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Do people with chronic pain judge their sleep differently? A Qualitative study

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Abstract

People with chronic pain often report sleep of "poor quality". However, it is unclear what defines sleep quality and whether their sleep quality judgment is influenced by factors other than sleep. We purposively interviewed 17 participants with and without chronic pain and thematically analyzed their interview transcripts. Four salient criteria for judging sleep quality were: (i) *Memories of night-time sleep disruptions*, (ii) *Feelings on waking and cognitive functioning during the day*, (iii) *Ability to engage in daytime physical and social activity*, and (iv) *Changes in physical symptoms* (*and pain intensity* among participants with chronic pain). Sleep quality judgment is complex and involves retrospective decision-making influenced by not only memories of the night but also how we feel and what we do during the day.

Keywords: sleep quality, chronic pain, physical activity, qualitative, thematic analysis

Introduction

Sleep quality is an elusive construct. Despite being a common criterion used to evaluate sleep, there is no authoritative definition of what sleep quality is and how it is being interpreted by the sleeper (Krystal & Edinger, 2008).

Researchers and clinicians have developed different methods to operationalize the construct. Some use multi-component questionnaires that solicit information about sleep patterns, presence of sleep disturbances and use of sleep medications to generate a global index of sleep quality (e.g. Pittsburgh Sleep Quality Index; Buysee, Reynolds, Monk, Berman, & Kupfer, 1989). Some ask for an overall rating of sleep quality anchored with generic descriptions of sleep quality such as “very poor quality” or “very good quality”, as seen in sleep diaries (Carney et al., 2012). Additional items measuring “restfulness during sleep” or “refreshness on waking” have also been used to tap into the construct (Akerstedt, Hume, Minors, & Waterhouse, 1994; Wilson, Watson, & Currie, 1998). Some consider the amount of polysomnography-measured slow wave sleep and the level of sleep efficiency as the best physiological correlates of people’s subjective rating of sleep quality (e.g. Keklund & Akerstedt, 1997). These methodological variations reflect the lack of consensus on what sleep quality entails, and although they are accepted methods for indexing sleep quality, they offer limited insights into the parameters people use to define their subjective sleep experience. There is also a tacit assumption that criteria used to judge sleep quality do not vary between individuals or clinical groups.

Two previous studies have specifically explored the subjective meaning of sleep quality in people with and without insomnia. Harvey, Stinson, Whitaker, Moskovitz and Virk, (2008) used a combination of three approaches (a “speak freely” procedure, a semi-structured interview, and a week’s worth of sleep diary) to identify sleep quality variables

that are judged to be most important by insomniacs and compared these with those variables highlighted by normal sleepers. Quantitative analyses of the data revealed that "tiredness on waking and throughout the day" was the most frequently used variable for defining sleep quality by both insomniacs (n=25) and normal sleepers (n=28). Importantly, the authors also found that people with insomnia had a greater number of requirements for judging sleep to be good quality than normal sleepers. Kleinman et al. (2013) conducted focus groups with 28 patients with insomnia at clinical research sites to explore the language people use to describe their sleep experience and sleep quality. The groups were invited to talk about their typical sleep pattern and any night-to-night variations in sleep they had experienced over the past weeks. They were also asked to write down words that describe to them a good night's sleep, which were then read to the group to generate discussion. Transcripts of the focus groups were qualitatively analyzed for themes. Common adjectives used to describe a good night's sleep were "restful", "peaceful", "deep", and "sound", whereas a bad night's sleep was often characterised by both physical and cognitive "restlessness". Consistent with the findings of Harvey et al. (2008), the patients appeared to define the quality of sleep primarily by their feelings on waking. Waking up feeling "tired" and "exhausted" were indicators of poor sleep quality. On the contrary, waking up "in a good mood", feeling "refreshed", "having clear mind", and "motivated" to get things done were indicators of good sleep quality. Transcripts of the focus groups were also reviewed by insomnia diagnosis to uncover potential differences between participants with primary insomnia and those with insomnia comorbid with another psychiatric or medical disorder. However, this review did not identify any clear differences between groups in term of the criteria they use to gauge sleep quality. Taken together, findings from both of these studies suggest non-specific feelings upon waking- rather than objective parameters of sleep are

111 crucial in shaping our judgment of sleep quality. Cognitive-behavioral models of insomnia
112 have explicitly recognised that subjective appraisals of sleep are integral to the pathogenesis
113 of insomnia disorder (Harvey, 2002; Lundh & Broman, 2000; Morin, 1993). Identifying the
114 criteria that people use to judge their sleep quality may provide new inroads for improving
115 patients' sleep experiences and help explain reports of poor sleep quality not accompanied
116 by polysomnography- or actigraphy-measured sleep abnormalities (Harvey & Tang, 2012).
117 This could be of importance in terms of advancing the understanding and treatment of
118 insomnia comorbid with long-term health conditions such as chronic pain.

119 Sleep disturbance is highly prevalent among people living with painful conditions
120 (Brievik, Collett, Ventafridda, Cohen, & Gallacher, 2006). Poor sleep quality is reported by as
121 many as 99% of patients with fibromyalgia- a long term condition marked by widespread
122 pain in the muscles, tendons, and ligaments (Theadom, Cropley & Humprey, 2007), whereas
123 clinical levels of insomnia were found in between 53 and 79% among mixed groups of
124 chronic pain patients seeking treatment from specialist pain clinics (McCracken, Williams, &
125 Tang, 2011; Tang, Wright, & Salkovskis, 2007). Patients often cite pain as a primary reason
126 for sleep disruption and poor sleep quality (Breivik et al., 2006; Morin, Gibson, & Wade,
127 1998), although a number of studies have also highlighted the role of cognitive and somatic
128 arousal during the presleep period and the presence of depression and dysfunctional belief
129 about sleep in predicting self-reported sleep quality (Smith & Haythornthwaite, 2004; Tang,
130 Goodchild, Hester, & Salkovskis, 2012; Theadom & Cropley, 2008). It remains to be
131 determined what are the key criteria for judging sleep quality among chronic pain patients
132 and to what extent these criteria differ by pain diagnosis.

133 The present study extended the investigation of sleep quality and definitions to
134 people with chronic pain, with a view to uncovering the common parameters they use to

judge their sleep quality. As sleep quality is a subjective judgment, we took an inductive qualitative approach to explore the mental representations of sleep quality in the patients' mind (Pope & Mays, 1995; Thomas, 2003). In depth one-to-one interviews were carried out to provide the data and context for the researchers to interpret and extract meanings. Three groups of participants with widespread musculoskeletal pain, localised musculoskeletal pain and no pain were included to allow for a comparison of sleep quality definitions across diagnostic groups (Egan et al., 2013; Tang et al., 2009).

Method

Participants

Six participants with fibromyalgia, five participants with back pain, and six healthy individuals were purposively sampled to respectively represent the presence of chronic widespread musculoskeletal pain, chronic localised musculoskeletal pain, and the absence of chronic pain. Participants were recruited through advertisements circulated within local pain patient support groups and flyers displayed across the university campus and the local community.

The inclusion criteria applicable to all participants were (1) aged between 18 and 65 years and (2) English-speaking. An additional inclusion criterion for participants in the fibromyalgia or back pain group was the presence of pain for at least six months, which is in line with the definition of chronic pain (IASP Task Force on Taxanomy, 1994). All participants in the fibromyalgia and back pain groups confirmed that they had received a formal diagnosis of fibromyalgia or back pain from a physician. Exclusion criteria applicable to all groups were: (1) physical disabilities or neurological disorders that prevent them from completing the questionnaire and/or attending the interview (e.g. visual impairment,

dementia); (2) severe psychiatric illnesses (e.g. psychosis); (3) sleep disorders that might explain sleep disturbance (e.g., sleep apnea, narcolepsy). Note that participants were not selected based on their sleep complaints, as the researchers were interested in exploring the judgment of sleep quality across the whole spectrum.

Although expert consensus suggests that data saturation for qualitative analysis is generally reached with 12 participants (Guest, Bunce, & Johnson, 2006), the current study interviewed 17 participants in total to provide data for qualitative analysis.

Procedure

Potential participants who responded to the recruitment drive were screened for eligibility over the phone. Those who met the inclusion and exclusion criteria were invited to complete a questionnaire and attend a semi-structured interview. Written informed consent was obtained from each participant prior to the commencement of the interview. The protocol of this qualitative study has been reviewed and approved by the relevant Research Ethics Committee.

Questionnaires were included to characterize the participants, and these comprised a blank body manikin to assess the spread of pain (Lacey, Lewis, Jordan, Jinks, & Sim, 2005), the Brief Pain Inventory to examine pain severity and interference (BPI; Cleeland & Ryan, 1994), Insomnia Severity Index to assess sleep problems (ISI; Bastien, Vallieres, & Morin, 2001), Epworth Sleepiness Scale to measure daytime sleepiness (ESS; Johns, 1991), Multidimensional Fatigue Inventory to assess fatigue (MFI; Smets, Garssen, Bonke, & Haes, 1995), Hospital Anxiety and Depression Scale to assess symptoms of anxiety and depression (HADS; Zigmond & Snaith, 1983), Dysfunctional Beliefs and Attitudes about Sleep Scale (DBAS; Morin, Vallieres, & Ivers, 2007) to measure beliefs and attitudes about sleep, and

finally, several standard questions about the participants' demographics such as age, sex, Body Mass Index (BMI), and employment status.

The semi-structured interview generated data for the qualitative analysis. Each interview was about 40 minutes long. During the interview, participants were invited to talk in depth about their current sleep patterns and how they make judgment about their sleep quality. To ensure coverage of these topics, five open-ended questions (see Table 1) were presented one at a time with supplementary questions from the researcher when a clarification or an elaboration was required. Participants were encouraged to talk freely and allowed to digress as they shared their experiences. This provided the researchers with rich contextual information to better understand the meaning of the speech. At the end of the interview, the participants were fully debriefed (i.e. being reminded of the aims of the research, given an opportunity to ask questions or express concerns about the study, and being asked if they would be agreeable to checking the themes extracted for accuracy at a later stage) and were reimbursed for their travel expenses.

All interviews were audio-recorded and transcribed verbatim by an independent professional transcriber. The transcripts were then reviewed by the interviewer (FR) and another member of the research team (EA) for accuracy.

Analysis

The data set for the current study comprised 17 transcripts. A thematic analysis was carried out on all transcripts in accordance with the Braun and Clarke (2006) guidelines. This particular inductive data analysis approach was chosen because it allows the researchers to explore criteria for judging sleep quality with the flexibility to generate unexpected insights from the data. The procedure for thematic analysis is transparent and structured. This

minimizes the researchers' bias in summarizing the themes emerged, although some may see this as a disadvantage because it limits the researchers' interpretative power. The qualitative data analysis software, Nvivo10, was used to organize transcripts and to manage the extraction of codes and emerging themes.

There were six key steps in analyzing the data. First, the lead author (FR) familiarized herself with the data by reading and rereading the transcripts. Initial ideas and impression related to the research questions were noted and highlighted. This step allowed the researcher to develop a thorough understanding of the data. Second, initial codes (i.e. brief description of the concepts identified from the data) were constructed as transcripts were being read again. All the coded data were then collated and semantically arranged. Third, potential themes were extracted from the coded data. Fourth, potential themes were carefully reviewed. At this stage, the researcher consulted and discussed with a senior researcher with clinical and research experience in pain and sleep (NT) regarding the precision of the themes and the relevance of the coded data. Differences in opinions were resolved by discussion. Fifth, to ensure our interpretation did not deviate from original meaning of the data, the extracted themes and codes were sent to a subsample of the participants (n= 7) for validation. Feedbacks from the participants were incorporated into the final stage of analysis, which led to the naming of each theme. The coded data were arranged into a table in accordance with the themes they supported. When generating the themes, the researchers not only paid attention to words used by the participants, but also the context in which the participants articulated themselves. Finally, the researchers compared and contrasted the themes across fibromyalgia, back pain and the healthy groups. This final step allowed the researchers to examine whether people with chronic pain

judged their sleep quality differently from those without chronic pain, and whether people with fibromyalgia evaluated their sleep quality differently from people with back pain.

The reporting of the current study closely adheres to the consolidated criteria for reporting qualitative research (COREQ) to promote comprehensiveness and transparency (Tong, Sainsbury, & Craig, 2007).

Results

Participant characteristics

Table 2 presents the demographics and clinical characteristics of the participants by group. Nine (52%) of the 17 participants were male, eight (48%) were female. Age of the participants ranged from 19 to 64 years old, with a mean age of 42.1 years (SD= 15.5) and a mean BMI of 27.9 (SD= 5.89). Of the 17 participants, 7 (41%) were in full-time employment, 7 (35%) were on sick leave, medically retired, retired or not working, and the remaining 3 (18%) were studying full-time.

Although no statistical analysis was performed on the questionnaire scores given the small sample size and the qualitative nature of the current study, the overall pattern of data appeared to suggest a stepwise progression in the spread of pain across the diagnostic group (healthy controls < back pain < fibromyalgia). The same pattern of stepwise progression by diagnostic grouping was also found for pain severity, pain interference, insomnia severity, dysfunctional beliefs and attitudes about sleep, fatigue, anxiety and depression. The only exception was daytime sleepiness, whereby the scores were identical between the back pain and the health control groups, although both groups reported a lower level of daytime sleepiness than the fibromyalgia group. Only the fibromyalgia group had a mean score above the clinical threshold for ISI (23.1), ESS (10.3), and HADS (anxiety=

12.5; depression= 12.3). These scores indicated severe clinical insomnia, significant daytime sleepiness, and probable presence of anxiety and mood disorders in the fibromyalgia group.

Thematic Analysis

Four salient themes emerged as criteria used by the participants to judge their sleep quality (See Figure 1). Each of these themes is presented below with direct quotes from the participants.

Theme 1: *Memories of night-time sleep disruptions*

There was a clear consensus that the participants judged their sleep quality based on their remembered ability to "switch off" and stay asleep. Awakenings in the middle of the nights were cited as indicators of poor sleep quality; the more memories of wakefulness, the stronger the feeling of having had a bad night's sleep. A good night's sleep was typically characterized by the general absence of interruptions to sleep and/or memory of noise or any non-sleep activities, as illustrated by the quotes that follow:

> "It's that sensation of really I have switched off, I am not aware of anything. That you know, those three hours where maybe the following day my husband said to me, 'Oh did you hear the thunderstorm last night?' 'No,' because it happened on those three hours and I didn't hear anything. I didn't hear the thunderstorm, I didn't notice the light, nothing, and that is for me a proper sleep. When I'm aware of everything else I'm not, and I get up noticing that I have not slept properly" (Fibromyalgia, Female, 49).

> "A good night's sleep is that it's not interrupted it will have little to no interruption. I mean if I do wake up it will only be the once and it will be for five minutes, when I am just sort of like hear a noise and I just roll over" (Back Pain, Female, 19).

> "There are some nights when I am woken up several times for whatever reason, you know and it can be a combination of factors I might need to go to the loo, or one of the boys might wake up, or the dogs, or George [pseudonym] who makes equally as much noise and I suppose if I felt that my sleep was very disturbed because of that, or because of a combination of those factors, I would feel I had a poor night's sleep" (Healthy, Female, 45).

Theme 2: *Feelings on waking and cognitive functioning during the day*

Feeling refreshed on waking emerged as a key criterion of good quality sleep. Although it was unclear what exactly was meant by "feeling refreshed", the participants noted that on days when they felt refreshed by sleep they would be motivated to get up and be ready to start the day without any hesitation. In contrast, a poor night sleep was generally associated with a struggle to get up in the morning, tiredness on waking, and the desire to stay in bed and get some more sleep. The feeling of being refreshed by sleep appeared to be linked to the ability to overcome the sleep inertia upon transitioning from sleep to wakefulness.

> "I know when I've had a good night's sleep because I would wake in the morning feeling refreshed" (Fibromyalgia, Male, 41).
>
> "A bad night's sleep I feel bad the next day and a good night's sleep I feel refreshed, ready to go, on the ball" (Back Pain, Male, 64)
>
> "It's [a good night's sleep] waking up fresh, get up easy, get stuck straight into whatever tasks I have to do, whatever I'm going to do, as opposed to having to will myself to climb out of bed and get organized" (Healthy, Male, 63).

The participants also retrospectively judged their sleep quality based on their daytime task performance. They noted that a night of poor sleep was typically followed by a day of forgetfulness and mind-wandering. They cited that they would have difficulty in finding words, struggle to stay focused on tasks, and be slow in thinking and retrieving information. Whereas on a day when they were able to function well and think clearly, they would typically consider themselves having had a good night's sleep. There appears to be an assumed direct link between sleep and daytime cognitive performance.

> "I will be thinking and, and trying to explain stuff to you, but my mind will just go completely blank. That gets worse on certain days, obviously with less sleep, but on other days I can sort of string together" (Fibromyalgia, Male, 41)

> "I feel more alert. I do quite a physical job, but it, it's very mental as well, there's a lot of measurements and stuff I have to take, and the days will fly and everything's clear, and if I haven't had a good night's sleep the run of the mill jobs are quite problematic I have to really concentrate on stuff that normally I could just fly through" (Back Pain, Male, 45).

> "If I've had a bad night's sleep I might have word finding difficulties, so, because I teach, and so I'm standing there and I'm trying to explain something and I feel slow selecting the words that I need to be able to explain" (Healthy, Female, 53).

Theme 3: *Ability to engage in daytime physical and social activity*

Another index commonly used by the participants to gauge their sleep quality was their ability to fully engage in physical and social activities during the day. The participants cited that, following a poor night's sleep they tended to find themselves avoiding social engagements. Lacking energy, they would cancel appointments to give themselves an opportunity to catch up on sleep. Daytime fatigue and social withdrawal during the day were perceived to be indicators of poor quality sleep.

> "Having a bit more energy say after a good night sleep I've got a bit more energy to be able to go a whole day and to do things, after a bad night's sleep fatigue will hit me at say half 3 in the afternoon eventually, plug's pulled and I fall asleep standing up more or less" (Fibromyalgia, Male, 34).

> "I say when I'm tired or if I've felt like I've had very little quality sleep, I can become quite withdrawn, I don't want to be involved, I don't engage, I don't want to make conversation, so that is very much the opposite of who I am. I mean I'm quite an enthusiastic person, quite an open person, and will engage with, I will happily talk to anybody. I'm working in a job where we interact with people, like staff and customers, and to then have that day where, and other people notice and they will say to me, 'Are you okay?' and, because it is very noticeable difference" (Back Pain, Female, 28).

> "After a good night's sleep, I'm more likely to do exercise because my day will be more organized. So with a good night's sleep I'm likely to be more active"(Healthy, Female, 53).

Theme 4: *Changes in physical symptoms and pain intensity*

The participants paid attention to their bodily sensations when they made judgment of their sleep quality. Physical symptoms (e.g., headache, migraine and sore eyes) and unexpected loss of appetite were used to infer poor sleep quality.

> "After a bad night's sleep I usually wake up maybe with a headache and my eyes quite tired or sore" (Healthy, Female, 25).

> "If I have a good night's sleep I feel that I don't really have like a migraine, and when I haven't had much sleep I have a feeling of a headache, of a migraine and also I don't have as much like tension in my neck and shoulders because I do find when I don't have much energy, I do have quite a lot of tension in my neck and shoulders so that's how I sort of know" (Back Pain, Female, 19)

> "Sometimes when I've had a bad night my appetite goes as well. I have to eat something to take my medication but I will force myself to eat a bit of toast or something you know just so I've got something in my tummy to take the tablets" (Fibromyalgia, Female, 45).

Additionally, for participants with fibromyalgia or back pain, they factored in their current pain when judging sleep quality. These participants perceived an increase in pain as an indicator of poor night's sleep and showed appreciation of the self-perpetuating cycle of pain and poor sleep. They believed that a poor night's sleep would aggravate pain and fuel the risk of re-injury. When describing the pain, the participants used words such as "tight" and "swelling". The choice of words appears to suggest that both musculoskeletal and inflammatory mechanisms are involved in the reciprocal link of sleep and pain.

> "After a bad night's sleep, my muscles and my joints can be really quite painful and tight cause I haven't rested them properly" (Fibromyalgia, Female, 45).

> "I feel constantly in pain, which obviously when I don't get enough sleep will aggravate that, and then because I've aggravated pain I don't get enough sleep. So I am on a vicious cycle, I can't sleep properly because of the pain, and I can't, because I am not sleeping, I then get in more pain" (Fibromyalgia, Male, 41).

> "If I've had a bad night and it's painful it's obviously because of the swelling, because it will be like swelling in the bottom of the spine, so I have to be careful all day in case I aggravate it even more, so, and, and it plays on my mind because it's there all day, so I am generally aware of it more and I have to be so much more careful in case I injure it" (Back Pain, Male, 45).

Discussion

Across participants with and without chronic pain, four key parameters emerged to be key criteria for judging sleep quality. Namely, these criteria were "*memories of night-time sleep disruptions*", "*feelings on waking and cognitive functioning during the day*", "*ability to engage in daytime physical and social activity*" and "*changes in physical symptoms and pain intensity*". Introception of pain intensity, however, only applied to participants from the fibromyalgia and back pain groups. Whereas previous studies have predominantly focused on night-time parameters as correlates of sleep quality (Akerstedt et al., 1994; Keklund & Akerstedt, 1997), the current findings suggest that sleep quality is also influenced by daytime parameters. This may seem counterintuitive, but not so much when considering that daytime dysfunction is core to the experience of insomnia and it is usually one of the main reasons why individuals seek treatment for their sleep problems (Kyle, Espie, & Morgan, 2010).

Theme 1: Memories of night-time sleep disruptions

To participants in the current study, being able to sleep through the night is a fundamental criterion for a good night's sleep. Indeed, multiple studies have shown that

subjective sleep quality was correlated with sleep efficiency, wake after sleep onset (WASO) and number of wake bouts in the night (Bastien et al., 2003; Diaz-Piedra et al., 2015; Feige et al., 2008; Keklund & Akerstedt, 1997; O'Donoghue, Fox, Heneghan & Hurley, 2009;). It is, however, interesting to note that under normal circumstances most people do not have access to sleep measuring technologies. As such, sleep quality judgments rest heavily on the absence of memories of awakenings and the non-specific recollection that the mind has "switched off". These underline the importance of successful formation of mesograde amnesia during sleep in shaping subjective judgment of sleep quality (Perlis et al., 1997, 2001).

Several factors may play a role in shaping the sleeper's memory of wakefulness. First, the duration and timing of the awakening. It has been suggested that if an awakening marks only a brief period of arousal as short as 16 seconds on the PSG recording (Perlis et al., 1997), then there is a good chance that the awakening would be forgotten and that it would not disrupt the natural mesograde amnesia of sleep. However, it should be mentioned that experimental induction of brief arousals (<3 seconds of minimum duration of alpha activity) in healthy volunteers during the sleep onset period has been associated with subjective reports of poor sleep quality and longer sleep onset latency that is not reflected in the PSG recording (Smith & Trinder, 2000). Second, certain stages of sleep such as N1 and REM can be easily experienced as wake, particularly in people with insomnia (Mercer, Bootzin, & Lack, 2002). Although the exact mechanism underpinning this phenomenon is not clear, the presence of excessive cognitive (e.g. worries) and physiological (e.g. pain) arousal may play a role in interpreting sleep as wakefulness, by blurring the distinction between wake and sleep during sleep onset period (Bonnet & Arand, 1992; Mercer et al., 2002). Third, memory of sleep can be influenced by the current mental

state of the sleepers. Hartmann and colleagues (2015) examined the correlation between a retrospective measure of sleep quality based on the PSQI (i.e. for the last month) and a prospective measure of sleep quality derived from two weeks of sleep diary in insomnia patients with and without a comorbid psychiatric diagnosis. They found that the correlation between the two sleep quality measures was moderated by mental health status, with a significantly weaker association being found in insomnia patients with a comorbid psychiatric diagnosis. These patients also had a higher PSQI score than those without a psychiatric diagnosis, but this difference disappeared when the effect of anxiety was partialled out. The authors therefore suggested that retrospective sleep quality judgment is, to some extent, negatively biased by the mood states of psychiatric patients. Finally, attentional bias towards sleep-related threat is a cognitive characteristic of people with insomnia (Taylor, Espie & White, 2003; Semler & Harvey, 2007; Spiegelhalder et al., 2010). Selective attention to and/or active monitoring of signs and cues of sleeplessness may also contribute to participants' memory of wakefulness by increasing the load of information processing and further elevating the levels of cognitive and emotional arousal. Understanding these factors that influence memory of wakefulness may help explain the often-observed discrepancy between the objectively estimated sleep and the sleeper's subjective sleep experience (Harvey & Tang, 2012).

Theme 2: Feelings on waking and cognitive functioning during the day

Both participants with and without chronic pain evaluated their sleep quality using information and cues that occur after sleep, on the subsequent day. In other words, people inferred their sleep quality based on how they felt on waking and what they could and could not do during the day. It is important to note that the retrospective nature of the sleep

quality judgment applies to not only the context of completing a questionnaire asking about overall sleep quality, but also on a daily basis when people are asked to give a sleep quality rating in the morning after each night of sleep. Non-specific feelings on waking appeared to be an important indicator of sleep quality. Participants used generic terms such as "unrefreshed", "tiredness", and "fatigue" to describe the effect of a poor night's sleep, highlighting an implicit assumption that one should be able to function well during the day when their sleep is restorative.

Theme 3: Ability to engage in daytime physical and social activity

Following from the previous theme, sleep quality judgment is also defined by the participant's daytime physical and social activity. The assumed link between sleep and next day activity apparently is bi-directional. In fact, participants even went as far as describing a tendency to do more after having had a good night's sleep and do less after having had a bad night's sleep. This is consistent with experimental findings reported by Semler and Harvey (2005), who gave pre-determined sleep quality feedback to 22 adults with primary insomnia who believed their sleep was being monitored and spontaneously analyzed. The feedback was either positive (good quality sleep condition) or negative (poor quality sleep condition) and was randomly given to the participants according to their assigned experimental condition, remotely via a pager immediately on waking. Over the 3 days of experiment, the authors found that the participants engaged in less physical activity (e.g. cancelling appointments, taking a daytime nap) on days following the receipt of negative feedback relative to positive feedback days. A similar association between perceived sleep quality and subsequent physical activity has also been observed among chronic pain patients in a daily process study conducted by Tang and Sanborn (2014), who asked 119

chronic pain patients with insomnia to monitor their sleep and physical activity in their natural living and sleeping environment for a week. In addition to wearing an actiwatch throughout the whole study, participants completed a daily electronic diary three times a day to provide subjective ratings of their sleep quality, pain and mood upon waking, in the first half of the day, and in the second half of the day. Fitting multilevel models on these time-specific data, the authors discovered that sleep quality rating of the night before was a significant determinant of the next day's physical activity as measured with actigraphy. Pain and mood ratings in the morning, however, did not predict subsequent levels of physical activity. These findings highlight a potential role of sleep quality judgment in the regulation of physical activity in general and within the context of chronic pain. Physical inactivity is a common issue of chronic pain (Hasenbring & Verbunt, 2010; Huijnen, Verbunt, Peters, & Seelen, 2010; Mcloughlin, Colbert, Steghner, & Cook, 2011). It has been postulated in the fear-avoidance model (FAM) as a form of avoidance behavior fuelled by pain catastrophizing and the consequent fear of pain and re-injury (Asmundson, Norton & Vlaeyen, 2004; Vlaeyen & Linton, 2000). For chronic pain patients with comorbid insomnia, subjective perception of poor sleep quality may well be an additional factor that promotes more focused attention on pain, negative thinking, and activity avoidance (Affleck, 1996; Asmundson, Norton & Vlaeyen, 2004; Vlaeyen & Linton, 2000). There may be value applying cognitive-behavioral therapy for insomnia (CBT-I) as an adjunct treatment for improving sleep and daytime functioning in people with chronic pain (Jungquist et al., 2010; Tang, Goodchild, Salkovskis, 2012), especially therapy with a cognitive component that addresses subjective perception/evaluation of sleep quality (Harvey et al., 2007).

Theme 4: Changes in physical symptoms and pain intensity

Physical changes and bodily discomfort (e.g. lose of appetite, muscle tension) were reported as signs of poor sleep quality across all participants with and without pain. These findings are consistent with those of Harvey et al. (2008), who found that body sensations on waking and throughout the day was mentioned by participants as a parameter of sleep quality judgment. Different from pain-free individuals, participants with chronic pain tended to focus their attention on subtle changes in pain spread and pain intensity and they used their pain experience to infer how well they have slept the night before (e.g. "The pain has been worse than usual this morning. I must have had a poor night's sleep"). Chronic pain participants explicitly described their sleep and pain experience as a vicious cycle, with poor sleep magnifying pain and worse pain resulting in further trouble sleeping. This type of pain-related sleep belief, if held rigidly and inflexibly, may play a role in furthering sleep disturbance and pain interference (Afolalu, Moore, Ramlee, Goodchild, & Tang, in prep).

Strengths, limitations, and implications

The current study is the first to uncover common parameters of sleep quality across individuals with and without a pain condition. The findings from this study have provided new insights into judgment of sleep quality from the sleepers' perspective and generated a number of testable hypotheses about the reciprocal link between perceived sleep quality and daytime functioning. However, generalizability of the results needs confirmation from future empirical studies with larger samples. The qualitative nature of the study also means that the researchers play an active role in analyzing and extracting themes from the data. Interpretations of the data/themes may have been influenced by the researchers' personal beliefs and biases, although we should note that several measures were taken to minimize

537 the researchers' biases, such as consulting a senior researcher and sending the codes and
538 extracted themes to a subsample of participants for validation. We closely followed the
539 Braun and Clarke (2006) guideline at each step of the analysis and provided example of
540 multiple quotes for each theme to ensure our interpretation of themes was fair and
541 transparent.

542 Findings emerged from the present study have a couple interesting implications.
543 Theoretically, if judgment of sleep quality is affected by not only memories of last night's
544 sleep but also feelings on waking and functioning during the day, sleep quality ratings may
545 vary throughout the day depending on the timing of assessment. Daily process studies with
546 multiple assessments of sleep quality will help clarify to what extent sleep quality changes
547 throughout the day and identify the contextual factors associated with these changes.
548 Future assessments of day-to-day sleep quality should consider factoring in the effect of
549 time. Standardizing the timing of sleep diary completion, for example, may help maximize
550 comparisons of sleep quality judgment between days, even within the same individual
551 (Carney et al., 2012). Clinically, it may be worthwhile educating the patients about the
552 influence of their sleep quality judgment on their subsequent daytime activities, as well as
553 the reverse inference of sleep quality based on mood, physical sensations, cognitive clarity,
554 and activities performed during the day. For patients with chronic pain, their use of pain as
555 an indicator of poor sleep appears to be stemming from the belief that sleep and pain
556 interact in a vicious cycle, with poor sleep magnifying pain and worse pain resulting in
557 further trouble sleeping. Loosening up this belief and eliminating pain from the sleep quality
558 judgment will allow the patient to embrace the treating of insomnia despite ongoing pain
559 (Tang, Goodchild, Hester, & Salkovskis, 2012; Afolalu, Moore, Ramlee, Goodchild, & Tang, in
560 prep). For patients with subjective insomnia not accompanied by objective sleep deficits,

promoting engagement in physical and social activities during the day may represent a new avenue for improving sleep quality.

Conclusion

In conclusion, this present study extends our knowledge of the way people with and without chronic pain judge their sleep quality. Sleep quality is not solely determined by night-time parameters but also by daytime processes through retrospective judgment. Particularly, people with chronic pain view pain experience and sleep quality as two linked entities that influence their ability to engage in daytime activities as planned. To the sleeper, using indirect indicators to infer sleep quality is only natural as they do not have access to sleep assessment technology and the experience of sleep is marked by darkness, loss of consciousness and amnesia. The current findings highlight the potential benefits of targeting daytime symptoms in attempts to improve sleep quality. A possible extension of FAM specifying the role of perceived sleep quality in influencing people's decision to engage in daytime physical and social activity may also offer a more comprehensive framework for understanding of chronic pain.

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Table 1

Interview Outline

1.	How would you describe your sleep? Can you tell me about your typical sleep pattern?
2.	How can you tell that you have had a good night's sleep?
3.	How can you tell that you have had a poor night's sleep?
4.	To you, what are the major difference between a good night's sleep and a poor night's sleep?
5	Is there anything that you would like to add about your sleep?

772 **Table 2**

773 Participant characteristics by group

	Fibromyalgia (*n*= 6)	Back Pain (*n*= 5)	Healthy pain-free (*n*= 6)
Demographics			
Sex			
Male	3	3	3
Female	3	2	3
Age (in years)	49 (11.6)	35.2 (19.2)	41 (15.3)
BMI	27.8 (5.4)	32.4 (6.2)	24.2 (3.6)
Employment status			
Full-time employment	1	3	3
On sick leave/ medically retired/ retired/ not working	5	-	2
Full-time studying	-	2	1
Clinical characteristics			
Body manikins (number of area shaded)	24.5 (9.9)	4.2 (3.1)	N/A
BPI- Present Pain Severity	6.1 (0.5)	3.8 (0.9)	0.5 (1.0)
BPI- Pain Interference	8.3 (0.9)	3.8 (1.6)	0.5 (0.8)
ISI	23.1 (3.7)	14.4 (4.2)	8.3 (3.3)
ESS	10.3 (7.4)	6 (4.8)	6 (3.5)
DBAS-16	7.23 (1.4)	4.3 (1.8)	3.2 (1.3)
MFI	88.8 (11.8)	56 (10.4)	47.5 (18.9)
HADS(A)	12.5 (2.7)	7.6 (1.8)	5 (2.7)
HADS(D)	12.3 (2.3)	5.6 (2.8)	4 (2.5)

Notes. Mean values are presented with standard deviations in parentheses unless otherwise specified. BMI= Body mass index. BPI= Brief Pain Inventory. ISI= Insomnia Severity Index. ESS= Epworth Sleepiness Scale. DBAS-16= Dysfunctional Beliefs and Attitudes about Sleep. MFI= Multidimensional Fatigue Inventory. HADS(A)= Hospital Anxiety and Depression Scale (Anxiety). HADS(D)= Hospital Anxiety and Depression Scale (Depression).

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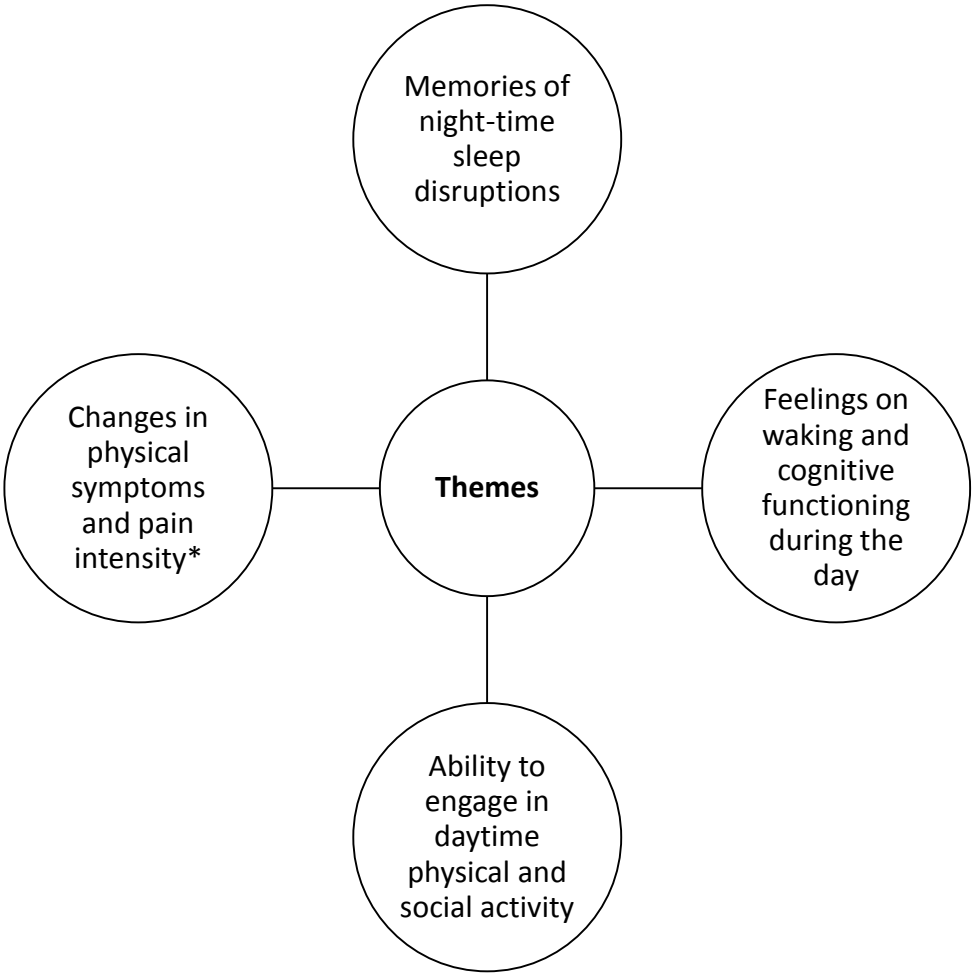
Figure 1

Themes emerged as criteria for judging sleep quality



*Introception of pain intensity only applied to the fibromyalgia and back pain groups