appropriate confounding variables such as age, gender and the taking of analgesics or sleep medication were also considered.

Methods

A cross-sectional survey was conducted to investigate subjective quality of sleep and identify its predictors in Taiwanese outpatients with OA. In a secondary study, quality of sleep was measured objectively in a sub-sample of participants. This was as treated as a feasibility study, given the costs and setting, with subjective and objective measurements compared to assess potential agreement. Data collection was completed in March 2011.

A convenience sample of patients were recruited from musculoskeletal and rehabilitation out-patient clinics from a large hospital in Taiwan. Patients were included in the main study if they: (1) had a diagnosis of OA from radiographic evidence; (2) were over 40 years of age, and (3) lived in the community in Taiwan. Participants were invited to complete a self-administered questionnaire. Those living close to the hospital were also asked whether they would like to take part in the secondary study, which involved wearing an Actigraph sleep monitor on the wrist to measure sleep objectively over a three day period. Proximity to the hospital was required as the Actigraph monitors were collected by the researcher from participants after the third day. Previously, a study has used a wrist Actigraph to measure sleep in individuals with other musculoskeletal disorders and this approach was deemed feasible with accurate sleep data being recorded (Goodchild et al., 2010).

Written consent was obtained from each participant. Ethical approval was obtained from the Institutional Review Board of China Medical University Hospital (DMR99-IRB-091) and the University of Manchester (10/1044/NMSW).

The primary analysis in this study was multiple regression, which was used to model the prediction of subjective quality of sleep. Sample size for multiple regression is decided by the recruitment rate, the

attrition rate and the number of explanatory variables in the regression model (Miles and Shevlin, 2001). For models with up to 15 explanatory variables with 5% significance, 80% power, moderate effect sizes, an 80% recruitment rate with 10% incomplete data, 237 participants needed to be approached in order to recruit 190 for the main study and to have at least 170 with complete data for analysis. For the secondary study, the measurement of objective sleep quality, the sample size was set at 30, which was sufficient for the reliable estimation of statistical parameters (Lancaster et al., 2004).

Data for the main study were collected using a self-administered questionnaire (in Mandarin Chinese) asking for information on demographics, clinical and medication, and incorporating Mandarin Chinese versions of four validated instruments to measure sleep, OA symptoms, anxiety and depression and health-related quality of life (HRQoL).

The Pittsburgh Sleep Quality Index (PSQI) was used to measure subjective perception of sleep quality and pattern of sleep (Buysse et al., 1989). The questionnaire consists of five open-ended and 14 closed questions on sleep (Likert scale, 0-3), with seven components: subjective sleep quality, sleep latency (two items), sleep duration, habitual sleep efficiency (three items), sleep disturbance (nine items), the use of sleeping medications, and daytime dysfunction (two items). The global score is the sum of the seven components, ranging from 0-21, higher scores representing a poorer quality of sleep. In addition, the global PSQI can be used to discriminate between good sleep (≤ 5 points) and poor sleep (> 5 points) (Buysse et al., 1989). The scale has demonstrated a high degree of internal consistency (Cronbach's alpha 0.83), as well as good sensitivity (89.6%) and specificity (86.5%) in adults (Buysse et al., 1989). The Chinese version of the PSQI has been validated for use (Tsai et al., 2005). The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) was used to assess pain, stiffness and physical activity for patients with hip and knee OA (Bellamy et al., 1988). Its global score ranges are 0–500 for pain, 0–200 for stiffness, and 0–1400 for physical functioning using the visual analogue scale (VAS). The VAS score can be normalised to correct for variation in subscale length, resulting in a score in the range 0–100 (Bellamy, 2009). A higher score means more severe pain, a higher level of stiffness, or worse physical functioning. The Chinese version of WOMAC has been validated for use and has an internal consistency of Cronbach's alpha for stiffness and physical function over 0.70 (Chou and Liu, 2007). The

5

Hospital Anxiety and Depression Scale (HADS) is a questionnaire was used to measure potential depression and anxiety (Zigmond and Snaith, 1983). Each item in the 14-item scale is scored from 0 for the best response to 3 for the worst response. Seven items give a score for depression, the other seven for anxiety, each subscale score ranging from 0-21. Both the internal consistency and reliability of the English version and Chinese Version of the HADS have been demonstrated (Zigmond and Snaith, 1983; Leung et al., 1999). HRQoL was assessed by the Short Form-36 Health Survey version 2 (SF-36v2) (Ware and Sherbourne, 1992). The scale has eight domains: physical function, role limitations because of physical health problems, bodily pain, general health perception, general mental health, role limitations because of mental health problems, social functioning, and vitality. The SF-36v2 enables norm-based scoring for HRQoL in the general population with a mean of 50 and standard deviation of 10 (Ware, 2000). The SF-36 Taiwanese version has acceptable internal consistency and reliability (Lu et al.,2003).

Piloting of the procedures and questionnaire was undertaken with 30 participants resulting in one minor change to the questionnaire. Most participants in the main study completed their questionnaire in the hospital, while a minority completed them at home and then returned them to the researcher.

The participants who agreed to use the Actigraph sleep monitor were provided with an explanation how to use it. It was similar in size to a wristwatch, and electronically recorded sleep latency, waking time after sleep onset, number of times awakening, total sleep time and sleep efficiency (the percentage of time the wearer slept while in bed). The researcher went to participants' homes to collect the monitors after the third day. There were only three wrist Actigraphs available so this limited the process of recruitment.

Statistical analysis

Data were analyzed with SPSS^{TM} Release 16.0 (SPSS, 2008). Distributions were assessed for normality in order to decide on statistical methods to be used for inferential analysis (Field, 2009), and they were found to be non-normal. Descriptive statistics were used to summarize characteristics of participants and validated measures of quality of sleep, pain, stiffness, physical function, emotional health and HRQoL. Confidence intervals were used for reporting the precision of sample means. Pearson's chi-square test, Fisher's exact test, the chi-square test for trend and the Mann-Whitney test were used to compare

demographic and clinical variables between the participants in the secondary study and those only included in the main study. As most of the continuous variables were skewed, Spearman's correlation was used to examine relationships between pairs of continuous variables and pairs where one variable was continuous and the other ordinal. Nonparametric tests were used to compare validated measures between groups (Mann-Whitney and Kruskal-Wallis tests) and to compare subjective and objective measurements of sleep within the secondary sample (Wilcoxon matched-pairs signed-ranks test).

Twenty variables were initially considered for the primary analysis, linear regression modeling, because the p-value of their association with global quality of sleep satisfied $p < 0.25$ (Hosmer and Lemeshow, 2000). Six categorical variables (gender, marital status, education level, use of analgesics, use of sleep medication, and severity of OA) were each converted into a binary dummy variable. In preliminary explorations, some subscale scores tended to interfere with each other and appeared to show no contribution to quality of sleep when included in the same model, even though individually they were all highly significant predictors ($p < 0.001$) and there was no statistical evidence of multicollinearity (Pearson's $r \leq 0.80$, tolerance ≥ 0.10). Underlying concepts were considered carefully and subscales were excluded where there was a theoretical overlap, with more specific subscales retained. Finally, 12 predictors of quality of sleep considered to be important were included in multiple linear regression modeling, with variables included hierarchically. Demographic variables were included in Model 1; clinical variables were added in Model 2; and scores from validated tools were added in Model 3. Four essential regression assumptions (lack of multicollinearity, linearity of relationships between predictors and the dependent variable, equality of variance of residuals, and normality of residuals) were assessed (Field, 2009) and appeared to be satisfied.

Results

Of 240 patients initially considered to be eligible for the study, 13 did not meet the eligibility criteria: six resided in nursing homes, four had language difficulties because they were South Asians, and three had cognitive impairment. The remaining 227 were approached to take part. The first 32 patients were approached for the pilot study and 30 agreed to take part (response rate: 93.8%). Of the remaining 195,

three refused with 192 completing the main study (response rate: 98.5%). The target of 30 participants for the secondary study was achieved.

Characteristics of participants

Table 1 summarises the main characteristics of the participants, comparing characteristics of those who volunteered to use the Actigraph sleep monitor with those who did not. Participants had a mean age of 68.3 years (median 70), with 67.7% aged 65 or over. Most were female (71.9%), married (75.0%), and living with others (92.7%). Most participants professed to follow a traditional religion (72.4%), with relatively few Buddhists (9.9%), Taoists (3.1%) or Christians (6.3%). Two-fifths (41.7%) had mild, two-fifths (40.1%) had moderate and one-fifth (18.2%) had severe OA. More than half suffered from co-existing chronic illness (56.8%), 64.1% were taking analgesia, and 4.7% took medication for mental health. Only a fifth took sleep medication (19.8%), despite most participants (87.0%) having trouble sleeping due to OA pain. Confidence intervals for mean and median scores on the normalised SF-36 physical and mental health components were below the norm of 50, confirming that the participants were below average in physical and mental function. The only statistically significant difference between the Actigraph users and those not participating in that part of the study occurred for HADS depression score. Those who volunteered had a significantly different depression score (p = 0.036), but the actual difference in medians was small (Actigraph median = 3.5, non-Actigraph median = 5).

Quality of sleep

The mean global PSQI score was 9.0 (SD 4.5) (Table 2). Most participants (n = 135, 70.3%, 95% CI 64.5% to 76.3%) had poor subjective quality of sleep (global PSQI > 5). Two components of the PSQI (sleep quality and sleep latency) had a mean of 1.7, reflecting more serious sleep problems, Participants' subjective sleep latency (the time taken to fall asleep) had a median of 25 minutes, the median subjective total sleeping time was 5.0 hours, and the median subjective sleep efficiency (the percentage of time in bed spent asleep) was 80.6%.

Complete objective sleep data were collected from all 30 participants in the secondary study. The median objective sleep latency was 12.2 minutes, median objective total sleeping time was 7.0 hours and the

median objective sleep efficiency was 90.3%. Comparing subjective with objective responses (Table 3), there were only moderate correlations between subjective and objective measures of both sleep latency and sleep efficiency (not statistically significant in this small sample), and no apparent correlation between subjective and objective total sleeping time. Participants significantly overestimated the time it took them to fall asleep (although the median difference was only 6 minutes), and significantly underestimated both the length of time (by a median of 1.2 hours) and the percentage of time in bed that they were asleep (by a median of over 10%).

Factors associated with subjective quality of sleep

There was a significant correlation between global PSQI score and age ($p = 0.009$) indicating that quality of sleep in older participants was poorer than in younger participants (Table 4). Female participants reported a poorer quality of sleep than males ($p = 0.033$). Participants with lower levels of education had poorer quality of sleep than participants with higher levels ($p < 0.001$). For severity of OA, means of the global PSQI score for participants were 6.7 in the 'mild' group, 10.1 in the 'moderate' group, and 11.9 in the 'severe' group ($p < 0.001$). Subjective quality of sleep in participants who were taking analgesics or sleep medication was significantly poorer than in participants who were taking no medication (both $p < 0.001$). Associations between the global PSQI score and marital status, number of co-existing chronic illness, and use of medication for mental health were not statistically significant. In terms of associations between measures, there were highly significant correlations between the global PSQI score and the three WOMAC subscales, HADS subscales (anxiety and depression), and the eight SF-36 subscales (all $p < 0.001$).

Predictors of subjective quality of sleep

In multiple regression analysis (see Table 5), Model 1 (demographic variables only) showed a significant overall association with subjective quality of sleep ($p = 0.001$, adjusted $R^2 = 7.1\%$), although only secondary education level ($p = 0.026$), adjusted for age and gender, was significant. The addition of clinical variables for Model 2 showed a significant improvement ($p < 0.001$) over Model 1, and Model 2 also showed a significant overall association with quality of sleep ($p < 0.001$, adjusted $R^2 = 34.6\%$).

Secondary education level (p = 0.040), taking analgesics (p < 0.001), taking sleep medication (p < 0.001), and severe OA (p = 0.001) showed significance in Model 2. The addition of the validated scores in Model 3 showed a significant improvement (p < 0.001) over Model 2, and also showed a significant overall association with quality of sleep (p < 0.001, adjusted R^2 = 49.6%). The final fitted model for multiple regression was: quality of sleep = 15.48 – 1.31 x secondary education level + 10.7 x taking analgesics + 3.40 x taking sleep medication + 0.03 x WOMAC pain + 0.21 x HADS anxiety – 0.10 x SF-36 general health – 0.09 x SF-36 social functioning.

Secondary education level (p = 0.020), taking analgesics (p = 0.044), taking sleep medication (p < 0.001), WOMAC pain (p = 0.043), HADS anxiety (p = 0.013), SF-36 role-physical (p = 0.007), and SF-36 social functioning (p = 0.017) were significant in the final model. Having severe OA and taking analgesics were related to the validated scores, which reduced their association with quality of sleep. As a result, severe OA changed from being a significant predictor in Model 2 to a non-significant predictor in Model 3. Sleep medication was the strongest factor to influence quality of sleep: those taking sleep medication had an average global PSQI score 3.4 points higher (worse) than those who did not. Sleep medication confounded the results of the other factors but this was an observational study and taking sleep medication was an observed characteristic that needed to be corrected for.

There were clear inter-relationships between the predictors. Age, gender, severity of OA and taking analgesics were removed from the regression model as being possible indirect predictors of quality of sleep, and the regression coefficients and significance of the remaining direct predictors were unaffected. Even adjusted for taking analgesics, severity of OA was significantly associated with WOMAC pain score (regression coefficient B = 18.98, p < 0.001), which itself was associated with poorer SF-36 role-physical scores (r = -0.36, p < 0.001). Age was associated with a higher severity of OA (Spearman's ρ = 0.29, p < 0.001). Women had significantly higher HADS anxiety scores (B = 1.31, p = 0.011) than men, adjusted for WOMAC pain and HADS depression score; interestingly, in the same regression model, WOMAC pain was not significantly associated with HADS anxiety (B = 0.02, p = 0.218). Women were less likely to have received secondary education than men (21.4% v 48.1%, p < 0.001), and being

female (B = -2.86, p = 0.024) and being older (B = -0.15, p = 0.007) were associated with poorer social functioning.

Discussion

This study found poor subjective quality of sleep in individuals with OA in Taiwan. The mean PSQI score of 9.0 (SD 4.5) was higher than an accepted normal cut-off of 5 (Buysse et al., 1989) and 70.3% of participants had global quality of sleep scores indicative of poor quality of sleep. Three previous studies also reported a higher prevalence of poor sleep quality in different OA population (Hawker et al., 2010; Parimi et al., 2012; Taylor-Gjevre et al., 2011). Of the PSQI components, sleep quality, sleep latency and sleep disturbance were the three with the highest mean scores (worst outcomes) in the present study. The ranking was similar but not identical to those in two other studies (Hawker et al., 2010; Taylor-Gjevre et al., 2011), which also differed slightly. Comparisons were difficult due to age and gender differences between the populations

Our study supports the findings of Wilcox et al. (2000): as age increased, subjective quality of sleep scores increased, indicating poorer sleep quality. Our study found a higher percentage (79.2%, n=130) of participants 65 years or older had a global PSQI score greater than five, compared to a Canadian study by Taylor-Gjevre et al. (2011) who found in their study population that 67% of OA patients had PSQI scores greater than 5. Accepting that poor quality of sleep was defined in different ways, our prevalence appeared to be much higher in older people with OA compared to older people in the general population in Taiwan. Females had a higher mean global PSQI score compared to males, similar to Hawker et al. (2010). Subjective quality of sleep among participants with a lower education level was worse than among those with a higher education level in our study, agreeing with a study in the USA (Wilcox et al., 2000). Subjective quality of sleep in participants with severe OA was worse than that of those with mild OA, agreeing with a study of Japanese patients with end-stage OA (Koyama et al., 2007). Levels of pain and physical function in our study were mild-to-moderate and our study agreed that quality of sleep was significantly worse in those who had OA pain (Koyama et al., 2007; Murphy et al., 2011) or poor physical function (Hawker et al., 2010).

Results from the comparison of subjective and objective sleep measures in 30 participants were promising. Allowing for pessimistic overestimations of sleep latency and underestimations of total sleep time, the subjective measures of sleep quality appeared to be valid in the population of individuals with OA in Taiwan. However, the analyses would need to be repeated with a larger group to explore the comparison in greater detail and improve the generalizability of the findings.

This study demonstrates that the Actigraph sleep monitor could be used to measure objective quality of sleep in individuals with OA in Taiwan. It has been used in this context in other countries. For example, a longitudinal study by Fielden et al. (2003) measured subjective and objective quality of sleep in 48 New Zealanders before and after total hip arthroscopy, using the Actigraph to monitor objective quality of sleep. Although the authors reported that quality of sleep was improved, they did not give details of the Actigraph results. Murphy et al. (2011) used the Actigraph only for sleep efficiency in a study of 55 women in the US with knee OA. Their mean sleep efficiency was similar to that in this study (85.9% versus 87.9%). The Actigraph has also been used with other musculoskeletal disorders to measure quality of sleep and its relationship with daytime fatigue (Goodchild et al., 2012).

Higher levels of pain, poorer physical function, and poorer emotional health were associated with poor subjective quality of sleep, as was poor health-related quality of life. There were no comparable studies of the relationships between quality of sleep and these factors for Taiwan, but findings generally agreed with those from studies in other countries. In the current study, 87.0% of participants had trouble sleeping at least once to more than three times a week because of their OA pain. Although their level of pain was mild-to-moderate, it significantly affected quality of sleep. High or moderate-to-severe levels of pain were found in other studies using the English version of the WOMAC (Bachrach-Lindström et al., 2008; Hawker et al., 2010; McHugh et al., 2008; Parimi et al., 2012) or the Korean version (Kim et al., 2011). Participants were elderly, had end-stage OA or were waiting for joint replacement surgery in those studies, different populations to the one accessed in the current study. A previous study in Taiwan assessed the level of pain in patients with knee OA as mild-to-moderate (Lai et al., 2007). Pain levels were slightly lower than this study, although in both studies, participants were recruited from large hospitals in Taiwan

that included specialist medical centres, and the severity of OA in participants was mild-to-moderate as diagnosed by radiography.

Although pain is a physical sensation common to all individuals, reactions to pain may differ according to culture and custom (Calliste, 2003). Most of the participants in our study followed a traditional religion and not Buddhism or Taoism. Different levels of pain were self-reported by our study participants compared with western studies (mild-to-moderate vs moderate-to-severe). Many Chinese may believe that pain is caused by an imbalance of "Yin" and "Yang" and tend to treat their pain by traditional methods, such as the use of Chinese medicine or acupuncture. Others prefer to perform religion ceremonies to eliminate pain before they contact a medical doctor (Chen et al., 2008). Two Taiwanese studies (Tsai, 2007; Tsai et al., 2008) reported that most patients with OA tried to ignore or tolerate their pain, although it interfered with their sleeping.

Participants with higher HADS anxiety and depression scores had a poorer subjective quality of sleep, agreeing with the findings of other studies (Allen et al., 2008; Hawker et al., 2010; Woolhead et al., 2010). This held even though participants did not appear to present problems with psychological distress, anxiety or depression in the current study. Culture may have an impact on anxiety and depression in the Chinese population, whether they come from the mainland, Taiwan or Hong Kong (Li et al., 2012; Lin, 1983; Parker et al., 2001). The prevalence of depression and anxiety, in the Chinese population tends to be lower than the generally assumed rate in western countries (Li et al., 2012; Lin, 1983; Parker et al., 2001). There may be several reasons for this. First, there is a more supportive family system in Chinese society, as most Chinese live within a larger family unit and in neighborhoods where people know each other, so there will be a better family and social support system in Chinese society than in western societies. Thus, there may be more mature help available through an extended family or neighbourhood, and more friendship available for those who are under stress in Chinese society (Parker et al., 2001; Wing, 2000). In our study, the majority of participants lived with their family in Taiwan. Second, Chinese show different help-seeking behaviour to westerners (Parker et al., 2001).

The association between subjective quality of sleep and the psychological dimension of HRQoL in the

current study agreed with that in a previous study (Taylor-Gjevre et al., 2011), but the association between quality of sleep and the physical dimension did not. As this was an observational study, all factors potentially affecting subjective quality of sleep in participants with OA were included in the regression models to reflect the true situation. Taking sleep medication was the strongest direct potential predictor, followed by SF-36 role-physical, HADS anxiety, SF-36 social functioning, WOMAC pain, not having had a secondary education, and taking analgesics. Interestingly, taking sleep medication was negatively associated with quality of sleep: participants taking sleep medication had a worse quality of sleep. In practice, sleep medication is commonly used by people with a poor quality of sleep in Taiwan, including patients with a chronic disorder such as OA. This was an observational study, and all factors potentially affecting the quality of sleep in participants with OA were included in the statistical models to reflect the true situation. In this study, sleep medication was found to be the strongest predictor of poor quality of sleep. Sleep medication is not a causal factor in predicting sleep quality, but its inclusion allowed the relationships between other factors and sleep quality to be estimated while being adjusted for sleep medication. It had to be included in the regression model otherwise the results could have been distorted. The assessment of sleep medication is often difficult as sometimes individuals may not take it regularly only when they feel it is required as there may be issues with dependency.

Relationships between potential predictors were revealing, with age appearing to affect severity of OA and social functioning. Being female appeared to affect anxiety, level of education and social functioning; and severity of OA appeared to have a strong impact on pain, which itself had a strong impact on physical function (physical role limitations). Both pain and physical function were strong predictors of subjective quality of sleep, so as might be expected, increased OA pain appeared to be a strong cause of poor quality of sleep, either directly, or indirectly through reduced physical function. Interestingly, OA pain did not appear to be causing anxiety in the participants when adjusted for gender and depression. Further research is needed to develop a conceptual model relating predictors of subjective quality of sleep in participants with OA.

Strengths and limitations

The study had a number of strengths. The sample size for the survey was achieved with an excellent response rate, optimizing the statistical power while minimizing potential selection bias. Completion of the questionnaires was high and the use of validated measurement tools strengthened the study. Confounding influences were present given the cross-sectional design but multivariable analyses were used to statistically control for known factors. One of the main limitations of the survey was the type of sampling used but due to the logistics of recruiting participants by one researcher at clinics, convenience sampling was used. The feasibility study measuring objective quality of sleep only had a small sample size, and caution needs to be taken when interpreting the findings. Individuals volunteered to take part in this part of the study and were selected for convenience of location to allow the researcher to collect the monitors afterwards. In addition, just having three Actigraph monitors available presented logistical issues in conducting this part of the study. None of those wearing the Actigraph monitors reported any problems and all Actigraph data were successfully collected.

Conclusions

This study has found a high prevalence of poor quality of sleep among individuals with OA in Taiwan, which was higher than a previous Canadian study (Taylor-Gjevre et al., 2011). A number of factors affect quality of sleep, such as osteoarthritis symptoms, anxiety, depression and social functioning. Predictors of poor quality of sleep included increased physical role limitations, higher anxiety, poorer social functioning, higher levels of pain, taking analgesics, and having a lower level of education. Health professionals need to discuss sleep issues with individuals with OA, perhaps by assessing their medication requirements and providing appropriate advice for reduced night time pain which may interfere with sleep.

References

Allen KD, Renner JB, Devellis B, Helmick, CG, & Jordan, JM (2008). Osteoarthritis and sleep: The Johnston County Osteoarthritis Project. Journal of Rheumatology 35(6): 1102-7.

Arden N, Nevitt MC. Osteoarthritis Epidemiology (2006) Best Practice & Research Clinical Rheumatology 20(1): 3-25. doi:10.1016/j.berh.2005.09.007.

Bachrach-Lindström M, Karlsson S, Pettersson LG, & Johansson T (2008). Patients on the waiting list for total hip replacement: A 1-year follow-up study. Scandinavian Journal of Caring Science 22(4): 536-42. doi: 10.1111/j.1471-6712.2007.00567.x.

Bellamy N (2009). WOMAC® Osteoarthritis Index: User Guide IX. English: Brisbane, Qld.

Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt LW (1988). Validation study of WOMAC: A health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. The Journal of Rheumatology 15(12): 1833-40.

Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ (1989). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. Psychiatry Research 28(2): 193-213. doi: 10.1016/0165-1781(89)90047-4.

Calliste LC (2003). Cultural influences on pain perceptions and behaviors. Home Health Care Management & Practice 15(3): 207-11. doi: 10.1177/1084822302250687.

Chen LM, Miaskowski C, Dodd M, Pantilat S (2008). Concepts within the Chinese culture that influence the cancer pain experience. Cancer Nursing 31(2): 103-8. doi: 10.1097/01.NCC.0000305702.07035.4d.

Chou YL, Liu S. (2007). The related factors of exercise behaviours and quality of life in knee osteoarthritis. An application of transtheoretical model. Physical Education Journal 40(1): 51-62.

Davis GC (2003). Improved sleep may reduce arthritis pain. Holistic Nursing Practice 17(3): 128-35.

Field A (2009). Discovering Statistics Using SPSS (3rd ed ed.). London: SAGE Publications.

Fielden JM, Gander PH, Horne JG, Lewer BM, Green RM, Devane PA. (2003). An assessment of sleep disturbance in patinets before and after total hip arthroplasty. Journal of Arthroplasty 18: 371-6. doi: 10.1054/arth.2003.50056.

Fujita K, Makimoto K, Hotokebuchi T (2006). Qualitative study of osteoarthritis patients' experience before and after total hip arthroplasty in Japan. Nursing & Health Sciences 8(2): 81-7. doi: 10.1111/j.1442-2018.2006.00253.x.

Goodchild CE, Treharne GJ, Booth DA, Bowaman SJ. (2010). Daytime patterning of fatigue and its associations with the previous night's discomfort and poor sleep among women with primary Sjögren's syndrome or rheumatoid arthritis. Musculoskeletal Care 8(2): 107-17. doi: 10.1002/msc.174

Hawker GA, French MR, Waugh EJ, Gignac MA, Cheung C, Murray B.J (2010). The multidimensionality of sleep quality and its relationship to fatigue in older adults with painful osteoarthritis. Osteoarthritis Cartilage 18(11): 1365-71. doi: 10.1016/j.joca.2010.08.002.

Hawker GA, Stewart L, French MR, Cibere J, Jordan JM, March L, Gooberman-Hill R(2008). Understanding the pain experience in hip and knee osteoarthritis - An OARSI/OMERACT initiative. Osteoarthritis and Cartilage 16(4): 415-22. doi: 10.1016/j.joca.2007.12.017.

He Y, Zhang M, Lin EHB, Bruffaerts R, Posada-Villa J, Angenneyer MC, Kessler R (2008). Mental disorders among persons with arthritis: Results from the World Mental Health Surveys. Psychological Medicine 38(11): 1639-50. doi: 10:1017/S0033291707002474.

Hosmer DW, Lemeshow S (2000). Applied Logistic Regression (2rd ed). New York Wiley.

Hutchings A, Calloway M, Choy E, Hooper M, Hunter DJ, Jordan JM, Palmer, L (2007). The Longitudinal Examination of Arthritis Pain (LEAP) study: Relationships between weekly fluctuations in patient-rated joint pain and other health outcomes. Journal of Rheumatology, 34(11): 2291-2300.

Kim KW, Han JW, Cho HJ, Chang CB, Park JH, Lee JJ, Kim TK (2011). Association between comorbid depression and osteoarthritis symptom severity in patients with knee osteoarthritis. Journal of Bone and Joint Surgery-American 93A(6): 556-63.doi: 10.2106/JBJS.I.01344.

Koyama Y, Miyashita M, Irie S, Takatori Y, Yamamoto M, Karita T, Kazuma K (2007). A study of the reality of daily life among patients with osteoarthritis of the hip undergoing conservative treatment. Journal of Orthopaedic Nursing 11(2): 81-90. doi: 10.1016/j.joon.2007.01.008.

Lai JN, Chen HJ, Chen CC, Lin JH, Hwang JS, Wang JD (2007). Duhuo jisheng tang for treating osteoarthritis of the knee: A prospective clinical observation. Chinese Medicine 2: 4-21. doi: 10.1186/1749-8546-2-4.

Lancaster GA, Dodd S, Williamson PR (2004) Design and analysis of pilot studies: Recommendations for good practice. Journal of Evaluation in Clinical Practice 10(2): 307-12. doi: 10.1111/j.2002.384.doc.x.

Leung CM, Wing YK, Shum A.Lo.K (1999) Validation of the Chinese-Cantonese version of the Hospital Anxiety and Depression Scale and comparison with the Hamilton Rating Scale of Depression. Acta Psychiatrica Scandinavia 100: 456-61. doi: 10.1111/j.1600-0447.1999.tb10897.x.

Li XJ, He YL, Ma-H, Liu ZN, Jian FJ, Zhang L, Zhang L (2012). Prevalence of depressive and anxiety disorders in Chinese gastroenterological outpatients. World Journal of Gastroenterology 18(20): 2561-68. doi 10.3748/wjg.v18.i20.2561.

Lin TY (1983). Psychiatry and Chinese Culture. Western Journal of Medicine 139: 862-67.

Lu JR, Tseng HM, Tsai YJ (2003). Assessment of health-related quality of life in Taiwan (1) . Development and psychometric testing of SF-36 Taiwan version. Taiwan Journal of Public Health 22(6): 501-11.

McHugh GA, Luker KA, Campbell M, Kay PR, Silman AJ (2008). Pain, physical functioning and quality of life of individuals awaiting total joint replacement: A longitudinal study. Journal of Evaluation in Clinical Practice 14(1): 19-26. doi: 10.111/j.1365-2753.2007.00777.x.

Miles J, Shevlin M (2001). Applying Regression and Correlation: A Guide for Students and Researchers. London: SAGE Publications.

Murphy SL, Lyden AK, Phillips K, Clauw DJ, Williams DA (2011). Association between pain, radiographic severity, and centrally-mediated symptoms in women with knee osteoarthritis. Arthritis Care & Research 63(11): 1543-49. doi: 10.1002/acr.20583.

Parimi N, Blackwell T, Stone KL, Lui LY, Ancoli-Israel S, Tranah GJ, Lane NE (2012). Hip pain while using lower extremity joints and sleep disturbances in elderly white women: Results from a cross-sectional analysis. Arthritis Care & Research 64(7): 1070-78. doi:10.1002/art.20256.

Parker G, Gladstone G, Chee KT (2001). Depression in the plant's largest ethinic group: The Chinese. American Journal of Psychiatry 158: 857-64.doi:10.1176/appi.ajp.158.6.857.

Somers TJ, Keefe FJ, Godiwala N, Hoyler GH (2009). Psychosocial factors and the pain experience of osteoarthritis patients: New findings and new directions. Current Opinion in Rheumatology 21(5): 501-6. doi: 10.1097/BOR.0b013e32832ed704.

SPSS, Inc. (2008). SPSS 16.0 FOR Windows 2008 Release 16.0.2. Chicago: SPSS Inc.

Stebbings S, Herbison P, Doyle TC, Treharne GJ, Highton J (2010). A comparison of fatigue correlates in rheumatoid arthritis and osteoarthritis: Disparity in associations with disability, anxiety and sleep disturbance. Rheumatology 49(2): 361-7. doi:10.1093/rheumatology/kep367. doi:10.1093/rheumatology/kep367.

Taylor-Gjevre RM, Gjevre JA, Nair B, Skomro R, Lim HJ (2011). Components of sleep quality and sleep fragmentation in rheumatoid arthritis and osteoarthritis. Musculoskeletal Care 9(3): 152-9. doi: 10.1002/msc.208.

Tsai PS, Wang SY, Wang MY, Su CT, Yang TT, Huang CJ, Fang SC. (2005) Psychometric evaluation of the Chinese version of the Pittsburgh Sleep Quality Index (CPSQI) in primary insomnia and control subjects. Quality of Life Research 14(8): 1943-52. doi: 10.1007/s11136-005-4346-x

Tsai YF (2007). Gender differences in pain and depressive tendency among Chinese elders with knee osteoarthritis. Pain 130: 188-94. doi: 10.1016/j.pain.2007.03.014

Tsai YF, Chu TL, Lai YH, Chen WJ (2008). Pain experiences, control beliefs and coping strategies in Chinese elders with osteoarthritis. Journal of Clinical Nursing 17(19): 2596-603. doi: 10.1111/j.1365-2702.2008.02306.x.

Veldhuijzen DS, Greenspan JD, Smith MT (2008). Sleep and quality of Life in chronic Pain. In J. C. Verter JC, Pandi-Perumal SR, Streiner D. (2008). Sleep and Quality of Life in Clinical Medicine. Totowa: Humana Press.

Verter JC, Pandi-Perumal SR, Streiner D (2008). Sleep and Quality of Life in Clinical Medicine. Totowa: Humana Press.

Ware JE (2000). SF-36 health survey update. Spine 25(24): 3130-39.

Ware JE, Sherbourne CD (1992). The MOS 36-item short-form health survey (SF-36). Conceptual framework and item selection. Medical Care 30(6): 473-83. doi: 10.1007/BF03260127.

Wilcox S, Brenes GA, Levine D, Sevick MA, Shumaker SA, Craven T (2000). Factors related to sleep disturbance in older adults experiencing knee pain or knee pain with radiographic evidence of knee osteoarthritis. Journal of the American Geriatrics Society 48(10), 1241-51.

Wing YK (2000). Recent advances in the management of depression and psychopharmacology. Hong Kong Medical Journal 6(1): 85-92. doi:10.3109/00048678109159439.

Woolhead G, Gooberman-Hill R, Dieppe P, Hawker G (2010). Night pain in hip and knee osteoarthritis: A focus group study. Arthritis Care and Research 62(7): 944-49. doi:10.1002/acr.20164. 10.1002/acr.20164.

Zigmond AS, Snaith RP (1983). The hospital anxiety and depression scale. Acta Psychiatrica Scandinavica 67(6): 361-70.

Table 1. Characteristics of sample of participants by Actigraph monitoring

Variable	Actigraph monitoring Yes (n = 30)	Actigraph monitoring No (n = 162)	Total (n = 192)	p
Age [median (range)]	67 (42, 88)	70.5 (42, 89)	70 (42, 89)	0.102[a]
Gender				
Male	12 (40.0%)	42 (25.9%)	54 (28.1%)	0.115[b]
Female	18 (60.0%)	120 (74.1%)	138 (71.9%)	
Education level				
Illiterate	8 (26.7%)	49 (30.2%)	57 (29.7%)	0.092[c]
Primary education	8 (26.7%)	73 (45.1%)	81 (42.2%)	
≥ Secondary education	14 (46.6%)	40 (24.7%)	54 (28.1%)	
Marital status				
Married	23 (76.7%)	121 (74.7%)	144 (75.0%)	0.095[d]
Separated or divorced	3 (10.0%)	4 (2.5%)	7 (3.6%)	
Widowed	4 (13.3%)	37 (22.8%)	41 (21.4%)	
Number of chronic illnesses				
0	13 (43.3%)	70 (43.2%)	83 (43.2%)	0.853[c]
1	10 (33.3%)	59 (36.4%)	69 (35.9%)	
≥ 2	7 (23.3%)	33 (20.4%)	40 (20.8%)	
Severity of osteoarthritis				
Mild	14 (46.7%)	66 (40.7%)	80 (41.7%)	0.795[c]
Moderate	10 (33.3%)	67 (41.4%)	77 (40.1%)	
Severe	6 (20.0%)	29 (17.9%)	35 (18.2%)	
Use of analgesics				
No	11 (36.7%)	58 (35.8%)	69 (35.9%)	0.928[b]
Yes	19 (63.3%)	104 (64.2%)	123 (64.1%)	
Sleep medication				
No	26 (86.7%)	128 (79.0%)	154 (80.2%)	0.334[b]
Yes	4 (13.3%)	34 (21.0%)	38 (19.8%)	
WOMAC pain score [median (range)]	19.8 (1.4, 80.2)	22 (2, 84.4)	21.5 (1.4, 84.4)	0.488[a]
WOMAC stiffness score [median (range)]	18.8 (0, 90)	25 (0, 96)	24.8 (0, 96)	0.389[a]
WOMAC physical function score [median (range)]	14 (1.9, 83.1)	20.7 (0.7, 80.5)	19.8 (0.7, 83.1)	0.063[a]
HADS anxiety score [median (range)]	4 (0, 12)	4.5 (0, 16)	4 (0, 16)	0.355[a]
HADS depression score [median (range)]	3.5 (0, 13)	5 (0, 16)	5 (0, 16)	0.036[a]
SF-36 physical health summary[e] [median (range)]	44.4 (23.4, 57.0)	40.2 (14.9, 57.0)	42.3 (14.9, 57.0)	0.354[a]
SF-36 mental health summary[f] [median (range)]	44.4 (27.5, 61.3)	44.4 (13.4, 64.1)	44.4 (13.4, 64.1)	0.254[a]

Global sleep score (PQSI) [median (range)]	10 (2, 19)	9 (1, 19)	9 (1, 19)	0.438[a]

Notes: WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index; HADS = Hospital Anxiety and Depression Scale; SF-36 = Short Form-36 Health Survey PSQI = Pittsburgh Sleep Quality Index.

[a] Mann-Whitney U test; [b] Pearson chi-square test; [c] chi-square test for trend; [d] Fisher's exact test; [e] 95% CI for mean 38.9 to 41.7, bootstrapped 95% CI for median 40.2 to 44.4; [f] 95% CI for mean 42.1 to 44.6, bootstrapped 95% CI for median 41.6 to 44.4

Table 2. Descriptive statistics for subjective (PSQI) and objective (Actigraph) measures of sleep quality

Sleep measurement	Mean (SD)	Median (Range)	95% CI for mean
Subjective (*N* = 192)			
Global score	9.0 (4.5)	9.0 (1, 19)	8.4 to 9.7
Subjective sleep quality score	1.7 (0.8)	2.0 (0, 3)	1.6 to 1.9
Sleep latency score	1.7 (1.1)	1.0 (0, 3)	1.5 to 1.8
Sleep duration score	1.4 (1.0)	1.0 (0, 3)	1.3 to 1.6
Sleep efficiency score	1.0 (1.1)	1.0 (0, 3)	0.9 to 1.2
Sleep disturbance score	1.4 (0.5)	1.0 (0, 2)	1.3 to 1.5
Use of sleep medication score	0.6 (1.1)	0 (0, 3)	0.4 to 0.8
Daytime dysfunction score	1.2 (0.8)	1.0 (0, 3)	1.1 to 1.3
Sleep latency (minutes)	46.7 (62.3)	25 (3, 300)	23.4 to 69.9
Total sleep time (hours)	5.3 (1.3)	5 (3, 8)	4.8 to 5.8
Sleep efficiency (%)	76.1 (18.3)	80.6 (28.9, 98.7)	69.3 to 82.9
Objective (*N* = 30)			
Sleep latency (minutes)	21.3 (25.0)	12.2 (5.7, 98.7)	12.0 to 30.6
Total sleep time (hours)	6.7 (1.1)	7.0 (2.7, 8.5)	6.3 to 7.2
Sleep efficiency (%)	87.9 (9.4)	90.3 (58.0, 98.7)	84.4 to 91.5
Waking time after sleep onset (minutes)	59.9 (38.4)	54.5 (5.7, 168.7)	45.5 to 74.2
Number of awakenings after sleep onset	1.4 (0.7)	1.3 (0, 2.7)	1.1 to 1.6

Note: PSQI = Pittsburgh Sleep Quality Index; objective measures are averages over 3 nights.

Table 3. Comparing subjective (PSQI) and objective (Actigraph) measures of sleep quality (N = 30)

Sleep variable	Objective v subjective		Objective minus subjective			
	ρ	p	Mean (SD)	Median (Range)	95% CI for mean	p
Sleep latency (minutes)	0.27	0.149	-25.4 (64.6)	-6.2 (-270.3, 92.0)	-49.5 to -1.2	0.042
Total sleep time (hours)	0.06	0.771	1.4 (1.7)	1.2 (-2.3, 4.5)	0.8 to 2.1	<0.001
Sleep efficiency (%)	0.28	0.130	11.9 (18.2)	10.5 (-32.9, 51.8)	5.1 to 18.7	0.002

Note: PSQI = Pittsburgh Sleep Quality Index; ρ = Spearman's rank correlation

Table 4. Association between global subjective quality of sleep (PSQI) and characteristics of participants (N = 192)

Variable	Association statistic	p
Age	$\rho = 0.19$	0.009
Gender	M-W Z = -2.14	0.033
Marital status	K-W $\chi^2 = 1.55$	0.067
Educational level	$\rho = -0.32$	<0.001
Number of co-existing chronic illnesses	$\rho = 0.06$	0.388
Use of analgesic	M-W Z = -4.50	<0.001
Use of sleep medication	M-W Z = -5.36	<0.001
Use of medication for mental health	M-W Z = -1.58	0.342
Severity of osteoarthritis	K-W $\chi^2 = 40.23$	<0.001
WOMAC pain	$\rho = 0.42$	<0.001
WOMAC stiffness	$\rho = 0.30$	<0.001
WOMAC physical function	$\rho = 0.48$	<0.001
HADS anxiety	$\rho = 0.35$	<0.001
HADS depression	$\rho = 0.46$	<0.001
SF-36 physical function	$\rho = -0.52$	<0.001
SF-36 role-physical	$\rho = -0.47$	<0.001
SF-36 bodily pain	$\rho = -0.49$	<0.001
SF-36 general health	$\rho = -0.28$	<0.001
SF-36 vitality	$\rho = -0.40$	<0.001
SF-36 social functioning	$\rho = -0.50$	<0.001
SF-36 role-emotional	$\rho = -0.50$	<0.001
SF-36 mental health	$\rho = -0.42$	<0.001

Note: PSQI = Pittsburgh Sleep Quality Index; WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index; HADS = Hospital Anxiety and Depression Scale; SF-36 = Short Form-36 Health Survey; ρ = Spearman's rank correlation; M-W Z = Mann-Whitney Z; K-W χ^2 = Kruskal-Wallis χ^2.

Table 5. Adjusted associations of variables with global subjective quality of sleep (PSQI) using multiple linear regression (N = 192)

Variable	Model 1 (demographic)			Model 2 (demographic + clinical)			Model 3 (demographic + clinical + validated scores)		
	Adjusted B	95% CI	p	Adjusted B	95% CI	p	Adjusted B	95% CI	p
Age	0.06	-0.01 to -0.12	0.081	0.01	-0.05 to 0.06	0.821	-0.02	-0.07 to 0.04	0.562
Female	1.18	-0.26 to 2.61	0.107	0.80	-0.42 to 2.01	0.195	-0.14	-1.25 to 0.98	0.810
Secondary education	-1.70	-3.19 to -0.21	0.026	-1.31	-2.57 to -0.06	0.040	-1.31	-2.42 to -0.21	0.020
Taking analgesics				2.04	0.91 to 3.17	<0.001	1.07	0.03 to 2.10	0.044
Taking sleep medication				4.62	3.31 to 5.94	<0.001	3.40	2.19 to 4.61	<0.001
Severe osteoarthritis				2.46	1.04 to 3.88	0.001	0.37	-1.15 to 1.88	0.633
WOMAC pain							0.03	0.01 to 0.07	0.043
HADS anxiety							0.21	0.04 to 0.37	0.013
HADS depression							0.07	-0.14 to 0.28	0.514
SF-36 role-physical							-0.10	-0.17 to -0.03	0.007
SF-36 general health							-0.02	-0.07 to 0.03	0.474
SF-36 social functioning							-0.09	-0.16 to -0.02	0.017

Note: PSQI = Pittsburgh Sleep Quality Index; WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index; HADS = Hospital Anxiety and Depression Scale; SF-36 = Short Form-36 Health Survey.

Model 1: $R^2 = 0.071$, F = 5.84, df = 3 and 188, p = 0.001

Model 2: change in $R^2 = .281$, F for change = 27.36, df = 3 and 185, p < 0.001; $R^2 = .346$, F = 17.82, df = 6 and 185, p < 0.001

Model 3: change in $R^2 = .161$, F for change = 10.18, df = 6 and 179, p < 0.001; $R^2 = .496$, F = 16.65, df = 12 and 179, p < 0.001