The Occupational Impact of Sleep Quality

by

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Abstract

While the importance of assessing the occupational consequences of insomnia and other sleep disorders is emphasised in clinical nosologies and research guidelines, there is little consensus on which aspects of occupational performance should be assessed, how such impairment should be measured, and how outcomes should be reported. The research programme described in this thesis aimed to address this issue. Chapter 1 presents a systematic review and methodical critique of studies reporting those aspects of occupational performance most impacted by (or most frequently associated with) insomnia symptoms and degraded sleep quality. Equivocal results, wide variations in reporting conventions, and the overall lack of comparability among studies, strongly indicated the need to develop a standardised metric able to quantify sleep related occupational performance and serve as an assessment and outcome instrument suitable for use in research and clinical settings. Informed by the literature review, Chapters 2-4 describe the development and validation of the Loughborough Occupational Impact of Sleep Scale ('LOISS'), a unidimensional 19 item questionnaire that captures sleep-related occupational impairment across a number of workplace domains over a 4-week reference period. Chapters 5-7 describe LOISS outcomes from: i) surveys in a random population sample; ii) a representative sample of the UK workforce; and iii) a clinical sample of patients with obstructive sleep apnoea (before and after treatment with CPAP). Overall, the scale showed strong internal consistency (Cronbach's alpha range=0.84-0.94) and test-retest reliability ($r=0.77$, $r^2=0.59$, $p<0.001$), high levels of criterion validity (significantly discriminating between good and poor sleepers), and proved an effective outcome measure in OSA. From

the survey data reported in Chapters 2-7, LOISS score distributions showed no consistent gender difference but did show a significant ageing gradient, with sleep-related occupational impairment declining with increasing age. In conclusion, the work presented here supports the usability, validity and reliability of the LOISS as an assessment and outcome instrument, and also demonstrates the utility of this instrument in exploring the dynamics of sleep-related occupational performance.

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Publications

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Foreword

The work presented here describes the developmental process of the Loughborough Occupational Impact of Sleep Scale "LOISS" and the subsequent testing of the scale in clinical and non-clinical populations. The thesis is organised as a series of chapters, starting with a critical review of existing literature in this area and the rationale for the work presented (Chapter 1). Chapters 2 and 3 describe the developmental processes involved in generating LOISS and are followed by reliability analyses in Chapter 4. Chapters 5, 6 and 7 each describe results from the application of LOISS in different populations; a random population sample; a cross-section of the British workforce and finally; a clinical sample of patients with obstructive sleep apnoea. Each Chapter loosely follows the convention of Introduction, Methods and Results, followed by a Comments section. Chapter 8 will draw the results from each Chapter together and discuss theoretical issues and conclusions based upon the research presented as a whole.

1. Literature Review

Prevalence of sleep related occupational impairment

Insomnia, at both symptom and syndrome level, is now widely recognised as a significant public health concern. Ohayon, (2002) reviewed international prevalence rates and estimated that up to 30-48% of people report insomnia-type symptoms. Estimates of insomnia symptom prevalence in the UK show similarly high rates, with a 2004 population survey of 2000 UK adults reporting that 58% of respondents experienced "disturbed sleep" on one or more nights in the previous week, and that 18% reported insufficient sleep on the majority of nights (Groeger, Zijlstra, & Dijk, 2004). Surveys which have focused exclusively on working adults show similarly high levels of sleep symptoms, with estimates of insomnia prevalence in the workforce ranging from 10% to 40% (Kuppermann et al., 1995; Linton & Bryngelsson, 2000; Simon & VonKorff, 1997). These latter rates are particularly significant, since 'impaired occupational functioning' is now considered an important diagnostic criterion for most forms of insomnia.

Formal diagnostic criteria for both primary and co morbid (formally, 'secondary') insomnia are provided in the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders* DSM-IV; (American Psychiatric Association. Task Force on DSM-IV, 2000), and the second edition of the *International Classification of Sleep Disorders* (ICSD-2; American Academy of Sleep Medicine, 2005). In both cases, diagnostic emphasis is placed on relationships between sleep quality and workplace performance.

A DSM-IV (American Psychiatric Association. Task Force on DSM-IV, 2000) diagnosis of primary insomnia, for example, uses the following criteria:

i. The predominant complaint is difficulty initiating or maintaining sleep or non-restorative sleep, for at least one month.

ii. The sleep disturbance (or associated daytime fatigue) causes clinically ***significant distress or impairment in social, occupational or other important areas of functioning*** (emphasis added).

iii. The sleep disturbance does not occur exclusively during the course of narcolepsy, breathing related disorder, circadian rhythm disorder or parasomnia.

iv. The disturbance does not occur exclusively during the course of another mental disorder (e.g. major depression disorder, generalised anxiety disorder e.g. delirium).

v. The disturbance is not due to direct physiological effects of a substance (e.g. a drug of abuse, a medication) or a general medical condition.

Similarly, though using a different terminology, ICSD- 2 (American Academy of Sleep Medicine, 2005) unpacks its general criteria for insomnia as follows:

a. A complaint of difficulty initiating sleep, difficulty maintaining sleep, or waking up too early, or sleep that is chronically non-restorative or poor in quality.

b. The above sleep difficulty occurs despite adequate opportunity and circumstance for sleep.

At least one of the following forms of daytime impairment related to nighttime sleep difficulty is reported by the patient:

i. Fatigue or malaise

ii. Attention, concentration, or memory impairment

iii. Social or vocational dysfunction (my emphasis added)

iv. Mood disturbance or irritability

v. Daytime sleepiness

vi. Motivation, energy or initiative reduction

vii. Proneness for errors or accidents at work or while driving (emphasis added)

viii. Tension, headaches, or gastrointestinal symptoms in response to sleep loss

ix. Concerns or worries about sleep

Despite this diagnostic emphasis on occupational impairment as a key diagnostic criterion for insomnia there is presently no agreement within sleep research or sleep medicine on which aspects of occupational performance are most affected by insomnia symptoms (or degraded sleep quality in general), or how such impairment should be measured.

The Occupational Impact of Sleep Quality and Insomnia Symptoms: A review of the current literature

The relationship between work performance and sleep quality is reciprocal and potentially complex (Metlaine, Leger, & Choudat, 2005). Thus, work schedules and occupational demands can act as precipitating and perpetuating factors in the development of insomnia (Spielman, Caruso, & Glovinsky, 1987), while as argued above, occupational dysfunction is also recognised as a consequence of insomnia (American Academy of Sleep Medicine, 2005; American Psychiatric Association. Task Force on DSM-IV, 2000). Evidence that working conditions impact on sleep quality is also provided in recent qualitative (Henry, McClellen, Rosenthal, Dedrick, & Gosdin, 2008) and quantitative (Ancoli-Israel & Roth, 1999; Knudsen, Ducharme, & Roman, 2007; Nakata et al., 2004) analyses indicating that work related stress, work scheduling and dissatisfaction with employment can be instrumental in the development and maintenance of insomnia symptoms. Such studies not only demonstrate the public health significance of work–sleep relationships, but also propose and evaluate possible causal mechanisms that originate in the workplace (e.g., stress, anxiety, inadequate sleep hygiene, etc.). However, the impact of insomnia symptoms on aspects of occupational performance has been less directly evaluated, with research in this area broadly divided between economic and clinical agendas. These different approaches have tended to conceptualise sleep–work relationships in different ways. Economic evaluations, generally conducted at the macro level, have focused on outcomes (typically, absenteeism) which attempt to capture the economic costs (usually from the societal or employers' perspective) of insomnia and insomnia symptoms among employed people (Godet-Cayre et al., 2006). On the other hand, clinical studies have focused on occupational impact as a personally experienced and potentially reversible consequence of insomnia (Snedecor, Botteman, Schaefer, Barry, & Pickard, 2008). Recognising these different emphases, researchers have stressed the need to clarify the direct contribution of insomnia and insomnia symptoms to economic productivity and to explore treatment options that mitigate occupational deficits arising from chronically disturbed sleep (Roth & Roehrs, 2003). However, while

insomnia-related impaired work performance continues to represent a significant cost burden on the individual worker (Henry et al., 2008) on health care systems (Metlaine et al., 2005) and on employers (Godet-Cayre et al., 2006), no attempt has been made to systematise and critique the insomnia/occupational health literature. Given this, the present review has three aims: i) to identify aspects of occupational performance most impacted by (or most frequently associated with) insomnia symptoms and impaired sleep quality as they appear in the literature; ii) to consider methodological issues which may account for variations in study outcomes; and iii) to identify research needs in this area.

Scope of review

To date, sleep related occupational impact research has largely focused on obstructive sleep apnoea and its (more easily quantifiable) impact on workplace sleepiness and tasks involving sustained attention. In order to maintain a focus on the occupational consequences of insomnia and insomnia symptoms in this review, studies with a primary focus on either shift work, or excessive daytime sleepiness arising in the context of obstructive sleep apnoea were excluded from the present review (these topics have been reviewed elsewhere, e.g., Landrigan et al., 2004; Akerstedt, 1998). Nevertheless, obstructive sleep apnoea will be addressed later in Chapter 7 in an investigation of assessment of the occupational impact of sleep quality in clinical practice. Accordingly, 'work' was operationalized as full time or part time paid occupational activity occurring within daytime hours (typically between 08:00 h and 18:00 h). Furthermore, since the specificity and detail of insomnia symptoms varied across studies (particularly from earlier to later studies) the review included those, which while not explicitly assessing 'insomnia' nevertheless reflect variations in subjective sleep quality (a judgment sometimes based on a single global item, e.g. Leigh, (1991). As used in this review the term 'sleep quality' refers broadly to perceptions of tiredness on waking, daytime fatigue, feelings of being rested and restored on waking, subjective adequacy of sleep, or the subjective frequency of night time awakenings (see Harvey, Stinson, Whitaker, Moskovitz, & Virk, 2008). While such experiences

certainly accompany insomnia, they also accompany normal variations in sleep parameters (Ohayon, 2002), and may be considered 'common denominators' of human sleep experience. Where reported detail allows, the terms 'insomnia', 'insomnia syndrome' and 'insomnia symptoms' are used as defined in the literature (Daley et al., 2009), and denote the inclusion of either formal diagnostic criteria (as in 'insomnia'/'insomnia syndrome') or more general subjective reports (as in 'insomnia symptoms') in the research methodology.

Articles and research output relating to the daytime occupational impact of insomnia symptoms in people of working age, irrespective of study design or date of publication, were located through a search of Web of Knowledge, Pub Med and Science Direct databases using a strategy broadly based on combinations of the keywords *sleep*, *insomnia*, *insomnia symptoms*, *work, vocation* and *occupation*, *employment* along with keyword searches of occupational domains; *workplace accidents*, *absenteeism*, *punctuality*, *job satisfaction*, *career progression, performance*, *daytime functioning* and *promotion*. Journals, article reference lists and library catalogues were also searched. As the aim of this review was to critically examine a relatively under researched area, conference proceedings and abstracts were also included. Only articles written in English, and concerning members of the adult workforce were included.

Results

A total of 30 studies, published between 1983 and 2010 were identified which reported data on daytime occupational impact in relation to insomnia, insomnia symptoms, or poor sleep quality. Broadly, the outcome measures used in these studies covered six domains of occupational functioning: absenteeism; workplace accidents; productivity; punctuality; job satisfaction and career progression. Findings from each of these domains will be considered in turn.

Absenteeism

Sleep-related absenteeism, defined in terms of whole days (Leger, Guilleminault, Bader, Levy, & Paillard, 2002) or hours absent (Bolge, Doan, Kannan, & Baran, 2009) from the workplace, was assessed in 16 studies covering a range of research methodologies and job types, and using a range of insomnia symptoms and definitions (see Table 1.1). The majority of studies reported significantly increased absenteeism among people with insomnia symptoms, though levels of reported absenteeism varied considerably across studies. In the earliest report of work-sleep associations using a US national probability sample, those reporting insomnia symptoms showed an average excess of 1.4 days of absence per year (relative to those with no insomnia symptoms, Leigh, (1991)). A subsequent US survey reported that poor sleepers missed an average of five more days of work per year than good sleepers (Schweitzer, Engelhardt, Hilliker, Muehlbach, & Walsh, 1992). Levels of absenteeism have also been associated with the severity of insomnia symptoms. In a Swedish study of 2066 people of working age (20–60 year olds), being "off work" in the previous week was reported by 7% of good sleepers, 13% of those reporting subjectively poor sleep, and by 28% of those meeting criteria for insomnia (Linton & Bryngelsson, 2000), though no data were reported on the duration of these absences.

In a detailed economic evaluation of insomnia (Daley et al., 2009), the mean number of hours absent from work in the past three months was estimated for three groups defined in terms of sleep quality: insomnia syndrome (SYND: those meeting DSM-IV criteria for insomnia diagnosis); insomnia symptoms (SYMPT: those meeting some, but not all the criteria for SYND); and good sleepers (GS: those with no insomnia symptoms). Absences from work were greatest for the SYND group (mean absence = 19.94 h±68.98 h), intermediate for the SYMPT group (mean absence = 14.29 h; ± 65.62 h), and lowest for the GS group (mean absence = 5.94 h; ± 39.13 h). All inter-group differences were significant.

Controlled comparisons of people with and without insomnia suggest that sleep symptom severity, and comorbidity, may confound to influence outcome measures

of workplace absenteeism. A comparison of "severe" insomniacs and "good sleepers" for example, showed that the insomniacs were more than twice as likely to report absenteeism "due to illness" over the past month (Leger et al., 2002). Similarly, retrospective studies have found that poor sleep quality (as defined by a Pittsburgh Sleep Quality index Score >5 (Buysse, Reynolds III, Monk, Berman, & Kupfer, 1989; score of >5) significantly predicts workplace absence in the past month (Doi, Minowa, & Tango, 2003) and the likelihood of entering long term sick leave (>90 days) two years later (Akerstedt, Kecklund, Alfredsson, & Selen, 2007). The influence of health status on sleep quality-absenteeism relationships is also strongly indicated in studies reporting progressively adjusted outcome models. Kuppermann et al., (1995) and Philip et al., (2006) both report that elevated levels of absenteeism among poor sleepers, apparent in univariate analyses, failed to reach significance when health confounders were added to multivariate models. Again, however, such findings may not be independent of sleep symptom severity. In a more recent study, insomnia symptoms meeting DSM-IV criteria were found to be a significant predictor of absenteeism in both a minimally adjusted model, and after controlling for anxiety, depression, somatic symptoms and pain in a fully adjusted model (Sivertsen et al., 2009).

The impact of socioeconomic and gender specific factors on sleep-related absenteeism have also been investigated. Among menopausal women participating in the US National Health and Wellness Survey, no significant differences in levels of absenteeism were found between those experiencing "chronic sleep maintenance insomnia characterised by night time awakenings", and good sleepers (Bolge et al., 2009). A case-control study of absenteeism across job categories (Leger, Massuel, & Metlaine, 2006) found significantly higher levels of "at least one period of absence over the previous two years" among blue collar workers with insomnia when compared with white collar workers with insomnia (64% versus 54% respectively). The duration of absences was found to be longest among women, and among people in managerial roles.

Absenteeism: comment

The most striking methodological difference among the studies reviewed here concerns the assessment of sleep quality and insomnia symptoms. In the three earliest studies, sleep problems were ascertained by asking, "Are you satisfied with your sleep?"(Leigh, 1991), "Do you sleep well without sleeping tablets?" (and, if "no", items focused on sleep duration, sleep latency and nocturnal awakenings, (Jacquinet-Salord, Lang, Fouriaud, Nicoulet, & Bingham, 1993; and "Do you now have problems with sleep?" (Kuppermann et al., 1995). In later research, however, methods of identifying insomnia/insomnia symptoms were more rigorous, and included: cut-off point scores (>5) on the Pittsburgh sleep quality index (Buysse, et.al 1989; Doi et al., 2003); a medical diagnosis of insomnia appearing at least twice a month in the respondent's record (Bolge, Balkrishnan, Kannan, Seal, & Drake, 2010); and duration of DSM-IV symptoms appearing over one month, and over two years (Leger et al., 2006). Only one study (National Sleep Foundation, 2008) combined symptoms of insomnia and hypersomnia in a single assessment, reporting a one month prevalence of "sleep-related absenteeism" of 2%.

The source of data also varied, with six studies using employer or government records to access absenteeism data, (Akerstedt et al., 2007; Johnson & Spinweber, 1983; Kuppermann et al., 1995; Leger et al., 2006; Philip et al., 2006; Sivertsen et al., 2009) while the remaining studies relied on self-report. In the only study to compare these sources (Kuppermann et al., 1995), it was found that while employer-recorded 'sick hours' over the past six months showed no differences in absenteeism between good and poor sleepers, self-reported absences were significantly higher among the poor sleepers (suggesting that self-reports are open to bias and/or that employer records, perhaps more sensitive to whole days of sickness absence, are less effective in capturing short periods of absence in the working day). There was also little consistency amongst studies concerning the way in which absences were measured. Outcomes ranged from days of absence in the past two weeks, (Leigh, 1991), days of absence over a two year period (Leger et al., 2006) absences of over 14 days only (Akerstedt et al., 2007), and total hours reported absent in a three month reference period (Daley et al., 2009). Whether or not days of absence, when reported, were continuous, was also not specified in

most studies. The merits of using hours over days to quantify absenteeism are unclear as no two studies are methodologically comparable.

It is also relevant to note that most studies were cross-sectional and involved the civilian workforce. The only longitudinal study of sleep quality and work performance identified in this review was Johnson & Spinweber's (1983) study of 2929 newly recruited naval seamen. This study found that the number of officially recorded 'unauthorised absences' and 'absences without leave' did not differ between people with insomnia and good sleepers, though no data were reported on authorised sickness absences. It is possible, therefore, that these particular outcomes are not analogous to 'absenteeism' as measured in civilian populations.

Finally, most of the surveys shown in Table 1.1 did not collect data on the causes of sleep-related absences (i.e., the specific reasons why people with insomnia/insomnia symptoms absent themselves from work). This would seem to be particularly relevant if workplace absenteeism is adopted as a treatment outcome in controlled trials. Randomised controlled trials have, for example, shown that the treatment of insomnia with Eszoplicone can reduce costs associated with worker absenteeism (Botteman et al., 2007; Snedecor et al., 2008). However, the present review identified no studies that tested the impact of non-drug treatments (e.g., CBT for insomnia) on reducing impaired occupational performance and absenteeism.

While the studies shown in Table 1.1 reflect a wide range of approaches to data collection and outcome measurement, there is a general agreement that insomnia symptoms increase the risk of absenteeism, that the degree of absenteeism risk increases with insomnia symptom severity, and that insomnia-related absenteeism is closely related to health status. In an attempt to harmonise outcome metrics, the base periods for which risk was estimated in seven of the studies shown in Table 1.1 (Bolge et al., 2009; Daley et al., 2009; Kuppermann et al., 1995; Leger et al., 2002; Leger et al., 2006; Philip et al., 2006) were standardised to one month (28 days), with durations of absenteeism then proportionately increased or decreased (with the assumption that 1 day = 8 h). Standardised in this way, the averaged absenteeism among those reporting

insomnia/insomnia symptoms was 7 h 10 min per month, while the average absenteeism among good sleepers was 5 h 5 min per month (an averaged excess of 2 h 5 min per month associated with insomnia). It should be emphasised, however, that this estimate provides only a crude guide. Among the 16 studies shown in Table 1.1, durations of absenteeism showed considerable variation about the mean. For the SYND (insomnia syndrome), SYMPT (insomnia symptom), and GS (good sleeper) groups in Daley et al's., (2009) study, for example, absenteeism means (SDs) were 19:94 h (68.98), 14:29 h (65.62) and 5.94 (39.13) respectively. Overall, however, the present literature shows little uniformity in defining, capturing or reporting episodes of sleep-related absenteeism. Where results are discordant with the broad conclusions summarised here, differences in sampling and methodology offer plausible explanations.

Accidents

A total of 11 studies were identified which assessed sleep-related accidents (see Table.1.2). Across all of these studies, and in addition to inter-study variations in the definition of sleep symptoms, there were wide variations in accident classification, which ranged from 'self reported accidents over the past month' (Doi et al., 2003) to 'fatal occupational accidents over a 20 year period' (Akerstedt, Fredlund, Gillberg, & Jansson, 2002). Only two studies report the absence of significant sleep-accident relationships. Poor sleep was not shown to be a predictor of workplace accidents in a sample of white collar telecommunications workers (Doi et al., 2003), a finding which may have been influenced by the low-risk (desk based) roles of the participants. Similarly, in a study comparing 785 matched pairs of good sleepers and those meeting DSM-IV criteria for insomnia Leger et al., (2006) self reported minor and major accident rates over a 12 month period showed no significantly elevated risk among people with insomnia. Nevertheless, accident rates at work were higher among the people with insomnia in this study, leading the authors to suggest that the failure to achieve significance

may have been due to the relatively small sample size of accident cases (number of accidents at work: Insomniacs = 13; Good Sleepers = 8).

The remaining eight studies report excess risk associated with a range of sleep symptoms. The National Sleep Foundation survey (National Sleep Foundation, 2008), for example, found that the risk of accidents and injuries at work was significantly higher among those reporting a sleep latency of >30 min. In a controlled study, those meeting DSM-IV criteria for insomnia reported significantly higher levels of industrial accidents over the past 12 months when compared with good sleepers (8% versus 1% respectively (Leger et al., 2002)). Similarly, in a large scale population survey (n = 69,584), an increased odds of work injury was reported for employees reporting poor sleep "most of the time" compared to good sleepers, in both men and women (Kling, McLeod, & Koehoorn, 2010). The same study indicated that both gender and type of job play large roles in the relationship between quality of sleep and accidents. Women in manual jobs or professional occupations (e.g., nursing, teaching) and men working in trades or transport had the highest odds of work injury. Of those studies reporting significant sleep-related accidents, not all focused exclusively on the workplace. Daley et al., (2009) found no relationship between sleep symptoms and the incidence of motor-vehicle accidents. However, this study did find that people with DSM-IV categorised insomnia syndrome were twice as likely as good sleepers to have experienced other types of accidents, including work-related incidents and falls, suggesting that the likelihood of having an accident may depend on the demands of the task being completed.

Sleep quality may also be affected directly through occupational injury or health problems. In a cross-sectional case-control study of 880 males in the construction industry, Chau et al., (2004), using logistic regression models, found that workers reporting an occupational injury with subsequent sick leave over the past two years were more likely to report shorter (<6 h/day) sleep durations, "not sleeping well", and the consumption of sleeping tablets than controls who had not had an injury. Similar results were found in a study of veterinarians, (Gabel & Gerberich, 2002) and in a case-control study of 2610 male French railway workers (Chau,

Mur, Touron, Benamghar, & Dehaene, 2004) which reported that "sleep disorder" symptoms (defined as a sleep duration of <6 h/day, "not sleeping well", and/or the consumption of sleeping tablets) were specifically related to injuries from physical exertion and pain due to movement. Fatal occupational accidents have also been associated with "difficulty sleeping in the past two weeks" (Akerstedt et al., 2002) although it is unclear in this study whether the sleep symptoms reflect insomnia or hypersomnia. The results shown in Table.1.2 also suggest that gender and employment type may be predictive of insomnia/insomnia symptom related accidents. The only prospective study of non-fatal occupational accidents Salminen et al., (2010) found that non-refreshing sleep, difficulty initiating sleep and the presence of any sleep disturbances were all associated with an increased risk of work-related injury in men but not women. However, in this study only injuries followed by a period of sick leave were included in the analysis.

Accidents: comment

In order to clarify relationships between sleep symptoms and work-related accidents, and allow comparisons across studies, there is a clear need to standardise definitions of, and reporting conventions for sleep-related workplace accidents (this in addition to the need to standardise the criteria for insomnia). In particular, the present literature emphasises the need for: greater detail in reporting the nature, severity and frequency of workplace accidents; clearer discrimination between motor-vehicle and other accidents (with clearer distinctions made between occupational and non-occupational driving); an improved understanding of the relative merits of using self report data and organizational records; and greater clarity in reporting accidents among those using, and not using, sleep medication. Regarding this latter point it may be relevant to note that all of the studies using organizational records (see Table.1.2) found significant sleep-accident associations, while the only two studies which did not find significant sleep-accident associations, used self-report data.

Accident severity is closely related to the separate issues of accident frequency (with minor accidents being more common), and accident relevance (where less

serious accidents may not impact greatly on quality of work or quality of life). In the present literature, findings of elevated risk (Table.1.2) combine minor accidents in the workplace, (Gabel & Gerberich, 2002) injuries resulting in sick leave, (Chau et al., 2004) and fatal accidents (Akerstedt et al., 2002). However, interactions between the seriousness of sleep-related workplace accidents, the severity and duration of insomnia symptoms, and pre-existing workplace risks, remain unclear.

The present literature also indicates that distinctions between motor vehicle and other accidents are important for two reasons. First, in those studies providing separate assessments, the risk of insomnia symptoms appears differentially associated with motor vehicle and non motor-vehicle accidents. For example, in their detailed community study, Daley et al.,(2009) found no significant association between sleep symptoms and motor-vehicle accidents, which the authors suggest may have been influenced by a low base-rate for motor accidents. Nevertheless, the possibility remains that over-learned tasks like driving may not be as vulnerable to sleep symptoms as other tasks executed in the workplace. Additionally, within motor-vehicle accidents, it is important to distinguish between occupational driving and non-occupational driving if only to discriminate between 'workplace' and 'non-workplace' accidents.

Finally, given the strong association between hypnotics and, for example, road traffic accidents (Gustavsen et al., 2008), it is relevant to note that none of the studies identified for this review examined possible relationships between hypnotic or sedative drug use and workplace accidents. In several studies, hypnotic drug consumption was either included in compound definitions of "sleep disorders" along with sleep symptoms, (e.g., Akerstedt et al., 2002; Chau, Mur, Touron et al., 2004; Kling et al., 2010) or directly assessed in each respondent. Medication for anxiety and depression such as selective serotonin reuptake inhibitors may also cause somnolence or fatigue which could influence occupational performance. However, in this analysis the contribution of such drug consumption on workplace accidents was not considered separately in multivariate models. The present findings indicate that insomnia symptoms

significantly elevate accident risk in the workplace, though the extent to which such accident risk is influenced by the concomitant use of hypnotic drugs (by people with insomnia symptoms) is less clear. This risk extends to blue and white collar workers, is associated with both serious and less serious accidents and, while reported for both sexes, may be greater in males than in females. These associations hold for both self-report and organizationally reported accidents, though self-report may be less sensitive. These findings are broadly in line with laboratory research indicating that insomnia and insomnia symptoms can negatively impact the efficiency of daytime psychomotor performance (Riedel & Lichstein, 2000).

Productivity

Impaired occupational productivity was assessed in 11 studies (see Table.1.3). Again, studies reflect little consensus on either the definition of workplace productivity, or how this construct should be measured. Work-related questionnaire assessment scales were adopted in a minority of studies. Using the work productivity and activity impairment questionnaire (WPAI: Reilly, Zbrozek, & Dukes, 1993), Bolge, Doan, Kannan, & Baran's (2009) internet survey found that people with insomnia had a 13% higher score for presenteeism (where presenteeism is defined as "impairment at work/reduced on-the-job effectiveness"), and a 10.3% greater overall work productivity loss (a combination of absenteeism and presenteeism) than good sleepers. The WPAI was also utilised in a study of menopausal women (Bolge et al., 2010) which found that those experiencing night time awakenings experienced 17.3% greater productivity impairment than women without insomnia symptoms, after controlling for demographics and comorbidity. Sleep-related productivity losses have also been quantified using a web based version of the work limitations questionnaire (WLQ:(Lerner et al., 2001). This study found that mean losses, calculated from survey scores, were significantly higher for people with insomnia than they were for good sleepers (Rosekind et al., 2010).

In contrast to these studies employing formal psychometrics, impaired productivity was also indicated in studies using single 'ad-hoc' items. For example, productivity was conceptualised only as a co-factor of absenteeism by Linton & Bryngelsson, (2000), who reported that three quarters of respondents surveyed said that poor sleep affected their work productivity. Similarly, a study of white collar workers found that, among poor sleepers, reported problems with 'occupational activities' were 2.5 higher than among those reporting good sleep (Doi et al., 2003).

More detailed survey data are provided by the National Sleep Foundation polls, which found that 93% of respondents agreed that 'not getting enough sleep' could impair a person's performance at work irrespective of insomnia status (National Sleep Foundation, 2002). More recently the National Sleep Foundation survey separated work productivity into task components and reported that most respondents agreed that inadequate sleep would make it "much" or "somewhat" harder to: read a report or business document for at least 1 h before feeling sleepy (68%); take on additional tasks at the end of a regular work day (66%); make careful, thought-out decisions (62%); listen carefully so that they remember what is being said (62%); and produce quality work to the best of their ability (61%), (National Sleep Foundation, 2008). Sleep duration was also related to difficulty concentrating and reluctance to interact with colleagues. In Johnson and Spinweber's (1983) longitudinal study of 2929 naval seamen, poor sleepers were judged less effective sailors than their good sleeping colleagues, with the authors concluding that "in all measures used as indices of navy performance, poor sleepers performed significantly less effectively" (p. 21). This study also indicated that performance deficits developed over time (i.e., "These significant performance differences [between good and poor sleepers] evolved during their navy tour…" (p. 24), but no research has since replicated these important longitudinal findings.

A particularly innovative approach to the assessment of work performance required participants to first report episodes of reduced productivity, and then estimate "by what proportion they thought their productivity had diminished" (e.g., 10%, 50% etc.; Daley et al., 2009). Most respondents in this study attributed

reduced productivity to fatigue, with a significant gradient reported between impaired productivity and insomnia syndrome (highest impairment), insomnia symptoms (lower impairment) or good sleepers (lowest impairment). The impact of task complexity in determining sleep-related reductions in productivity was investigated in a group controlled study (Leger et al., 2002) which reported that 18% of people with severe insomnia, but only 8% of good sleepers (GS) felt they had exhibited 'poor efficiency' in the workplace over the previous month. While this study found no significant differences between people with insomnia (PWI) and GS on the reported difficulty in completing complex tasks, it did find that PWI were significantly more likely than GS to report having made errors at work which could have had serious consequences (15% versus 6% respectively). These findings were replicated in a later case-control study using 369 matched pairs of PWI and GS, (Leger et al., 2006) with PWI estimating that they were less efficient, and less energetic at work than good sleepers. It is interesting, however, that in this subsequent study there were no significant differences between PWI and GS groups when rating their achievements of annual objectives, suggesting that people with insomnia may appraise their short-term achievements more negatively (Kuppermann et al., 1995).

There were no studies which compared the productivity differences in job types in relation to sleep. One study devised a six-item job performance scale to measure work productivity in a largely white collar sample and found that people with insomnia symptoms had significantly lower job performance scores than good sleepers (Kuppermann et al., 1995). This difference remained significant after multivariate analyses controlling for health variables.

Productivity: comment

The literature suggests that, perhaps more so than for other aspects of work performance, the assessment of productivity would benefit from an improved operationalization of the construct, and greater detail in relation to gender, age, and task demands in study reports. The finding that productivity is negatively influenced among those menopausal women who experience interrupted sleep

(Bolge et al., 2010), for example, clearly points to nuance in age, gender and medication use variables. None of the studies reviewed in this section distinguished between the types of tasks workers were required to do, for example whether physically demanding, time pressured, or safety critical. Improved granularity in reporting task variables would not only assist interpretation, but also deliver a literature more relevant to the needs of occupational health and sleep medicine.

The literature also suggests that 'productivity', however defined, is closely related to fatigue, sleepiness and performance issues. For this reason it is also important to discriminate between symptoms of insomnia, hypersomnia and other sleep disorders since, while the performance impact of these symptoms may overlap, the clinical implications may differ. The use of terms like 'not getting enough sleep'(National Sleep Foundation, 2002), for example, is clearly valuable in capturing sleep-related problems, but leaves unclear whether affirming such a symptom indicates insomnia, hypersomnia or another disorder of sleep. Finally, with only one longitudinal study in Table.1.3, (Johnson & Spinweber, 1983) further research using prospective and longitudinal designs, which can evaluate the temporal development of impairment and performance change in the workplace, is clearly required.

In summary, those reporting insomnia symptoms experience subjective reductions in workplace productivity (where 'productivity' is defined in terms of subjective 'efficiency', subjective 'error proneness', feelings of occupational competence, or a perceived general ability to 'get more things done'). This impairment appears to be related to symptom severity, with more severe symptoms producing greater reductions in productivity, and may develop incrementally over time. However, results from one study (Leger et al., 2002) suggest that people with chronic insomnia may show awareness of impaired workplace performance and compensate on "better sleep" days, thus mitigating potential differences between good and poor sleepers in annualised work objectives.

Punctuality

That sleep quality and insomnia/insomnia symptoms could impact occupational punctuality (i.e., arriving in the workplace 'on time') is intuitively plausible, since habitual poor sleep could result in compensatory 'oversleeping', or significantly reduced morning arousal and efficiency levels. However, while absenteeism and workplace accidents represent discrete events likely to be captured in organizational records (for legal and contractual reasons), it is recognised that the widespread use of flex time/flexitime schedules (e.g. Hooker & Britain, 2007), may lower levels of time accountability in some occupations. Furthermore, reluctance to report lateness for work (for fear of reprisals) may also 'mask' any insomnia-related problems of punctuality.

The present search strategy identified three relevant studies reporting findings on sleep quality and punctuality. Results from the US National Sleep Foundation (National Sleep Foundation, 2008) poll found that 12% of respondents reported being late to work in the past month due to sleepiness or a sleep problem. Given the structure of this specific questionnaire item (i.e., 'late due to sleepiness or a sleep problem'), however, it is not possible to discriminate between the general attributions of those late for work, and the specific occupational consequences of sleep disorder symptoms. Nevertheless, the finding does supply a useful population baseline against which to compare more specific findings. Of the two remaining studies which compared the self reported punctuality of good and poor sleepers, Leger et al., (2002) found that 12% of people with insomnia and 6% of good sleepers reported being late to work over the previous month. These differences, however, were non-significant. Similarly, lateness for work in the previous month did not differ significantly in a prospective study (David & Morgan, 2008) comparing 40 people meeting DSM-IV criteria for insomnia (6% late/month), and 40 good sleepers (4% late/month). None of these studies, however, indicate whether punctuality was reported in the context of flexible or non-flexible work regimes.

It is possible that studies quantifying absenteeism by hours of work missed could be measuring some lateness for work by proxy (Daley et al., 2009; Kuppermann et al., 1995). However, it is also the case that the neuroticism (van de Laar, Verbeek, Pevernagie, Aldenkamp, & Overeem, 2010), anxiety (Harvey, 2002) and hyper vigilance (Bonnet & Arand, 2010) which predispose individuals to insomnia may also mediate a greater concern for punctuality. This conclusion is supported by findings which show that, in the general population, while conscientiousness (as measured using a German version of the revised neuroticism-extroversion-openness personality inventory (Borkenau & Ostendorf, 1993): is related to all aspects of punctuality in the workplace, neuroticism is actually associated with significant 'earliness' (Back, Schmukle, & Egloff, 2006).

Punctuality: comment

The construct of punctuality introduces opposing dynamics into the occupational consequences of insomnia symptoms, with fatigue and compensatory time in bed compatible with reduced punctuality, while anxiety and neuroticism, which frequently predispose individuals to insomnia, encouraging punctuality and even earliness. Nevertheless, and despite being a relatively straightforward construct to assess, punctuality is infrequently included in studies of the occupational impact of insomnia/insomnia symptoms. For clarity of interpretation, questions on punctuality should be independent of lateness attributions, and results should indicate whether flexitime is an option for survey or study respondents, and whether such practices interact with reported punctuality. In the present review, results from three studies do not support the proposition that, relative to good sleepers, people with insomnia symptoms are more likely to report reduced workplace punctuality.

Career progression

Given the evidence that insomnia symptoms can negatively impact a person's ability to perform effectively at work, it is reasonable to suggest that this could, in turn, impact longer-term career progression (development, promotion, etc.). The present review identified six studies which examined aspects of career progression in relation to sleep symptoms, with all six suggesting impaired career progress (see Table .1.4).

The longitudinal study of US naval recruits (Johnson & Spinweber, 1983) showed that insomnia symptoms were significantly associated with both a reduced likelihood of promotion recommendations, and the attainment of higher pay grades over a six year period. In agreement with these findings, a case-control study in France found that people with insomnia were significantly more likely to report that their career advancement had either been blocked, or had been insufficient over the past five years, relative to good sleepers (43.5% versus 31.4% respectively (Leger et al., 2006). This study also found that, over the same five year period, dismissal rates did not differ significantly between those with insomnia, and good sleepers (dismissal rates being 3% versus 2.4% respectively).

The possibility that sleep symptoms may be associated with movement within, or premature exit from the workforce was addressed in three studies. A study of 5000 physicians (Heponiemi et al., 2009) found that insomnia symptoms were associated with both higher levels of personal distress and intentions to change profession, suggesting the possibility that occupational stress may be influencing both sleep quality and career plans. Relationships between insomnia, health, and retirement from the workforce were explored in a retrospective cohort study of 37,308 working age persons originally screened for the Norwegian health study, (Sivertsen et al., 2006) the outcome being the award of a disability pension (i.e., retirement from the workforce on the grounds of disability) 18–48 months after screening. After adjustment for anxiety, depression and somatic health confounders, the risk of being awarded a disability pension remained significantly elevated among those reporting insomnia at baseline. A similarly conducted study

among 6599 working persons (aged 40–45 years; Sivertsen et al., 2009) examined the role of insomnia-related daytime symptoms in predicting work disability, and found that short sleep duration without insomnia complaints was not a significant risk factor. However, DSM-IV categorised insomnia (which included daytime consequences) and long sleep duration both emerged as significant risk factors for permanent work disability. In agreement with these Norwegian findings, a public health survey of 56,732 workers in Finland found that insomnia complaints at baseline predicted long term work absence attributed to mental, circulatory and musculoskeletal disorders at three year follow up (Salo et al., 2010). Furthermore, the study also found that those reporting sleep disturbances at baseline were less likely to return to work than those reporting good sleep. However, it is possible that the sleep quality reported in this study may have reflected compromised health status at baseline. Nevertheless, a reasonable conclusion to draw from these latter three studies is that insomnia symptoms can accelerate the onset of work disability, and represent a barrier to career progression.

Career progression: comment

Career progression is clearly a multidimensional construct, which includes promotion, remuneration, continuity, and duration of employment, and the congruence between desired and achieved occupational goals. Where occupations are associated with continuity of employment and a hierarchical career structure (for example, the armed forces), the construct of 'progression' is accessible to both straightforward assessment and interpretation, with subjective reports verifiable against objective records. However, in occupations where career trajectories are less predictable, or where labour is more casualised, the construct may have less clarity and less meaning. For this reason, case control comparisons of workers within the same industry would seem the preferred method for assessing progression. Further analyses of this construct are certainly warranted by the results summarised here. Though limited, the present evidence supports the view that, in terms of promotion, remuneration, and the duration of healthy working life, insomnia is a significant and independent barrier to career progression.

Nevertheless, the confounding effects of sleep quality and general health status remain inadequately controlled in some studies.

Job satisfaction

That insomnia symptoms are linked with decreased quality of life is well documented (Kyle, Morgan, & Espie, 2010; Zammit, Weiner, Damato, Sillup, & McMillan, 1999). The extent to which satisfaction at work influences this general relationship (or is influenced by this relationship) is less well understood. Of six relevant studies addressing sleep-job satisfaction relationships (Table.1.5), all but one reported significant associations between broadly defined aspects of fulfilment in the workplace, and sleep quality. In many cases, however, the causal ordering of these outcomes is unclear. A survey of French workers, for example, found that reports of a "bad atmosphere at work" and low job interest were significantly associated with sleep disturbances in both male and female employees (Jacquinet-Salord et al., 1993). Similar results were found in a study of white collar telecommunications workers which used a two item scale to measure work satisfaction (Kuppermann et al., 1995). While respondents with insomnia/insomnia symptoms showed significantly less satisfaction with work than good sleepers in uncontrolled analyses, this difference disappeared when psychological and physical health confounders were added to the model.

The existence of a reciprocal relationship between sleep quality and job satisfaction relationship is also plausible. Feelings of fatigue have been shown to cause work dissatisfaction (Lavie, 1981), and it is likely that unhappiness with one's occupation could lead to emotional disturbance and sleep problems (Bastien, Vallieres & Morin, 2004). In a small sample of administrative workers, the effect of sleep quality on job satisfaction was found to be significantly mediated by feelings of hostility, joviality and attentiveness (Scott & Judge, 2006), while a large scale survey of 5090 Japanese white collar workers (Doi et al., 2003) showed that job dissatisfaction was the second most strongly associated factor underlying poor

sleep quality after perceived stress. Proxy variables of job satisfaction such as experiences of workplace bullying (Niedhammer, David, Degioanni, Drummond, & Philip, 2009) and exposure to transformational leadership (i.e., that style of inspirational leadership which leads to positive changes in those who follow (Munir & Nielsen, 2009), have been linked with impaired and improved sleep quality respectively.

Job satisfaction: comment

Job satisfaction is a subjective variable which impacts, and reflects mood. The likely operation of a reciprocal relationship between such satisfaction and insomnia symptoms places particular demands on methodologies designed to elucidate causal ordering. Respondent attributions, prospective studies, and multivariate analyses should all be considered when this aspect of occupational assessment is considered. The present data support the existence of a reciprocal relationship between insomnia symptoms and job satisfaction. From the perspective of sleep quality outcomes, therefore, inadequate job satisfaction should be regarded as a possible cause or consequence of insomnia symptoms.

Discussion

The importance of recognizing and assessing the occupational consequences of insomnia and insomnia symptoms has been emphasised in clinical nosologies (American Academy of Sleep Medicine, 2005; American Psychiatric Association. Task Force on DSM-IV, 2000) and expert recommendations (Buysse, Ancoli-Israel, Edinger, Lichstein, & Morin, 2006). The present review found that the measured occupational consequences of degraded sleep quality fall broadly into six categories, with the majority of research addressing worker absenteeism, accidents and productivity, and considerably fewer studies looking at punctuality,

career progression and job satisfaction. With the single exception of punctuality, which did not show convincing evidence of negative impact, all other measured outcomes showed impairment associated with poorer sleep quality. A reasonable conclusion to draw from the present review, therefore, is that insomnia-type sleep disturbances, assessed at symptom, syndrome and diagnostic levels, are consistently associated with reduced safety and productivity in the workplace, increased levels of sickness absence from the workplace, and impeded career progression and reduced job satisfaction among individual workers. In relation to the aim of identifying methodological issues which may account for outcome differences, the present literature reflects wide variations in the definition of constructs, methods of data collection, and style of reporting, all of which impact the results reported. Nevertheless, it is apparent that the more recent studies are increasingly standardizing diagnoses and symptom assessment, suggesting a growing conformity in this area of research.

It is also apparent that when insomnia is assessed at symptom, syndrome and diagnostic levels, occupational impact appears as a gradient, with the diagnosed cases showing the greatest decrements, and the 'symptom' cases showing the least, e.g.,Daley et al., (2009). Since symptom-level insomnia assessments clearly deliver meaningful results, and may reflect important sub-clinical states, an exclusive focus on insomnia syndrome and diagnosis does not seem appropriate. However, it should be recommended that where insomnia symptoms alone are assessed, those assessments should include symptom descriptions, and reported symptom frequencies, in line with DSM-IV (TR);American Psychiatric Association. Task Force on DSM-IV, (2000) and ICSD-2 (American Academy of Sleep Medicine, 2005) diagnostic criteria (Buysse et al., 2006).

Studies included in the present review broadly divide into primary research (where new data have been collected), and secondary analyses (where institutional or national databases have been examined for relationships between sleep quality and occupational outcomes). Both approaches have their merits, with secondary analyses generally utilizing large datasets, and delivering high levels of statistical power, (Sivertsen et al., 2006) while primary data collection better

serves formal hypothesis testing, (Daley et al., 2009; Leger et al., 2006). While the former could certainly benefit from greater standardization of assessment metrics, the latter appear constrained by what is actually recorded as primary data. Regarding the first of these points, it is apparent that while there are well validated and widely used metrics for measuring the impact of insomnia on daytime fatigue, mood, sleepiness, and quality of life, there remains a dearth of validated instruments designed to address the impact of insomnia on occupational functioning. Along with the standardization of procedures which capture sleep-related occupational impact at the institutional and national levels (e.g., population rates of absenteeism, workplace accidents, etc.), there remains an important need to develop instruments which capture and explore the occupational impact of sleep quality at the individual level (i.e., instruments which quantify an individual's levels of sleep-related occupational impairment). Such instruments could then be used to explore those elements of presenteeism (i.e., reduced on-the-job effectiveness) most closely associated with sleep quality which are currently neglected in the occupational health literature. While the WPAI, (Reilly et al., 1993) and the WLQ, (Lerner et al., 2001) as used in the present literature, (Bolge et al., 2009; Rosekind et al., 2010) are preferred over ad-hoc occupational assessments, neither is specifically designed to detect occupational impairment arising from inadequate sleep quality or quantity. The design and use of more sleep-specific instruments, therefore, would seem justified.

Greater conformity in the style of reporting could also help to clarify outcomes. Despite the considerable attention on absenteeism, for example, the present literature shows no agreement on how this variable should be quantified (hours or days), often fails to report whether days of absenteeism are continuous or contiguous, and does not always provide information relevant to interpreting reported absences (sickness, unexplained, etc.). Since hours provide for a greater level of detail, and would enable whole day equivalents to be estimated, we would recommend the preferential reporting of hours/unit of study. It follows from this that the length of a typical working day in that industry should also be reported.

A further limitation of the present literature is the absence of a clear cross-cultural perspective, allowing the impact of culturally different work ethics and workplace attitudes to be examined. It is possible, for example, that the daytime effects of impaired night time sleep might, to an unknown extent, be mitigated by a cultural tolerance of daytime sleeping. The practices of inemuri (Steger, 2006) (brief daytime sleeps taken while present in the workplace) in Japan, and siesta (Burazeri, Gofin, & Kark, 2003) in some Latin and Mediterranean countries are particularly relevant here, though all of these geographical locations are under-represented in the present review. Similarly, differences in work ethic might also impact questionnaire data on workplace performance, though recent evidence suggests that, even in countries like Japan where work-ethic strength is typically high, reported levels of workplace sleep disorders can also be high (Doi, 2005).

Research Aims

The present review has clearly identified the need to develop a metric which captures and explores the occupational impact of poor sleep quality at the individual level. In response to this need, the research programme described in this thesis addressed the following research objectives.

i. To develop a prototype scale suitable for use as an assessment and an outcome measure of sleep-related occupational impairment.

ii. To pilot, validate and refine the prototype scale in samples of UK workers.

iii. To use the final scale as an assessment measure in a UK workforce sample.

iv. To test the utility of the final scale as a clinical outcome measure

Table 1.1 The impact of insomnia/insomnia symptoms on absenteeism

Authors, year of publication	Study design (method)	Sample N (location)	Sample described as:	Mean age (SD)†	Outcome measure; response format where available (source)	Impact of symptoms on absenteeism	Sleep problem defined as
Johnson & Spinweber, (1983)	Longitudinal study (Survey)	2292 (USA)	Naval seamen	20.5 (2.6)	Unauthorised absences in the past 6 years (ER)	NS	Overall, what kind of sleeper are you? (Very good-Very poor)
Leigh, (1991)	Cross-sectional study (Personal interview)	1308 (USA)	Male and female workers	39 (ND)	Whole day absences in past 14 days (SR)	Odds of absenteeism significantly elevated $p < 0.05$	DIS or DMS at night in the past year (Often-Never)
Schweitzer et al., (1992)	Case-control study (Telephone interview)	1105 (USA)	Male and female workers	45 (ND)	Frequency of whole day absences in the past month (SR)	Odds of absenteeism significantly elevated $p < 0.01$§§§	Frequency of poor sleep nights n the past month (0->6)

Jacquinet-Salord et al., (1993)	Case-control study (Personal interview)	7629 (France)	Mechanical, chemical engineering & non industrial workers	38.9 (11.2)	Any incidence of absence from work in the past year (SR)	Significantly higher levels of absenteeism $p < 0.001$	TST, SOL, number of awakenings.
Kuppermann et al., (1995)	Case-control study (Telephone interview)	588 (USA)	Telecommunic-ations workers	36.6 (ND)	Hours of absence in past 6 months (ER) AND "Have you missed work in the past 4 weeks due to illness or injury?"; Yes/No (SR)	Significantly higher levels of absenteeism for self report data only $p < 0.01$§§§	Do you now have problems with sleep? (No response format provided)
Linton & Bryngelsson, (2000)	Cross-sectional study (Postal survey)	3000 (Sweden)	Male and female workers	41 (ND)	"Being off work in the past week" Yes/No (SR)	28% of those meeting DSM-IV criteria absent in past week compared to 7% for good sleepers.	DSM-IV criteria

Leger et al., (2002)	Cross-sectional study (Postal survey)	11,372 (France)	Male and female workers	ND	Any absence from work in the past year, cause and duration. Day absences in the past week (SR)	NS§	DSM-IV criteria
Doi et al., (2003)	Case-control study (Survey)	4868 (Japan)	Telecommunications workers	20–59	Frequency of absence periods in the past month (SR)	Odds of absenteeism significantly elevated $p < 0.05$§§§	DSM-IV criteria
Leger et al., (2006)	Case-control study (Survey)	738 (France)	Managers, white and blue collar workers	43.8 (ND)	Frequency of whole day absences in the past 2 years AND number of days absent from work, up to a total of 3 months consecutively in past 3 years. (ER,GR)	Significantly higher levels of absenteeism $p < 0.001$§	DSM-IV criteria

Philip et al., (2006)	Case-control study (Survey)	2265 (France)	National electricity and gas workers	51.0 (3.0)	Frequency and duration of absences in the past year (ER, GR)	Significantly higher levels of absenteeism $p < 0.01$	DSM-IV but included people without daytime impairments
Akerstedt et al., (2007)	Longitudinal study (Postal survey)	8300 (Sweden)	Male and female workers	16–64	Incidence of absence period >14 days consecutively in 2 year follow up (GR)	Odds of absenteeism significantly elevated $p < 0.05$	Disturbed sleep or daytime fatigue (No response format provided)
National Sleep Foundation, (2008)	Cross-sectional study (Telephone interview)	1000 (USA)	Male and female workers	18+	Incidence of "Not going to work" in the past month; "Yes/No" (SR)	2% of respondents reported absenteeism due to sleep problem.	Sleepiness or sleep problem in the past month (Rarely-Every night)
Bolge et al., (2009)	Cross-sectional study (Internet survey)	19,711 (USA)	Male and female workers	18+	Estimated percentage of work time missed in past week using WPAI(Reilly et al., 1993) (SR)	Significantly higher levels of absenteeism $p < 0.01$§§§	Self-report of physician diagnosed insomnia

Daley et al., (2009)	Cross-sectional study (Telephone interview)	953 (Canada)	Male and female workers	43.7(14.0)	Hours of absence in the past 3 months (SR)	Significantly higher levels of absenteeism $p < 0.05$	DSM-IV criteria
Sivertsen et al., (2009)	Historical cohort study (Postal survey)	6599 (Norway)	Male and female workers	40–45	Total number of days of absence (only including those >14 days consecutively) in past 4 years (GR)	Significantly higher levels of absenteeism $p < 0.01$	DSM-IV criteria
Bolge et al., (2010)	Cross-sectional study (Internet survey)	1446 (USA)	Menopausal female workers	51.7 (8.8)	Estimated percentage of work time missed in past week using WPAI (Reilly et al., 1993) (SR)	NS§§§	Chronic DMS with night time awakenings ≥2 per week for over 1 month AND an impact on daytime activities.

Note: † = age range provided if no mean available. GR = government records data. ND = no data or insufficient details provided. NS = not statistically significant at $p \leq 0.05$ level.SD = standard deviation.SR = self report data. WPAI = work productivity and activity impairment questionnaire. Health variables controlled in the analyses reported (N.B health variables varied between studies):§ = psychological health controlled.§§§ = psychological and physical health controlled.

Table.1.2 The impact of insomnia/insomnia symptoms on workplace accidents

Author, year of publication/	Study design (method)	Sample *N* (location)	Sample described as:	Mean age (SD)†	Outcome measure; response format where available (source)	Impact of symptoms on accidents	Sleep problem defined as
Gabel & Gerberich, (2002)	Case-control study (Postal survey)[a]	688 (USA)	Veterinarians	24–80	Animal related work injuries in the past month (SR)	Odds of accident significantly elevated $p < 0.05$§	<6 hours sleep per night on average in the past month
Akerstedt et al., (2002)	Longitudinal study (Telephone interview and personal interview)[b]	47,860 (Sweden)	Male and female workers	16+	Fatal occupational accidents in a 20 year follow up (GR)	Odds of accident significantly elevated $p < 0.05$	Difficulties sleeping in the past two weeks (no response format provided)
Leger et al., (2002)	Cross-sectional study (Postal survey)‡	11,372 (France)	Male and female workers	ND	Industrial accidents in the past year (SR)	Significantly higher levels of accidents $p < 0.05$§	DSM-IV criteria

Doi et al., (2003)	Case-control study (Survey)‡	4868 (Japan)	Telecommunications workers	20–59	Accidents in the past month (SR) Included traffic accidents	NS§§§	DSM-IV criteria
Chau et al., (2004)	Case-control study (Personal interview)c	1760 (France)	Construction workers	ND	Occupational injuries with sick leave in the past 2 years (ER)	Significantly higher levels of injury $p < 0.001$§§	Sleeping <6 h per day AND/OR "not sleeping well" AND/OR regular consumption of sleeping pills
Chau, Mur, Touron et al., (2004)	Case-control study (Personal interview)c	2610 (France)	Railway workers	ND	Occupational injuries with sick leave in the past 2 years (ER)	Significantly higher levels of occupational injury $p< 0.05$	As Chau et.al., (2004) above.
(Leger et al., 2006)	Case-control study (Survey)‡	738 (France)	Managers, white and blue collar workers	43.8 (ND)	"Did you have any minor accidents at work in the past month?" (Yes/No) (same format for severe accidents) (SR)	NS§	DSM-IV criteria

National Sleep Foundation, (2008)	Cross-sectional study (Telephone interview)[d]	1000 (USA)	Male and female workers	18+	Injury and accidents in the past year (SR)	28% of those with longer sleep latency (>30 min) reported accidents in the past year compared to 7% of those with shorter sleep latency (≤30 min)	DIS and "short" TST
Daley et al., (2009)	Cross-sectional study (Telephone survey)[‡]	953 (Canada)	Male and female workers	43.7(14)	Work-related accidents and falls in the past 6 months (SR)	Significantly higher levels of accidents $p < 0.05$	DSM-IV criteria
Kling et al., (2010)	Cross-sectional (Survey)e	69,584 (Canada)	Male and female workers	15–64	Work-related injury in the past year which was serious enough to limit normal activity (SR)	Odds of accident significantly elevated $p < 0.05$[§§§]	Jenkins sleep scale(Jenkins, Stanton, Niemcryk, & Rose, 1988)

Salminen et al., (2010)	Prospective study (Postal survey)[f]	40,386 (Finland)	Municipal and hospital workers	44.8 (ND)	Incidence of occupational injury with sick leave in the year following baseline survey (ER)	Odds of accident significantly elevated in men $p < 0.05$[§]	TST; incidence that sleep is refreshing. (Never-most of the time) AND/OR sleeping pill consumption in past month.
Note: † = age range provided if no mean available. Hours of sleep per night. ER = employer records data.GR = government records data. ND = no data or insufficient details provided. NS = not statistically significant at $p \leq 0.05$ level.SD = standard deviation.SR = self report data. Health variables controlled in the analyses reported (N.B health variables varied between studies):[§] = psychological health controlled. [§§] = physical health controlled.[§§§] = psychological and physical health controlled							

Table.1.3. The impact of insomnia/insomnia symptoms on workplace productivity variables.

Author, year of publication	Study design (method)	Sample N (location)	Sample described as:	Mean age (SD)†	Outcome measure; response format where available (source)	Impact of insomnia symptoms on productivity variables	Sleep problem defined as
(Johnson & Spinweber, 1983)	Longitudinal study (Survey)	2292 (USA)	Naval seamen	20.5 (2.6)	Sailing ability and "indices of navy performance" (ER)	Poor sleepers less effective in areas of navy performance than good sleepers.	Overall, what kind of sleeper are you? (Very good-Very poor)
Schweitzer et al., (1992)	Case-control study (Telephone interview)	1105 (USA)	Male and female workers	45(ND)	Whole days of poor productivity in the past month (SR)	Significantly lower levels of productivity $p < 0.05$§§§	Frequency of poor sleep nights in the past month (0->6)

Kuppermann et al., (1995)	Case-control study (Telephone interview)	588 (USA)	Telecommunications workers	36.6 (ND)	6-item job performance scale Scored from 1 to 5 over past 4 weeks (SR)	Significantly lower levels of productivity $p < 0.05$§§§	Do you now have problems with sleep? (No response format provided)
Linton & Bryngelsson, (2000)	Cross-sectional study (Postal survey)	3000 (Sweden)	Male and female workers	41 (ND)	4 item job performance scale Response format from "not at all affected" to "very much affected" (SR)	49% of people with insomnia and 40% of poor sleepers report reduced work capacity (ND on good sleepers)	DSM-IV criteria
Leger et al., (2002)	Cross-sectional study (Postal survey)	11,272 (France)	Male and female workers	ND	Reported reduction in efficiency in the past month using a 0–100 visual analogue scale (SR)	Significantly lower levels of productivity $p < 0.001$§	DSM-IV criteria

Doi et al., (2003)	Case-control study (Survey)	4868 (Japan)	Telecommunications workers	20–59	"Problems with occupational activities" in the past month; no response format specified (SR)	Odds of reduced performance significantly elevated $p < 0.05$§§§	DSM-IV criteria
Goetzel, Ozminkowski, & Long (2003)	Case-control study (Survey)	738 (France)	Managers, white and blue collar workers	43.8 (ND)	Reported reduction in efficiency in the past month using a 0–100 visual analogue scale from WPSI (SR)	Significantly lower levels of productivity $p < 0.001$§	DSM-IV criteria
Bolge et al., (2009)	Cross-sectional study (Internet survey)	19,711 (USA)	Male and female workers	18+	Estimated % of reduced productivity in the past week using WPAI (SR)	Significantly lower levels of productivity $p < 0.01$§§§	Self-report of physician diagnosed insomnia

Daley et al., (2009)	Cross-sectional study (Telephone interview)	953 (Canada)	Male and female workers	43.7 (14.0	Estimated % of reduced productivity in the past 3 months (SR)	Significantly lower levels of productivity $p <$ 0.001	DSM-IV criteria
Bolge et al., (2010)	Cross-sectional study (Internet survey)	1446 (USA)	Female workers with SR menopausal symptoms	51.7 (8.8)	Estimated % of reduced productivity in the past week. WPAI(Reilly et al., 1993) (SR)	Significantly lower levels of productivity $p <$ 0.001§§§	Chronic DMS with night time awakenings ≥2 per week for over 1 month AND an impact on daytime activities.
Rosekind et al., (2010)	Case-control study (Internet survey)	4188 (USA)	Health care, manufacturing, ground and air-based transportation workers	Insomnia group: 40.0 (10.3) Good sleepers: 40.2 (11.4)	Mean global score from WLQ (Lerner et al., 2001) (SR)	Significantly lower levels of productivity $p <$ 0.05	DSM-IV criteria

Note: † = age range provided if no mean available. ER = employer records data. ND = no data or insufficient details provided.SD = standard deviation.SR = self report data. WPSI = work productivity short inventory. WPAI = work productivity and activity impairment survey. WLQ = work limitations questionnaire. Health variables controlled in the analyses reported (N.B health variables varied between studies):§ = psychological health controlled.§§§ = psychological and physical health controlled.

Table .1.4 The impact of insomnia/insomnia symptoms on career progression

Author, year of publication	Study design (method)	Sample *N* (location)	Sample described as:	Mean age (SD)†	Outcome measure; response format where available (source)	Impact of insomnia symptoms on career progression	Sleep problem defined as
Johnson & Spinweber, (1983)	Longitudinal study (Survey)[a]	2292 (USA)	Naval seamen	20.5 (2.6)	Pay grade, re-enlistment & promotions in 6 year follow up (ER)	Significantly lower career progression $p < 0.001$	Overall, what kind of sleeper are you? (Very good-Very poor)
Leger et al., (2006)	Case-control study (Survey)‡	738 (France)	Managers, white and blue collar workers	43.8 (ND)	WPSI(Goetzel et al., 2003) (SR)	Significantly lower career progression $p < 0.01$§	DSM-IV criteria

Sivertsen et al., (2006)	Historical cohort study (Survey)‡	37,308 (Norway)	Male and female workers	44.03 (ND	Permanent work disability in 4 year follow up (GR)	Significantly elevated work disability $p < 0.001$§§§	DSM-IV criteria
Heponiemi et al., (2009)	Case-control study (Postal survey)[b]	5000 (Finland)	Physicians	45.9 (9.8)	"If it were possible would you like to change to another profession with a similar salary?" Yes/No/Perhaps (SR)	Significantly elevated desire to change career $p < 0.01$§	Jenkins sleep scale: (Jenkins et al., 1988)
Sivertsen et al., (2009)	Historical cohort study (Postal survey)‡	6599 (Norway)	Male and female workers	40–45	Permanent work disability in 4 year follow up period (GR)	Significantly elevated work disability $p < 0.001$	DSM-IV criteria

Salo et al., (2010)	Prospective cohort study (Survey)b	56,732 (Finland)	Local government workers	44.5 (9.7)	Incidence of long term (≥90 days) illness related to work disability in mean follow up of 3.3 years from baseline (GR)	Significantly elevated odds of work disability $p < 0.001$ §§§	Jenkins sleep scale: (Jenkins et al., 1988)

Note: † = age range provided if no mean available. ER = employer records data.GR = government records data. ND = no data or insufficient details provided.SD = standard deviation.SR = self report data. WPSI = work productivity short inventory. Health variables controlled in the analyses reported (N.B health variables varied between studies):§ = psychological health controlled.§§§ = psychological and physical health controlled.

Table.1.5 The impact of insomnia/insomnia symptoms on job satisfaction

Author, year of publication	Study design (method)	Sample N (location)	Sample described as:	Mean age (SD)†	Outcome measure; response format where available (source)	Impact of insomnia symptoms on job satisfaction	Sleep problem defined as
Jacquinet-Salord et al., (1993)	Case-control study (Personal interview)	7629 (France)	Mechanical, chemical engineering & non industrial workers	38.9 (11.2)	"Interest in job" (SR)	Significantly lower job satisfaction $p < 0.001$	TST, SOL, number of awakenings.
Kuppermann et al., (1995)	Case-control study (Telephone interview)b	588 (USA)	Telecommunications workers	36.6 (ND)	2 item work satisfaction scale (SR)	NS §§§	Do you now have problems with sleep? (No response format provided)
Doi et al., (2003)	Case-control study (survey)‡	5868 (Japan)	Telecommunications workers	20–59	Satisfaction with job; 1 = Very satisfied-5 = very dissatisfied (SR)	Significantly lower job satisfaction $p < 0.001$§§§	DSM-IV criteria

Scott & Judge, (2006)	Case-control study (Survey)c	51 (USA)	Insurance company workers	34.9 (11.8)	Mean JSS (Brayfield & Rothe, 1951) (SR)	Significantly lower job satisfaction $p < 0.05$	Jenkins sleep scale: (Jenkins et al., 1988)
Munir & Nielsen, (2009)	Case-control study (Postal survey)d	274 (Denmark)	Health care assistants	45 (9.9)	Exposure to transformational leadership at work and self efficacy using GTL(Carless, Wearing, & Mann, 2000) and SES: (Schwarzer & Jerusalem, 1995) (SR)	Significantly lower job satisfaction $p < 0.01$	4-item sleep quality survey over past two weeks. Example item "Have you found it difficult sleeping at night? (All the time-Not at all)
Niedhammer et al., (2009)	Cross-sectional study (Survey)e	7694 (France)	Male and female workers	40.0 (10.3)	Exposure to workplace bullying in the past year. LIPT(Leymann, 1992) (SR)	Significantly lower job satisfaction $p < 0.01$§§§	DIS AMD/OR DMS

Note: † = age range provided if no mean available. ER = employer records data.GR = government records data. GTL = global transformational leadership scale. JSS = job satisfaction scale. LIPT = Leymann inventory of psychological terror. ND = no data or insufficient details provided. NS = not statistically significant at $p \leq 0.05$ level.SD = standard deviation.SR = Self report data. SES = self efficacy scale. Health variables controlled in the analyses reported (N.B health variables varied between studies):§ = results presented controlled for psychological health variables.§§§ = results presented controlled for physical and psychological health variables.

2. Item generation

Introduction

As concluded in the previous Chapter, despite the importance attached to workplace performance in sleep medicine, there existed (at the time of writing) no standardized measure for quantifying the occupational impact of degraded sleep quality at the individual level. This point, emphasized by Buysse et al., (2006) in their recommendations for a Standard Research Assessment for Insomnia, has meant that there is no reliable and specific outcome measure for assessing either the occupational impact of effective treatments, or screening populations in epidemiological studies. The next 2 Chapters describe the development of an outcome measure designed to meet this need. The present Chapter first explains the initial steps taken in theoretically grounding the measure, and then describes the process of item generation to populate the measure, selecting items to include in such a metric.

Theoretical Considerations

Typically, instruments which assess the personal e.g. the Sickness Impact Profile (SIP): Bergner, Bobbit, Pollard, Martin & Gilson (1976); the Illness Perception Questionnaire (IPQ): Weinman, Petrie, Moss-Morris & Horne (1996), or occupational e.g. the Work Limitations Questionnaire (WLQ): Lerner, Amick, Rogers, Malspeis, Bungay & Cynn (2001); the Short-Form 36 (SF-36): (Ware, Kosinski, & Keller, 1994) correlates of health status have been designed to capture the impact of existing and recognizable conditions and health problems. The SIP, for example, assesses "sickness related dysfunction" across a range of activities including usual daily work (Bergner et al., 1976), while the WLQ assesses work limitations in relation to "on going or permanent medical conditions" (Lerner et al, 2001). Similarly, the SF-36 specifically addresses the impact of "your physical

health" and "any emotional problems" on workplace functioning (Ware et al., 1994). When assessing the occupational impact of sleep quality, this emphasis on "sickness", "medical conditions" and "health problems" reduces the utility of such scales for two reasons. First, those with insomnia-type sleep symptoms may not regard themselves as "sick" or having a "medical condition/health problem", a conclusion consistent with the relatively low levels of medical consultations seen among people with insomnia (e.g. Morin, LeBlanc, Daley, Gregoire, & Merette, 2006). Secondly, where sleep disorders are comorbid, the consequences of degraded sleep quality can become confounded with those of general health status.

In theory, these issues could be addressed by substituting the terms "sleep disorder" or "insomnia" for "sickness", "health problem", etc. (see, for example, Morgan, Dixon, Mathers, Thompson and Tomeny, 2003). However, such a strategy can introduce further problems, since many of those meeting criteria for sleep disorders may not consult practitioners (e.g. Morin et al., 2006) and, in the absence of a formal diagnosis, may not identify with formal diagnostic labels (like, for example, "insomnia"). There is also a more fundamental limitation in applying "diagnostic" constructs when assessing the occupational impact of sleep quality. Unlike illnesses, disabilities and clinical symptoms, which are discrete or categorical states experienced by certain individuals, sleep quality is a universal experience which varies within and between all individuals. A tool which aimed to quantify only the occupational impact of a given sleep disorder would fail to capture the occupational impact of normal variations in sleep quality, and would have little face validity among those members of the workforce who do not regard themselves as having "disordered" sleep.

Procedures

In developing the new sleep outcome, the research programme was strongly influenced by the working procedures suggested by the US Food and Drug Administration (FDA) for the development of patient-reported outcome (PRO) measures to use in clinical research (Food and Drug Administration, 2006). These

procedures involve a 5 stage iterative process which broadly reflects the organisation of this thesis.

i. Hypothesise Conceptual Framework

The extensive literature review conducted in Chapter 1 informed the conceptual framework outlined above. The occupational impact of sleep quality is conceptualised as a variable continuously distributed throughout the working population and is not restricted to people with sleep disorders. It is also assumed that a metric which captures sleep related occupational impact would have utility in behavioural sleep medicine beyond the assessment of insomnia. An empirical test of this conceptualisation is provided in this Chapter.

ii. Adjust Conceptual Framework and Draft Instrument

Patient input is recommended when developing a PRO instrument. The present Chapter describes the generation of an item 'pool' using qualitative methods (focus groups) among people with 'normal' and clinically disturbed sleep.

iii. Confirm Conceptual Framework and Assess Other Measurement Properties

The item pool will then be piloted in a sample of workers, and results subjected to reliability and validity analyses (Chapter Three). Items can then be removed or reworded, depending on the psychometric properties of the scale. The resulting scale will aim to maximise validity and reliability, while minimising the number of scale items.

iv. Collect, Analyse and Interpret Data

The newly developed scale will then be administered to representative samples of workers, and its epidemiological performance will be analysed and interpreted (Chapters Four, Five & Six).

v. Modify Instrument

At all stages of scale development, modifications to the ordering and content of items, the inclusion or exclusion of items, and the response format were considered, either in response to psychometric analyses, or in response to user feedback and behaviour. Throughout the research programme, the aim was to produce an evidence-based scale in line with FDA recommendations and best psychometric practice.

Testing the "occupational impact of sleep" concept

Conceptualised as a variable "continuously distributed throughout the working population and... not restricted to people with sleep disorders" (see above) the occupational impact of sleep construct was initially tested as follows (see David and Morgan, 2007; Kucharczyk, Morgan & Hall, 2012).

In the absence of a sleep-specific metric, a literature review was conducted to identify scales suitable for assessing the impact of chronic illness and/or disability on occupational performance. Of these the 25-item Work Limitations Questionnaire (WLQ: Lerner et al, 2001) assessed the widest range of occupational activities and demands. Broadly, the WLQ assesses an employee's level of difficulty (or ability) to perform 25 specific job demands over the previous 2 weeks. The questionnaire delivers sub-scale scores for 4 domains (Time Management; Mental/Interpersonal aspects; Output Demands; and Physical Demands). Selected people with insomnia (PWI) and control 'good' sleepers who responded to a

newspaper advertisement (see appendix) were then asked to: i. complete WLQ ratings in relation to their sleep quality (substituting "sleep quality" for all references to illness, disability, etc); and ii. to suggest any other areas of occupational performance they felt were influenced by their sleep. To improve face validity in the present exercise, the 6 items from the Physical Demands sub-scale (e.g. experiencing difficulty/ability to "bend, twist or reach…"; "lifting, moving and carrying objects weighing more than 10 lbs.") were omitted. At the time of assessment, participants also completed the Pittsburgh Sleep Quality Index (PSQI; Buysse et. al 1989), and the SF-36 (Ware et al 1994). On completion, all participants were invited to comment on any aspect of the assessment.

Participants

People were eligible for the People with Insomnia (PWI) group if they: i) met Diagnostic and Statistical Manual of Mental Disorders; DSM-IV. American Psychiatric Association, 1994) criteria for primary insomnia ; ii) scored >5 on the Pittsburgh Sleep Quality Index (PSQI; Buysse et.al., 1989); iii) were aged between 25 and 50 years; iv) had a body mass index (BMI) within the range (18.5-30); v) scored <20 on the Beck Depression Inventory (BDI; Beck, Steer & Brown, 1996); vi) were not awaiting or undergoing hospital treatment or regularly attending their general practitioner for any long-term health problems; vii) were not taking psychotropic medication (including hypnotics); and viii) were engaged in non-shiftwork daytime occupations. Control 'good' sleepers met criteria 3-8 and scored ≤5 on the PSQI. The PWI group (n = 43) comprised 26 women and 17 men (mean age 39 ± 7.6); the control group (n = 43) included 32 women and 11 men (mean age 36 ± 7.4).

Results

Using pooled data from all 86 participants, a Cronbach's alpha coefficient of 0.95 was obtained, indicating a satisfactory level of internal consistency. Mean scores were then computed separately for the PWI and control group, and compared using an independent t test. Scores were significantly elevated among PWI (PWI Group mean = 19.6 ± 13.2 v Control Group mean = 10 ± 7.74; $F = 16.83$, $p<0.001$), providing support for the concurrent validity of the assessment.

Participant feedback

In post-assessment debriefings which had followed this first presentation of the WLQ items, participants had suggested a total of five additional and important occupational scenarios impacted by sleep quality which were not covered by the questions asked. These were: waking up for work on time; arriving at work on time; working effectively in the afternoon; maintaining stamina throughout the day; and gaining satisfaction from work. These scenarios were then added as supplementary items, and administered to the same participants 16 weeks after the first assessments. The total 24 items (19 + 5 supplemental items) showed activity across the potential score range (measured range = 0-80; mean = 25), and a Cronbach's alpha coefficient of 0.93 for the pooled data. Once again, scores significantly differed between PWI and control participants (PWI Group mean = 16.7 ± 12.2 v Control Group mean = 8.1 ± 7.0; $F = 10.1$, $p<0.001$). To further explore validity, correlation coefficients were computed between the pooled occupational impact of sleep assessment scores and: i) global PSQI scores; and ii) 'vitality' domain scores from the SF-36 (a domain equivalent to a fatigue scale; see Morgan et al, 2003). Occupational impact of sleep scores correlated positively and significantly with PSQI global scores ($r = 0.54$, $p< 0.001$) and negatively and significantly with the SF-36 vitality ($r = -0.66$, $p< 0.001$). Thus, higher levels of

sleep disturbance and lower levels of vitality significantly predicted higher levels of sleep related occupational dysfunction.

Conclusion

This initial test delivered adequate proof of concept for a multi-item scale focused exclusively on variations in occupational performance arising, in the judgement of participants, from variations in sleep quality. Specifically, the test provided support for the usability, face validity, internal consistency reliability, and construct validity of such a scale. Recognising that the initial scale was derived from a limited range of items, the next stage of the research programme sought to widen the range of occupational scenarios, and refine the response format.

Full item generation

The comprehensive literature search in Chapter 1 identified a total of 30 studies which reported data on daytime occupational impact in relation to insomnia, insomnia symptoms, or degraded sleep quality. Broadly, the outcome measures in these papers could be clustered within 6 'domains' of occupational functioning: absenteeism; workplace accidents; productivity; punctuality; job satisfaction and career progression. In order to identify occupational themes directly relevant to lived experience and able to inform questionnaire item generation, these domains were used as discussion prompts in a series of four focus groups among working people.

Item Generation Focus Groups: Design and Recruitment

Approval was gained from the Loughborough University Ethical Advisory Committee. Following from the conceptualisation of the occupational impact of sleep quality as a variable continuously distributed throughout the working population and not restricted to those with sleep pathology, groups were designed to capture the views of both those who experienced the most prevalent sleep disorders (OSA and insomnia), and those who experienced good sleep. Advertisements were placed in GP and dental practices, libraries, community noticeboards, and direct invitations were sent to a local (Leicestershire) sleep apnoea patient association. People who expressed an interest in participating in "…an informal discussion group about sleep and work" were asked to contact the researcher at the Loughborough Sleep Research Centre (SRC). The advertisement stated that participants must be in full-time, paid, day-time employment, that participation would be rewarded with a £15 shopping voucher, and that all expenses would be paid. Contact details included a direct telephone number and email address for the researcher. Those responding to the advertisements were sent an information sheet (see Appendix) together with the following screening assessments:

i. Pittsburgh Sleep Quality Index (PSQI)

The PSQI (Buysse et al., 1989) consists of 19 self report items assessing sleep quality and sleep disturbance in the past month. The scale consists of 7 components (subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleep medication and daytime dysfunction), which combine to give a global sleep quality score between 0 and 21. The PSQI can identify good and poor sleepers using a validated cut point score of 5 and shows high reliability (Cronbach's alpha= .83, test retest=0.85). This cut off point of 5 was used to screen good and poor sleepers for the focus groups.

ii. The Epworth Sleepiness Scale (ESS)

The ESS (Johns, 1991) is a short questionnaire which assesses the likelihood of dozing or falling asleep in 8 different daytime situations. A score of 11 or more indicates daytime sleepiness, a score of 18 indicates extreme daytime sleepiness. The ESS is used as a clinical diagnosis and assessment tool for sleep apnoea. Participants scoring 11 or more were screened for exclusion in the good sleeper group and inclusion in the sleep apnoea group.

Recruitment

A total of 32 people returned screening assessments. These participants were divided into four groups: people with insomnia symptoms (two groups due to high response rate); people with sleep apnoea (one group); and "good sleepers" (one group). Those in the insomnia symptoms groups (13 females, 3 males in total; mean age 41 ± 15.8) scored >5 on the PSQI, (mean=11.90± 2.73), ≤10 on the ESS (mean=7.16 ± 4.12) and did not have a diagnosis of any other sleep disorder. The sleep apnoea participants consisted of 1 woman and 6 men (mean age 53 ± 5.0); each had a doctor's diagnosis of obstructive sleep apnoea and had been prescribed Continuous Positive Airway Pressure (CPAP) treatment (mean ESS=8.25 ± 4.0) . The "good sleepers" group of 7 women and 2 men (mean age 34 ± 9.3) all scored ≤5 on the PSQI and <10 (mean=4.0± 1.42) on the ESS. All participants confirmed they were of working age (18-65), and employed in full time, 9-5 day jobs. 64% of the sample were employed in white collar roles and 36% in blue-collar employment.

Method

Each focus group was conducted in a comfortable University seminar room. Groups were audio recorded, lasted 60-90 minutes, and were facilitated by the researcher (EK). Refreshments were provided and participants had the opportunity to ask questions of the researcher before giving formal written consent. Participants were told that they were under no obligation to talk and could leave the discussion group at any time.

Semi structured focus group schedules were devised using input from the literature review and consultation with colleagues who specialise in this area. Due to the different nature of insomnia and sleep apnoea, slightly different question schedules were used for each of the groups, however each aimed to elicit responses about individual experiences of how sleep disorders can affect workplace performance (see Appendix). Group discussion was initiated by first asking participants to think of words which could describe how they feel at work following a poor night of sleep (e.g. “drained”, “anxious”, etc.). Words offered were written on a whiteboard. Following this, open prompts were used to encourage discussion of sleep and work relationships. The questions asked in the insomnia symptoms and sleep apnoea groups followed the same basic format but included some condition-specific items (for example, the effectiveness of CPAP equipment in reducing sleepiness at work was discussed in the sleep apnoea group). Discussion in the “good sleeper” group centred around more general aspects of relationships between sleep and work. Input from the researcher was minimal and active discussion was encouraged within the group although prompts from the schedule were used if discussion deviated from the topic for too long.

Following the initial discussions, participants in all groups were asked to fill in the 24 item prototype scale and then informal discussion was encouraged about the relevance of each of the items on the scale and its overall face validity. After the discussion participants were invited to ask questions and were given a debrief sheet explaining their right to withdraw their data at any time (in line with University ethical practice; see Appendix).

Analysis

Audio recordings for each group were transcribed verbatim. Pseudonyms were assigned to each participant and were used throughout the transcription in order to ensure confidentiality.

Thematic analysis was used to gather in-depth insight into an individual's experience of their sleep-work relationship. Using guidelines from Boyatzis (1998), the process of analysis was qualitatively conducted in a 6-fold procedure. First, each transcript was read through by the researcher. Second, the transcript was read again and any areas relating to sleep and occupational performance were highlighted and given a temporary code which was relevant to the content of the text (e.g. concentration, stress etc.). Third, passages from the text were grouped together by their temporary code to form initial themes which appeared to have a common meaning. Fourth, the transcript was read through again and any appropriate data was coded under the new initial themes. Fifth, this process was repeated for each of the transcripts, adding new themes where relevant and rechecking the previous transcripts for evidence to support these additions. Finally, themes were collapsed and dominant themes which provided a representation of the data as a whole were retained. Themes were re-labelled using appropriate text from the transcript. All themes and supporting quotations were then assessed by a senior sleep researcher (Professor Kevin Morgan of the Clinical Sleep Research Unit) for clarity.

Focus Groups: Results

General Issues

None of the groups reported absenteeism or lateness (in relation to sleep quality), or considered these to be the most significant or likely consequence of disturbed

sleep. Across all groups, however, poor concentration, delayed decision-making, communication avoidance and difficulty with new tasks were identified as both significant and likely consequences of sleep disturbance. Career progression was considered an issue only by some in the OSA group, where daytime symptoms had inhibited their applying for promotion, though reduced job satisfaction was common to both the OSA and insomnia groups. All groups described compensatory tactics, reflecting awareness of impairment. Good sleepers generally anticipated restorative sleep on subsequent nights, while those with insomnia and OSA did not. Overall, it was felt that employers did not rate the sleep needs of their employees as an occupational health concern.

Specific Themes

Analysis of all transcripts identified three major themes, each connected with sub themes suitable for potential survey items which, it was felt, reflected aspects of sleep related workplace functioning not included in the prototype scale (see Table 2.1). Examples of participant quotes are presented to support the inclusion of these themes and sub-themes (see Table 2.2)

Table 2.1. Themes and sub-themes derived from focus group transcripts

Themes	Sub categories
Task management	Procrastination
	Creativity
	Helping others
	Focusing on a computer screen
	Work life balance
Maintaining	Doing "just enough" work
Stamina	Sleepiness/fatigue at work
Interactions with	Communication
People	Lack of assertiveness
	Mood regulation

Task management

Participants in all groups related a number of functional workplace impairments to the quality of their sleep. Difficulty in managing multiple tasks, and prioritising workload effectively were frequently reported, particularly in the insomnia group. Participants appeared to organise their workload in two ways; firstly; to put off doing more complex tasks in favour of those requiring less mental input e.g. emailing; or secondly, to complete harder tasks first "to get them out of the way" as they envisaged a slump in productivity in the afternoon when they would not be able to complete these tasks. Differences in task management style among the focus group participants could be attributed to variations in job flexibility and personal autonomy in the workplace.

Procrastination

Putting off work tasks that were felt to be more difficult when fatigued or sleepy was frequently reported by all groups, this was attributed to poor sleep and seemed to be closely related to an inability to sustain attention and concentrate on the task at hand.

Creativity

Particularly in the insomnia group, respondents associated poor sleep with difficulty in creative thinking, and struggled if this was required of them at work.

Helping others

In the OSA group, participants with responsibilities to provide support for other colleagues or students avoided "helping" scenarios as they were already struggling to complete their own workload due to fatigue and sleepiness.

Focusing on a computer screen

The majority of participants were in white collar desk based employment and using computers was felt to both cause and exacerbate fatigue.

Work-life balance

Despite agreement in insomnia and OSA groups that sleep quality could impact their workplace productivity, it was generally agreed that participants would still meet deadlines and manage their workload. This often meant catching up with work in their spare time which could be detrimental to their social lives and relationships.

Maintaining stamina

Across all groups, participants reported feeling fatigued in the afternoon and the negative effect this had on performing complex tasks, communication and staying focused. This was exacerbated by the condition in the insomnia and OSA groups but was also experienced frequently by good sleepers after an occasional self-imposed short sleep period.

Doing "just enough" work

Although participants generally reported meeting the demands for their job, even at the expense of their free time, it was that they "knew their limits" and would not exceed this level of work, usually completing just enough to meet the needs of their employer.

Interactions with people

Sleepiness/fatigue

Participants in the OSA group discussed difficulties in staying awake at work (usually pre CPAP treatment but still experienced occasionally following treatment). In OSA, sleepiness was more likely to happen in a sedentary situation such as a meeting, but could still occur even when faced with high pressure or a complex task. Daytime sleepiness as opposed to fatigue was mentioned less frequently in the insomnia and control groups although there were reports of taking unauthorised nap breaks in all groups e.g. in a toilet cubicle or a car. In all groups, daytime sleepiness and fatigue was seen as a nuisance. Napping was not seen as beneficial or practical addition to the workday.

In contrast to the sleep deprived OSA participants who reported sleeping at work (willingly or otherwise) if the opportunity presented itself, control group participants reported more fatigue than actual sleepiness and generally reported that catching up on sleep at work would not be feasible due to a) time constraints b) a need to be comfortable in order to sleep and c) perceived social disapproval of daytime sleepiness.

Exposure to fresh air was seen as a good tactic for avoiding sleepiness and outdoor work was favoured although this was not possible for the majority of people. This was well demonstrated by an exchange between two participants in the OSA group (Table 2.2).

Communication

In the insomnia group, verbal reasoning and communication were felt to be directly affected by poor sleep. Fatigue and sleepiness in sedentary workplace situations such as meetings where individuals were expected to contribute were reported as a concern in all groups. Participants favoured working alone and also

reported avoiding answering their telephones when feeling the effects of poor sleep.

Lack of assertiveness

Participants in the insomnia group lacked confidence in their own abilities as communicators after a poor night of sleep, particularly in situations that required them to take charge of a situation and be assertive.

Mood

Despite reporting a lack of assertiveness with people in the workplace, participants in all groups felt that lack of sleep could cause them to be uncharacteristically irritable and "snappy" with colleagues. This was usually accompanied by a feeling of regret afterwards. Nobody reported any physical acts of aggressive behaviour resulting from poor sleep.

Table 2.2. Text examples from focus groups

Theme	Text example	Participant group (gender)
Procrastination	Sometimes, I find it very difficult to read and write which is the main part of my job so it's, I just can't do that… and I can just go on for weeks without doing any reading or writing and I then feel terrible.	Insomnia (F)
	If you've got photocopying to do it's fine but if you've got something that really needs brain power you put it aside 'til the next day..	Insomnia (F)
	If you've got a paper to submit or something you can't really write a paper in the morning, you just keep checking your emails.	Insomnia (M)

	Working with different types of data that have got to be collated, I just lose my way and I get confused.	Insomnia (F)
	Working with different types of data that have got to be collated, I just lose my way and I get confused.	Control (F)
	I tend to look at all the things I've got to do and start one and think.. oooh no. And then I'll get up and go and make a drink and I see what you mean, your minds not really on… you're still working but you're just not…	Control (F)
	I also find if you're doing something where you're really engaged, that keeps your concentration going.	Insomnia (F)
Task management	When I don't sleep for long lengths of time I just can't do any work at all. If possible I just check my emails or something like that but not any reading or writing.	Insomnia (F)
	there are certain tasks I have difficulty with. I can certainly lecture, even on two hours sleep. That's not a problem for me. There is a whole number of things it doesn't interfere with but staying focused on tasks that I would always, you know, always find demanding is difficult I think. You know, typing I could do with zero sleep.	Insomnia (F)
	If I am knackered I will just drink some coffee and work away on the harder jobs I have to do first and get them out of the way, so that in the afternoon when I slump it is easier.	Insomnia (M)
Creativity	I don't feel very creative when I'm tired, I just think "Come on I've got to do something good soon" and I've just had a whole day where I've just chucked everything away that I've done and I've not managed to produce anything worthwhile.	Insomnia (F)
Helping others	I am supposed to come up with new ideas but I was finding that…well the jargon term is that I was reactive rather proactive- I was just coping and would look for any excuse for a sit down.	OSA (M)

	I didn't have the energy to try and sort out his problem. I was busy trying to figure out what the hell I was supposed to be doing, like why have I got this on my laptop, that sort of thing. You tend to be dismissive and brush them off.	OSA (M)
	My personality has always been to help people, but with the sleep apnoea I'd be like 'go away and leave me alone, I've got enough trouble trying to work out what this is'.	M, OSA
Focusing on a computer screen	You might have two or three computer screens with a document on each one, and because you're the manager you're normally left on your own and you have to concentrate and pull thread from each one.. then I'd lose it totally, completely and I'd have to walk away, go outside then come back in and try and start again and pull these threads together.	OSA (M)
	I have to do a lot of work on computers and I sit there looking at the screen and I'm like "woah" .	Insomnia (F)
	Working on the computer in the morning I am very tired.	Insomnia (F)
	It can help than not being at work and sitting in front of the screen. I think as soon as you get home and just sort of chill.	Control(F)
Work-life balance	If you have no sleep, you're still able to perform, you feel bad, but you're still able to perform but then…… you don't sleep again, you're still not too bad really, you're still able to do most tasks.	Insomnia (F)
	On the ones (tasks) that you've got to do, priority wise you do focus, but other things say like at home the ironing or even say getting meals, you don't bother doing those…	Insomnia (F)
	I'm on contract so I've got to hit targets so if I don't finish it in 8 hours it goes to 12 hours unfortunately…. my wife thought I just wasn't pulling my weight.	OSA (M)

	So yes we might be able to achieve all these things at work but other areas might be suffering that's really… that's probably where I get my anger from. I'm a bit annoyed about that because you know, work isn't everything and other things in life are passing me by.	Insomnia (F)
	I keep thinking I've got to be more alert, I've got to be more energetic even it takes writing until 3 o'clock in the morning, which I do sometimes, and that's what it takes. But of course it doesn't.. you can't actually do that and then do all the other stuff.	Insomnia (F)
	You feel guilty about not being able to give your full attention at home to the wife and kids because all you want to do when you get home is just slump in the chair. Like go away, leave me alone, I've given all I can give all day, I've had enough now	OSA (M)
Maintaining stamina	I can't do detail in the afternoon. In the morning I'm okay but come the afternoon…	Insomnia (M)
	If I haven't had a good night sleep I will soldier on in the day, I'll be running on adrenaline and I'll be okay until 2-3pm and then it hits me and then I really feel I'm underperforming.	Control (F)
Doing "just enough"" work	I do think I could do so much more…. Well I know I could. If I've had a sleep I can get my tasks done so much better, I'm brighter, I'm nicer to people, I'm just a much nicer person..	Insomnia (F)
	There were stages when you were wouldn't put your all in and were less productive. In other words, you knew your limits and you wouldn't push yourself any further.	OSA (M)
	I could do more work, I could write things better, I could research things better but… I do just better than enough and I'm not really bothered.	Insomnia (M)

	I personally think you don't use your full potential so you tend to work within your means. If somebody gives you a chance to do something you think 'I don't know if I'll manage that'.	OSA (M)
	I had a promotion opportunity and I had to literally turn it down because I knew that the job I'd got I could cope with but any more than that, I'd be doing my employer a damage.	OSA (M)
Sleepiness and fatigue	I've made a little makeshift bed out of crates and lab coats at work before…	OSA (M)
	Once the pressure starts to build up the eyelids start to drop and you find yourself suddenly thinking, what have I been doing for the last quarter of an hour	OSA (M)
	In the afternoon looking at plots of little figures and I was putting in the wrong figures or I'd even nod off.	OSA (M)
	Concentration levels are very short. Particularly afternoon meetings, I would dread them because I knew I would go to sleep and I've been elbowed by a boss before now when I was in the office job	OSA (M)
	I go to the loo and fall asleep. I make sure nobody else is in there, and I go into the cubicle and that's it… the trouble is you say power nap but I have to consciously try and wake myself up otherwise I'll be there all afternoon. So yeah I just sit like this with my head down. I could do this now, I could go to sleep now.	Insomnia (F)
	I'm fortunate in having an office to myself so I have been known to put some coats on the floor and just drift off	OSA (M)

	1: I 'd love to be able to just put my head down and have a twenty minute nap in my lunch break but my office is not comfortable enough to do so…. 2: I'd worry I wouldn't wake up. I've gone and sat in my car before if I've had a late night but I can't properly snuggle up and… because I wouldn't wake up again. I don't think you do, I think you'd be too conscious that you're not in a comfortable place.	Control (two females)
	1: I don't think that short amount of nap would refresh me.* 2: Well you hear about power naps but I couldn't do them. 3 : I can't do it, I can't nap ever	Control group,(2 females and one male*)
Compensatory tactics	1. I am a research physicist and I mix lethal high voltages with military explosives so it requires concentration! 2. not a time to fall asleep! 1. Outdoors, when I'm doing this and I've got people there to keep me focused I'm fine but sitting at my desk and I've got to do the mental work and I don't have somebody to focus on, you are just thinking… and I'm drifting away.	OSA (2 males)
	I used to have to excuse myself if I was office bound, or keep a window open.	OSA (M)
	I'm great out in the fresh air- that helps a lot, but if I was at the computer or reading a book..	Insomnia (F)

Communication	I don't want to communicate with people. If I've got to 'phone people up and organise things I will put it off until I'm more awake or alert. Otherwise I'll just try to do tasks that just involve me when I can't communicate properly.	Insomnia (F)
	I'm in charge of what I do and I don't have to talk to anyone. It might be the reason why I'm doing what I'm doing. I think I'd struggle at work if they suddenly changed my role and I had to do presentations and stuff like that.	Insomnia (M)
	…it just feels like a fog. Like if I'm in a meeting and it's my turn to speak I just feel a bit thick..	Insomnia (F)
	My speech can be slurred. And ordinarily I am quite articulate but there are times when I listen to myself speak and I think… what are you trying to say? It's all jumbled up and it won't come out.	Insomnia (F)
	Communicating is my problem….slurring my words and not knowing words, them not coming into my head	Insomnia (F)
Lack of assertiveness	I get really nervous about talking to customers on the phone. I always feel a bit like I'm going to be weak with them, like I'm perhaps not going to stand my ground.	Insomnia (F)
	I have to discipline students in the library and I find that very difficult because I'm half asleep and I don't feel geared up for it basically. I'd just rather just go into the back office and just work on something individually until I feel a bit more sort of with it and then I can come out and be a bit more bossy.	Insomnia (F)
Mood	Well I've snapped at colleagues before then felt absolutely dreadful that I've done that then gone back and apologised..	Insomnia (F)
	I find I'm in a different mind set if I'm short on sleep. I'm quite grumpy and short with people so that impacts on everything.	Control (F)

	I knew I'd had a bad night's sleep when I would come to work and I'd have a fuse that was about that long.. one wrong word was enough.	OSA (M)
	I think it emphasises some of your concerns in life, so you're in a bad mood and don't feel very happy. And the sleep is the cause but you find different things to blame it on.	Insomnia (F)

Item generation

In the next stage of questionnaire development a pool of 30 questionnaire items which addressed the themes above were drawn up and discussed with colleagues who specialise in clinical sleep research (Professor Kevin Morgan), and sleep medicine (Dr Andrew Hall of University Hospitals of Leicester). Following this consultation, the number of items was scaled down to 15, which were then drafted and added to the prototype scale. The main reasons for item removal at this stage were duplication (where 2 or more items were judged to overlap in content), and lack of generality (where the item addressed a task or concern unlikely to be relevant to all workers e.g. sending emails.

The resulting 40 item prototype scale addressed aspects of punctuality, absenteeism, efficiency, productivity, job satisfaction, stamina and communication (see Table 2.3). Since the response format (which required participants to rate how frequently (all of the time, most of the time, some of the time, a little bit of the time, never/not applicable) their sleep quality had made it difficult to perform the occupational function specified in that item) had proved successful in the initial development of the scale, it was retained in the 40-item prototype. The original 2-week response time-frame, however, was adjusted, in line with participant feedback, to match the SF-36 and the PSQI (i.e. "in the past 4 weeks"). This ensured that subsequent comparisons between the PSQI and the prototype scale would share a focus on the same time periods.

Table 2.3. Prototype scale items and origin.

Scale Item	Pilot	New
Wake up for work on time	X	
Arrive at work on time	X	
Get going easily at the beginning of the workday	X	
Keep to a routine or schedule	X	
Do work carefully	X	
Maintain stamina throughout the day	X	
Think clearly when working	X	
Concentrate on your work	X	
Do your work without making mistakes	X	
Feel you have done what you are capable of doing	X	
Handle the workload	X	
Work without losing your train of thought	X	
Easily read or use your eyes when working	X	
Start on your job as soon as you arrive at work	X	
Control your temper around people when working	X	
Work fast enough	X	
Work the required number of hours		X
Balance your work with your free time		X
Do work without taking unauthorised rests or breaks		X
Keep working effectively in the afternoon		X
Concentrate on more than one task at a time		X
Be creative		X
Prioritise easy and difficult tasks effectively		X
Speak to people on the telephone		X
Focus on the more complex tasks related to your job		X
Contribute to team work		X
Speak to people face to face		X
Finish the work day on time		X
Be assertive with people you encounter in the workplace		X
Control your irritability at work		X
Always answer your telephone when it rings		X
Gain satisfaction from your work		X
Remember to meet deadlines		X
Get through the day without caffeinated drinks		X
Keep your mind on your work		X
Stay awake during a shift		X
Focus on a computer screen		X
Learn new tasks or skills		X
Do more than just enough work		X
Contribute to meetings		X

Comment

This Chapter explained the theoretical grounding of the measure and the process of item generation. Following PRO development recommendations information was gathered from respondents with and without disordered sleep to generate an item pool. The following Chapter will discuss the piloting and revision of the 40 item prototype scale.

3. Pilot and item reduction

Introduction

Having generated a range of items to populate a prototype scale to assess the occupational impact of variations in sleep quality (described in Chapter 2), the next stage of the research program involved piloting the 40 item scale in a sample of workers in order to generate a database suitable for detailed psychometric analyses. The specific aim of these analyses was to produce a final scale, based on the lowest number of items, which showed an acceptable degree of: 1) face and internal consistency reliability; and 2) concurrent validity. To achieve these research aims, this stage of the research comprised 2 components. First, an online survey in which respondents were invited to complete the prototype scale and the PSQI. Second, from the resulting dataset, reliability analyses of the prototype scale were conducted, with modifications made to the scale as appropriate. On completion of this process, an exploratory factor analysis was also conducted to examine the underlying structure of the items included in the finally modified scale. Approval for these components of the research was gained from the Loughborough University Ethical Advisory Committee.

Method

The 40 item prototype scale, together with the PSQI and demographic questions addressing age, sex, occupation (industry, job type), and occupational status (full or part-time; grade) was mounted on a secure online survey hosting website (Survey Monkey). Details of the site were distributed from online bulletin boards, social networking sites and by word of mouth. Since the main aim of the activity

was to collect a population of responses sufficient to assess the psychometric properties of the prototype scale, no attempt was made to obtain a representative or random sample of participants. Nevertheless, in order to optimise sample validity, inclusion criteria (presented at the beginning of the questionnaire) required that respondents were aged 18-65 and currently in full time employment.

Target sample size

Several factors influenced the estimated minimum sample size required, including the need for robust reliability analyses and the need for adequate statistical power when comparing the prototype scale scores of sub-groups (e.g. males/females; blue and white collar workers; those reporting higher and lower levels of (PSQI) sleep quality). In earlier analyses using the 'proof of concept' scale which supplied items for the current prototype (see Chapter 2), good and poor sleepers (defined in terms of PSQI scores), had shown significant differences in sleep related occupational impairment, with a mean difference of 8 scale points, and an overall scale standard deviation (SD) of 14 points. Using these outcomes as a guide, then to detect a difference of at least 8 scale points, assuming an overall SD of 14.0, a 5% significance (alpha) level, and 80% power, would require 49 subjects per group (i.e. 49 good sleepers and 49 poor sleepers). To allow for some variation in this estimate, a minimum sample size of 140 aimed for. The questionnaires remained 'live' for a period of one month, during which time this target was exceeded.

Statistical analyses

In line with psychometric convention (Cronbach, 1988), internal consistency reliability was assessed using split-half correlation coefficients and the Cronbach's

alpha statistic. Face validity was judged against completion rates (of the prototype scale), while evidence of concurrent validity was provided by product-moment correlations calculated between the prototype scale scores, and global scores from the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989). These latter analyses were based on the reasonable expectation that, a priori, a scale, which validly quantified degrees of occupational impact arising from experienced disturbances of sleep, should show a positive and significant covariation with a valid measure of sleep quality. However, a further expectation was that, if the new metric contributed new information, then such a correlation should be modest, allowing for substantial variance in the new measure not to be accounted for by the existing PSQI. Further, exploratory analyses using the prototype scale scores included sub-group comparisons using independent samples t-tests. In particular, respondents were divided into poor sleepers (i.e. those scoring above 5 on the PSQI, a score range indicative of "clinically significant sleep disturbance", (see Buysse et al., 1989), and good sleepers (those with PSQI score ≤5), with prototype scale scores compared in these sub-groups.

Results

Of 266 participants who completed the survey, 28 participants failed to meet the inclusion criteria. A further 16 respondents did not complete the survey and were excluded from the analysis, leaving a remaining sample of 222.

The demographic characteristics of the survey participants are shown in Table 3.1. Occupational types were stratified into 3 categories based on UK Office of National Statistics (ONS) classification (Office of National Statistics, 2000). Group 1; Higher skilled occupations (including Managers and Professionals); Group 2; Intermediate skilled occupations (including Associate Technical Professions, and Administrative and Secretarial roles); and Group 3: Lower skilled and Manual occupations (including Skilled Trades, Sales, Customer Services and Elementary roles).

Survey Reliability Analyses

Overall, the summed 40 items showed a mean summed score of 33.82 ± 27.82, satisfactory level of reliability (Cronbach's alpha = 0.97; and split half correlation: r = 0.93), a modest, though significant degree of shared variance with PSQI scores (r= 0.55; p<0.01), and effective discrimination between those above and below the PSQI cut point of 5 (N = 222; t = 7.2, p<0.001), mean summed score = 20.02±17.75 (PSQI ≤5) vs. 44.99±29.49 (PSQI>5). All analyses were conducted using SPSS (v17).

Table 3.1. Characteristics of field survey sample

Characteristic	
N	**222**
Age: mean (SD)	**36.74(11.63)**
PSQI score: mean (SD)	**6.92 (3.97)**
PSQI score >5: n (%)	**122 (55.0)**
PSQI score ≤5: n (%)	**100 (45.0)**
Occupational level: n (%)	
Higher	**117 (52.71)**
Intermediate	**87 (39.23)**
Lower	**18 (8.14)**
Hours worked/week: n (%)	
≥35	**187(84.23)**
<35	**35 (15.85)**

Item Reduction

In order to identify the smallest number of key items consistent with satisfactory reliability and validity, three approaches were adopted to item reduction. Using scaling procedures in SPSS (v17), items were removed from the original 40 item

pool if: i) the item-total correlation was <0.40; ii) the item showed a high proportion (>50%) of "not applicable" responses; and iii) the item was highly correlated with, and was judged (on the basis of response patterns) to effectively duplicate, another item. The integrity of the remaining scale (viz: Cronbach's alpha; the split half correlation; and the correlation between the prototype scale scores and the PSQI global scores) was tested at each stage of item reduction. This iterative process resulted in a total of 21 items being removed. The remaining 19 items were regarded as a single scale: the Loughborough Occupational Impact of Sleep Scale (LOISS: see Appendix).

Properties of the Loughborough Occupational Impact of Sleep Scale (LOISS)

Item-total correlations for each of the selected 19 LOISS items for all participants, and for those classified as 'good' and 'poor' sleepers (scoring ≤5 or >5 on the PSQI respectively) are shown in Table 3.2. The 19-item scale appeared active across its range, with scores distributed from 0-76 (the highest possible score) with an overall mean of 15.71 ± 13.74 and median of 14.0.

Table 3.2. Corrected Item-Total Correlations and Cronbach's Alpha if Item Deleted scores for LOISS

LOISS Item	All participants Alpha=.960		Good sleepers (PSQI ≤ 5) Alpha= . 939		Poor sleepers (PSQI >5) Alpha= .954	
	r	Alpha if item deleted	r	Alpha if item deleted	r	Alpha if item deleted
1. Arrive at work on time	.55	.960	.48	.939	.53	.955
2. Do work without taking unauthorised rests or breaks	.62	.959	.51	.938	.60	.954
3. Concentrate on more than one task at a time	.81	.957	.76	.933	.79	.951
4. Do work carefully	.81	.957	.70	.935	.80	.951
5. Maintain your stamina throughout the day	.76	.958	.70	.935	.71	.952
6. Focus on the more complex task related to your job	.85	.956	.78	.933	.83	.950
7. Speak to people face to face	.68	.959	.52	.938	.68	.952
8. Do your work without making mistakes	.81	.957	.67	.935	.82	.951
9. Finish the work day on time	.66	.959	.66	.935	.61	.954
10. Feel you have done what you are capable of doing	.81	.957	.75	.933	.79	.951
11.Control your irritability at work	.63	.959	.59	.937	.56	.954
12.Gain satisfaction from your work	.78	.957	.72	.935	.76	.951
13. Handle the workload	.85	.956	.83	.932	.82	.950
14. Easily read or use your eyes when working	.60	.960	.44	.940	.59	.954
15. Keep your mind on your work	.79	.957	.70	.935	.76	.951
16. Stay awake at work	.51	.961	.51	.938	.48	.955
17. Do more than "just enough" work	.79	.957	.66	.936	.78	.951
18. Work fast enough	.76	.958	.69	.935	.73	.952
19. Learn new tasks or skills	.86	.956	.79	.933	.84	.950

Reliability of LOISS

Overall, the 19 item scale showed satisfactory reliability, with a Cronbach's alpha of 0.96 (and a split half correlation of r = 0.91), exceeding guide values of alpha ≥0.8 for use of an instrument in clinical practice, and alpha ≥ 0.7 for use in research (see Nunnally & Bernstein, 1994). The analyses showed that the alpha for the scale would only be increased by 0.001 if any items were deleted so all were retained. Overall corrected item total correlations ranged from 0.86 for "Learn new tasks or skills" to 0.51 for "Stay awake at work" (see Table 3.2).

Means and score ranges for the 19-item scale are shown in Table 3.3. The 19 item scale showed effective discrimination between those above and below the Pittsburgh Sleep Quality Index cut-point for 'clinically disturbed sleep' (PSQI ≤5: mean LOISS score = 8.92± 8.73; PSQI >5: mean LOISS score = 21.27±14.60; t = 7.80, $p<0.001$ suggesting concurrent validity. In bivariate correlations the 19-item scale shared a modest, though significant degree of variance with PSQI scores (r = 0.56; $r^2 = 0.31$; $p<0.01$). Independent t-tests indicated that there was no significant relationship between LOISS scores and age, gender or hours worked (see Table 3.3).

Table 3.3. Mean LOISS Scores (Range; SD) Within Field Survey Sub-Groups

Sub-group (total n= 222)	Mean LOISS score (Range; SD)	p[a]
Overall score (n)	15.71 (0-76; 13.74)	
Age (median = 33)		
>Median age (n = 110)	16.17 (0-61;15.29)	
<Median age (n = 112)	15.25 (0-76; 12.08)	NS (p=0.62), t=0.49
Gender		
Male (n = 64)	14.13 (0-47; 12.41)	
Female (n = 158)	16.35 (0-76; 14.24)	NS (p=0.27), t=-1.09
Sleep disturbance		
PSQI score ≤5 (n = 122)	8.92 (0-34; 8.73)	
PSQI score >5 (n = 100)	21.27 (0-76; 14.60)	p<0.001, t=7.80
Occupational level		
Higher (n = 118)	16.13 (0-61; 13.95)	
Intermediate (n = 87)	15.17 (0-76; 12.87)	
Lower (n = 17)	15.56 (0-64; 16.93)	NS F(2,218)=0.12, p=0.88
Hours worked/week		
>36 (n = 118)	16.13 (0-61; 13.95)	
≤35 (n = 104)	15.25 (0-76; 13.62)	NS (p=0.64), t=0.47.

Note. Sub-group means compared using independent samples t-tests (for 2 sub-groups) or one way ANOVA (for >2 sub-groups). [a] significance of differences between means for sub-group totals.

The relationship between LOISS scores and individual PSQI component scores assessed by Pearson's product-moment correlations can be seen in Table 3.4. Results suggested that the relationship between sleep quality and sleep related occupational impairment is not specific to any PSQI component.

Table 3.4. Correlations between global LOISS scores and component scores of Pittsburgh Sleep Quality Index (PSQI)*

PSQI component	r
Sleep quality	**.50**
Sleep latency	**.34**
Sleep duration	**.30**
Habitual sleep efficiency	**.31**
Sleep disturbance	**.39**
Use of sleeping medication	**.50**
Daytime dysfunction	**.28**

Note. ***Pearson's product moment coefficients**
****all correlations significant to p<0.01**

Exploratory Factor Analysis

To explore the structure of the newly developed LOISS scale, the selected 19 items were included in an exploratory factor analysis using principal components extraction procedures followed by Varimax rotation. Coefficients below 0.40 were suppressed in the analysis. The resulting solution identified two principal components accounting for 59.21% (eigenvalue = 10.97) and 5.31% (eigenvalue = 1.00) of the variance respectively (see Table 3.5). Given the overall pattern of loadings, the first principal component was labelled "performance" (since it loaded primarily on those items concerning experienced work efficiency and execution), while the second smaller factor was labelled "vitality". Although the second factor had a low eigenvalue, it was retained since it could be clearly interpreted as "vitality" as each of the 4 items loading on this factor reflected the individual's level of vitality. When assessed independently items loading on these two factors, showed a satisfactory level of reliability as measured by Cronbach's alpha ('performance' = 0.96; 'vitality' = 0.77). Factor loadings can be seen in Table 3.5 .

Table 3.5. Factor Loadings and Communalities (h2) for Varimax Orthogonal Solution for LOISS

Loughborough Occupational Impact of Sleep Scale Item	Factor 1 "Performance"	Factor 2 "Vitality"	h^2
1. Arrive at work on time		.57	**.43**
2. Do work without taking unauthorised rests or breaks		.71	**.62**
3. Concentrate on more than one task at a time	.80		**.74**
4. Do work carefully	**.70**	.45	**.70**
5. Maintain your stamina throughout the day	.56	**.59**	**.66**
6. Focus on the more complex task related to your job	.77	.41	**.77**
7. Speak to people face to face	.63		**.51**
8. Do your work without making mistakes	.78		**.72**
9. Finish the work day on time	.75		**.58**
10. Feel you have done what you are capable of doing	.82		**.75**
11.Control your irritability at work	.60		**.45**
12.Gain satisfaction from your work	.75		**.67**
13. Handle the workload	.79		**.77**
14. Easily read or use your eyes when working	**.50**	.41	**.42**
15. Keep your mind on your work	**.64**	.50	**.66**
16. Stay awake at work		.83	**.70**
17. Learn new tasks or skills	.80		**.72**
18. Do more than just enough work	**.62**	.48	**.62**
19. Work fast enough	.78	.41	**.78**

Note. **n=222. Boldface indicates highest factor loadings**

Comment

The results from the program of work described in Chapters 2 and 3 allow three broad conclusions. First, both the focus group outcomes and the questionnaire surveys provide support for the conceptualization of the 'occupational impact of sleep quality' as an experience common to all members of the workforce, rather than a construct limited in meaning only to those with on-going (and diagnosable) sleep problems. This conceptualization has important implications for both the design, and the utility of workplace assessments, since it allows for the general screening of the entire workforce (rather than just the targeted assessment of those with existent sleep disorders). Second, the areas of 'occupational impact' identified in the focus groups and rated in the questionnaire surveys support the view that the influence of sleep quality on workplace performance can differ, in some important respects, from the influence of health status alone. And third, that the 19 item LOISS shows a breadth, reliability and validity consistent with its use, and further development, in research and clinical settings. In particular, the 19 item scale showed high levels of internal consistency, and a pattern of relationships with sleep quality (as measured by the PSQI) supporting its construct validity. This validity rests on the ability of LOISS to discriminate between those who score above and below the PSQI cut-point of 5. Given the proven validity of the PSQI, and its ability to asses sleep quality in a range of sleep disorders, the evidence of concurrent validity offered here also supports the criterion validity of the 'occupational impact of sleep' construct.

Exploratory factor analysis indicated a two-factor structure for LOISS. However, the high internal consistency of the total scale, together with the low eigenvalue

for the smaller factor may not be robust. While the present factor analysis followed Kline's (1994) guidelines to use a minimum 2:1 ratio of participants to survey items when conducting exploratory factor analysis, a more thorough understanding of the factor structure of the LOISS will be established by use of a confirmatory analysis in a larger sample in Chapter 6.

All of the analyses conducted here relied on a single point of measurement (the online survey) to deliver data on which the LOISS instrument was judged. In clinical practice, however, it is often desirable to make repeated, serial measurements in order to monitor progress and outcomes. Similarly, in public or occupational health surveys, it may be necessary to screen the same population on more than one occasion. In the next Chapter, therefore, consideration is given to the test-retest reliability of the 19 item scale.

4. Test-retest reliability

Introduction

The analyses so far considered have resulted in a 19 item scale showing an acceptable level of internal consistency and concurrent validity. In order to examine the performance of the scale when used as a serial (i.e. repeated) measure, typical in clinical practice, this Chapter considers the test-retest reliability, or temporal stability, of the LOISS in a sample of workers. According to DeVellis pp. 43 (DeVellis, 2003) "the rationale underlying reliability determinations of this type is that if a measure truly reflects some meaningful construct, it should assess that construct comparably on two separate occasions". However, while the analyses reported in the previous Chapter supported the construct validity of 'sleep related occupational impairment', it is reasonable to suggest that such a construct is likely to behave more like a state characteristic (i.e. a characteristic which may be expected to vary over time as sleep quality itself varies) rather than a trait characteristic (i.e. a personally enduring attribute). Recognising this introduces a methodological challenge to the test-retest assessment of any scale, namely the selection of an optimal inter-assessment period. In the present case, the interval between the initial test, and subsequent retest must be sufficient to allow a robust test of reliability, but not sufficient to allow substantial 'natural' variations in sleep quality to influence outcome. For this reason, the time frame used in the LOISS response format (i.e. 4 weeks) was considered too long, and a 2 week follow up period was selected for the present study. This resulted in a 2 week 'overlap' of the (tested and retested) time frames. This overlap was considered a strength of the design, allowing for plausible test-retest reliability assessment, while reducing the possibility of results being excessively influenced by 'natural' variations in sleep quality. Broadly, the analyses addressed 3 inter-related research questions;

i. As judged by global mean values, do LOISS scores show stability over a 2-week period?

ii. as judged by the strength of the correlation coefficient, do LOISS scores at Time 1 (T_1) predict LOISS scores at Time 2 (T_2)?

iii. given that T_1 –T_2 change in LOISS scores would be expected to vary as a function of change in PSQI scores, do LOISS scores at T_1 predict LOISS scores at T_2 after adjusting for the degree of PSQI T_1 –T_2 change?

Method

Approval for the study was obtained from the Loughborough University Ethical Advisory Committee. Opportunity sampling was used to recruit participants. Information about the study was distributed on social networks, public notice boards, and word of mouth. Participants were required to be in paid employment, aged 18-65 and able to give informed consent. Participants responding to advertisements were provided with an information sheet (see Appendix) explaining that the study was focused on relationships between sleep quality and occupational performance, and required them to complete the LOISS, the PSQI, and demographic questions on two occasions, two weeks apart. The survey was mounted on Bristol Online Surveys, a secure online survey hosting website. Participants' e-mail addresses were linked to an individual study number using a mail-merge procedure so they could be emailed a link to the survey. Participants were asked to follow the link, enter their personal study number and complete the survey before midnight the following day (T_1). Two weeks later the same participants were sent the same link and asked to complete the questionnaires again before midnight the following day (T_2).

Participants

A total of 43 participants completed the survey at both time points. The sample included 27 females (62.8%) and 16 males (37.2%); mean age 35.14 ± 13.13 years (median= 28 years, range = 20 – 64 years). The sample was 48.8% "White - British, Irish, or other White background"; 46.5% "Asian or Asian British – Indian, Pakistani, Bangladeshi, other Asian background"; 2.3% "Mixed – White and Black Caribbean, White and Black African, White and Asian, other mixed background"; and 2.3% "Chinese or other ethnic group". Participants worked an average of 39.01 ± 7.99 hours per week (range = 15 – 60 hours). Using ONS occupational categories (Office of National Statistics, 2000), 37.2% of the sample worked in Associate Professional and Technical occupations; 25.6% worked in Professional occupations; 11.6% worked in Administrative and Secretarial occupations; 9.3% worked in Skilled Trade occupations; 7% worked as Managers and Senior Officials; 4.7% worked in Personal Service occupations; and 4.7% worked as Process, Plant and Machine Operatives.

Results

LOISS and sleep quality (PSQI)

Global scores on PSQI and LOISS for each participant were computed using SPSS syntax. The PSQI score range was 1-13 at T_1 (mean 6.16 ±2.77) and 1-14 at T_2 (mean=5.60±2.69). This indicated that 58.1% of participants scored above the cut-point for clinically disturbed sleep at T_1 and 46.5% at T_2 suggesting a relatively high level of sleep disturbance in this opportunity sample. Global LOISS scores at T_1 and T_2 are shown in Table 4.1

Table 4.1. LOISS global scores at Time 1 and Time 2 (n=43)

	T_1	T_2	p
LOISS score range	0-50	0-64	
LOISS mean (SD)	17.21 (12.77)	15.56 (12.61)	NS
Cronbach's alpha for LOISS	0.95	0.94	
Split-half reliability coefficient	0.87	0.84	
PSQI (Mean; SD)	6.16 (2.77)	5.60 (2.69)	0.05

Reliability

Cronbach's alpha was calculated to test the internal consistency of the LOISS scale using the current sample. LOISS at T_1 showed high internal consistency Cronbach's alpha = 0.95, split half reliability = 0.87), and similarly high values for LOISS T_2 alpha= 0.94, split half= 0.84) suggesting satisfactory reliability.

In order to address research questions 1 and 2, T_1 and T_2 scores were first compared using paired t-tests. Product moment correlation coefficients were then computed for the paired (T_1 and T_2) scores. No significant differences t (42) = -1.25, p=0.22 were present for LOISS scores, with T_1 and T_2 values showing a positive and significant correlation (r = 0.77, r^2=0.59, p<0.001, two tailed). PSQI scores at T_1 and T_2 were significantly different (t (42) = 2.01, p = 0.05), see Table 4.1 .

Impact of sleep quality on LOISS T_2 scores

In order to address the third research question, PSQI change scores (T_1 minus T_2) were first computed. A multiple regression model was then used to predict the scores of LOISS T_2 (dependent variable) from LOISS T_1 and PSQI change scores (covariates) using the Enter method. A significant model emerged, as shown in

Table 4.3 (F (2, 40) = 29.00, p<0.001). The model explained 57.1% of the variance (Adjusted R^2 = 0.571). Table 4.2 indicates further that PSQI change score was not a significant independent predictor of LOISS at T_2.

Table 4.2. Unstandardised and Standardised regression coefficients for variables entered into the model.

Variable	B	SE B	β
LOISS T_1	0.76	0.10	0.77*
PSQI change score	-0.33	0.70	-0.05
***p=<0.001**			

Table 4.3 Unstandardised and Standardised regression coefficients for PSQI variables entered into the model.

Variable	B	SE B	β
LOISS T_1	0.87	0.10	0.84**
Sleep Quality change score (PSQI)	0.29	2.31	-0.13
Sleep Latency change score (PSQI)	-2.49	1.74	-0.15
Sleep duration change score (PSQI)	-0.69	3.14	-0.003
Habitual Sleep Efficiency change score (PSQI)	6.07	2.46	0.32*
Sleep Disturbance change score (PSQI)	-5.79	3.06	-0.19
Daytime Dysfunction change score (PSQI)	1.40	2.21	0.67
***p<0.05 **p=<0.001**			

Comment

This Chapter aimed to evaluate the reliability of the LOISS scale by analysing the consistency of LOISS scores at two time points (T_1 and T_2). LOISS scores showed stability over the two week time period, and scores from each time point were highly correlated. Mean scores decreased by 1.56 points on the LOISS from T_1 to

T_2, and the difference was not statistically significant. Although LOISS scores remained stable over time, PSQI scores indicated a significant (although modest) improvement in sleep quality ($p<0.05$), potentially suggesting that sleep related occupational impairment is a more stable construct than self-reported sleep quality.

5. Population survey

Introduction

The previous Chapters have described the need for, and the development of, a metric specifically designed to quantify the occupational impact of disturbed sleep. To this end, the data so far analysed have been derived from convenience samples, and used mainly to inform the development of the 19 item scale. In order to assess the utility of the scale in describing populations, and to examine its performance in a more representative epidemiological sample, the present study was designed to recruit and assess the sleep-related occupational performance of randomly selected members of the public. The present Chapter describes the epidemiological and methodological background, the sampling procedure, and the results from the first population survey designed to use the 19 item LOISS. Within the context of the present research programme, this study had 2 research aims:

i. To assess the psychometric performance of the 19 item LOISS scale in a representative sample of adult workers; and

ii. To assess normative levels of sleep-related occupational impairment in a representative sample of adult British workers.

Background

It has been estimated that approximately 6-10% of the adult population meets DSM-IV diagnostic criteria for insomnia (Morgan, 2012; Ohayon, 2002). Ohayon (2002) further estimates that the prevalence of "insomnia symptoms" is much higher, with around a third of the population experiencing at least one of the symptoms which contribute to a DSM-IV diagnosis (i.e. problems initiating sleep,

maintaining sleep, early morning awakening, or unrefreshing sleep). Similar prevalence rates were identified in a UK survey of 8,800 adults in 2000, where sleep problems were the highest reported "psychological symptom", experienced by 29% of respondents (Singleton, Bumpstead, O'Brien, & Meltzer, 2000). However, and despite the growing interest in quantifying the prevalence of sleep complaints, population surveys of insomnia rarely report the impact of sleep quality on daytime or occupational performance. Some indication of occupational impact is nevertheless provided by national surveys. The UK General Household Survey (Groeger et al., 2004) , for example, interviewed 1,997 UK adults and found that those reporting insufficient sleep on a majority of nights over the previous week had significantly less energy for; and less satisfaction and success from work, home and leisure than those reporting sufficient sleep the majority or all of the nights in the past week. The inclusion of home and leisure in this response format makes it impossible to partial out the independent effect of poor sleep on work, but the results suggest that sleep could have a "dose response" impact on perceived work performance.

Considered in terms of overall workforce efficiency, this finding appears particularly relevant in the light of recent evidence suggesting that the UK has a high prevalence of insomnia symptoms when compared with other countries. An international survey of over 10,000 individuals in the USA, Western Europe and Japan found that 36% (95% CI: 33-39%) of the UK population sample reported sleeping problems (excluding sleep apnoea and restless legs syndrome) in the previous year (Leger, Poursain, Neubauer, & Uchiyama, 2008). This was the second highest prevalence rate of all surveyed countries, 13% higher than in Japan and Spain and 20% less than in the United States (see Figure 5-1).

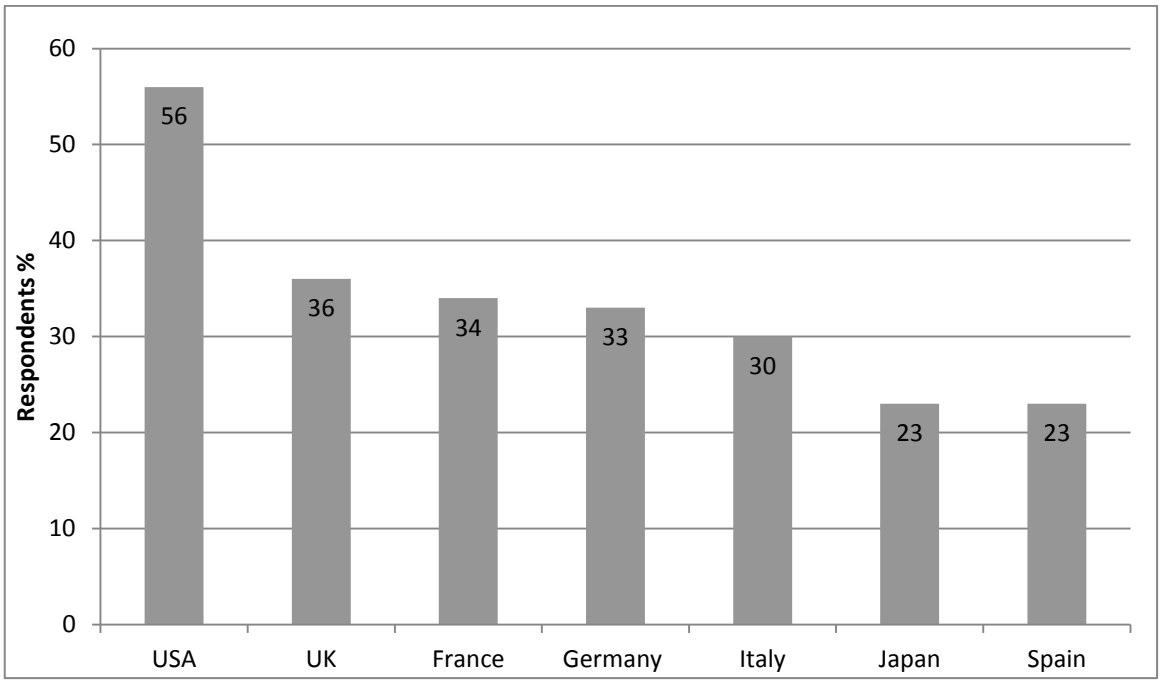

Figure 5-1 Prevalence of self-reported sleep problems in an international sample. Adapted from (Leger et al., 2008) .

Daytime functioning was also investigated in this survey, with participants asked *"Would you say that your sleep problems impact your professional activities?* and found a positive response of 60% in Japan, 51% in the USA and 42% in Western Europe, although no UK data was individually reported. It remains the case that, to date, no published UK study has assessed sleep related occupational impairment in an employed population sample.

Method

Ethical approval for this study was obtained from the Loughborough University Ethical Advisory Committee. In order to generate a sample of UK workers distributed across occupational types and demographic groups, the study used the

'postal screening' approach suggested by Cartwright, (1987). First, having identified Nottingham City as the target area for the survey, an electronic version of the Nottingham City Electoral Role (listing the names and addresses of 110,137 adults) was obtained from Nottingham City Council. These names were entered into an SPSS data file, and a random 4% sample selected. Letters were then sent to all the selected names asking for a freepost card (included in the letter) to be completed and returned if there was an employed person willing to participate in the survey resident at that address.

Those returning cards were assigned a participant number to ensure confidentiality and then sent an information sheet by post detailing the study (see Appendix). Eligible participants (adults in paid employment) who gave informed consent were then offered two possible ways to complete the survey. Participants were either given a web address to complete the survey online (www.surveymonkey.com) or alternatively, they were provided with a hardcopy questionnaire booklet and a freepost return envelope. Sent dates were recorded on a Microsoft Excel spreadsheet. Individuals who had been posted a survey but not responded within two weeks were sent a reminder letter with a further copy of the questionnaire. The online and booklet versions of the survey questionnaire were otherwise identical, and comprised general items including age, ethnicity, gender, height and weight (to calculate Body Mass Index), job title and business, industry, number of hours worked per week, employee or self-employed, typical work schedule (i.e. whether they worked during the daytime, shift work during the day only or shift work that included night work), and consumption of arousal altering substances (i.e. stimulants and over the counter sleep aids). The questionnaire also included the following formal assessments:

i. *Sleep related occupational impairment*, using the Loughborough Occupational Impact of Sleep Scale (LOISS; Kucharczyk, Morgan, David, & Hall, 2011) .

ii. *Sleep Quality*, using the Pittsburgh Sleep Quality Index (PSQI; Buysse et.al 1989).

iii. *Daytime sleepiness*. The Epworth Sleepiness Scale (ESS) assessed the daytime sleepiness of respondents (Johns, 1991). This data was used to identify those at risk of Obstructive Sleep Apnoea as well as in correlations with sleep-related occupational impairment.

iv. *Health related quality of life.* The EQ5D (Kind, 1996) EuroQol Group, 1990) was included to capture co-morbid health issues such as anxiety, depression, pain and mobility that may mediate the relationship between sleep quality and occupational performance (Philip et al., 2006). The subjective global health rating included in the EQ5D is usually captured on a visual analogue scale, however this format was not possible for the online survey and so the question was adapted so that respondents rated their health on a scale of 1-10 instead. This data allowed for correlations between health and sleep related occupational impairment and also to see whether health mediated the relationship between sleep variables and sleep related occupational impairment.

All participants were offered an incentive of entry into a prize draw to win shopping vouchers (Lovetoshop.com) if they returned the survey before a cut off date 2 weeks after receiving the survey. Prizes were vouchers worth £50 (x1), £20 (x2) or £10 (x1).

Sample size

Sample size estimations for the present survey were based on two factors. The first was a modification of the earlier assumption concerning the ability of the LOISS scale to discriminate significantly between PSQI-defined good and poor sleepers. Analyses reported in Chapter 3 show that the 19-item LOISS scale showed a significant (mean= 12.32) difference between good and poor sleepers (defined as those with a PSQI score <6 or >5 respectively). Using these outcomes, to detect a difference of at least 12.00 scale points, assuming an overall SD of 13.74 (see Table 3.3, Chapter 3), a 5% significance (alpha) level, and 80% power, would require 22 subjects per group (i.e. 22 good sleepers and 22 poor sleepers). However, since this difference would be tested within sub-groups of males and females, then, assuming approximately equal numbers within the gender groupings, the study would require 4 x 22 participants (n = 88). Again, to allow for variation in the actual parameters, attrition and missing data, a sample size target of 120 was aimed for in the present survey. This target would also accommodate the second factor, the sample size needs of the reliability analyses. Using Monte Carlo procedures to model outcomes, Yurdugül (2008) has shown that, where the eigenvalue of the first principal component of a scale exceeds 10, minimum sample sizes of 30 will deliver unbiased estimates of coefficient alpha (while eigenvalues of 3-6 require n-sizes approaching 100). In the principal components analysis reported for the 19-item LOISS (Chapter 3) the eigenvalue of the first component was 10.97.

Analysis

In order to address the principal research aims, analyses were divided into two parts. In the first part, internal consistency of LOISS scores were assessed using Cronbach's alpha statistic and split-half correlation coefficients. Assessments of concurrent validity were conducted by computing correlation coefficients between

the LOISS scores, global and component PSQI scores, and ESS scores, and by examining the health and wellbeing of those scoring above and below the mean LOISS score. In the second part, descriptive statistics for LOISS scores were considered for the sample as a whole, for men and women separately, and for selected clinical and occupational sub-groups. Differences in sub-group means were tested using ANOVA or appropriate t-tests, with alpha set at the 0.05 level. All analyses were conducted in SPSS v17.

Results

Of the 4500 individuals who requested initial information about the study, 185 individuals completed questionnaires. 31 completed questionnaires were excluded because respondents indicated that they were retired (n=6), unemployed (n=20), under 18 or over 65 years old (n=4) or unable to work due to disability (n=1). The final sample included in analyses was therefore 156 (total N sizes may vary due to missing data on some variables). Basic demographic information for the sample is presented in Table 5.1. The sample was 88% White British, 59.5% Female, with 70 % working daytime (9-5) hours. The mean age of respondents was 40.38, ± 12.64 ranging between 19 and 65 years.

Table 5.1. Demographic Characteristics of Sample

Variable	Total	Male	Female	p*
Sample size: n (%)	154 (100)	62 (40.5)	89 (59.5)	
Age of sample: mean ±(SD)	40.38, ± 12.64	40.85 ± 13.11	40.0 ± 12.38	NS
Shift Pattern: n (%)				NS
Daytime only:	108 (70%)	43 (69.4%)	63 (69.2%)	
Shifts (days only): n (%)	23 (15%)	11 (17.7%)	12 (13.2%)	
Shifts (with nights): n (%)	23 (15%)	7 (11.3%)	16 (17.6%)	
Hours worked weekly: n (%)				p= 0.02
<20	18 (11.7%)	5 (8.1%	13 (14.3%)	
21-35	39 (25.3%)	10 (16.1%)	29 (31.9%)	
>35	97 (63 %)	47 (75.8%)	49 (53.8%)	
Job type: n (%)				NS
High skill	11 (7.9 %)	5 (8.1%)	6 (7.1%)	
Medium skilled	49 (31.8%)	13 (21%)	36 (39.6%)	
Low skill	79(51.3%)	37 (59.7%)	42 (46.2%)	
Age Groupings: n (%)				NS
18-24	17 (11%)	9 (14.5%)	8 (8.8%)	
25-34	40 (25.5%)	13 (21%)	26 (28.6%)	
35-44	38 (24.8%)	16 (25.8%)	22 (24.2%)	
45-54	34 (22.2%	13 (21%)	21 (23.1%)	
55-65	25 (16.3%)	11 (17.7%)	14 (15.4%)	
Sleep Quality : n (%)				NS
PSQI >5	82 (53.2%)	26 (41.9%)	46 (50.5%)	
PSQI≤5	72 (46.8%	36 (58.1%)	45 (49.5%)	
***Daytime sleepiness* : n (%)**				NS
ESS>10	29 (19 %)	55 (88.7%)	22 (24.2%)	
ESS≤10	124 (81 %)	7 (11.3%)	68 (74.7%	
Estimated Total Sleep Time, hours in past month: mean, ±SD (range)	6.64 ± 1.17 (2-10)	6.45 ± 1.21 (2-9)	6.76 ± 1.20 (3-10)	NS

NB. Total Ns vary due to missing data.
Significance results refer to Chi-squared comparisons for categorical group comparisons. Independent T- tests were used for Mean, SD comparisons.

Reliability and concurrent validity of LOISS

Descriptive scores for the LOISS, PSQI, ESS and EQ5D are shown in Table 5.2. Analyses of the 19 item LOISS scale showed activity across the score range (minimum score = 0; maximum score = 62) a satisfactory degree of reliability (Cronbach's alpha = 0.95; Spearman-Brown random split half correlation: r= 0.94), and a modest, though significant degree of shared variance with PSQI scores (r = 0.31; p<0.001) and ESS scores (r = 0.54; p<0.001). The sample had a mean Global PSQI score of 6.42 ± 3.21, with 53.2 % of participants reporting scores >5, consistent with clinically impaired sleep (see Table 5.1). LOISS scores showed effective discrimination between those above (mean LOISS= 22.12 ± 16.61) and below (11.47 ± 11.46) this PSQI cut point t (41.05) = -4.10; p<0.001.

Table 5.2. Health and sleep profiles of 156 randomly selected adult workers aged 19-65

Variable	Total	Male	Female	Significance
LOISS: mean (SD)	13.64 (13.05)	11.66 (11.81)	14.91 (13.78)	NS
PSQI: mean (SD)	6.42 (3.21)	6.63 (3.41)	6.31 (3.09)	NS
ESS: mean (SD)	6.66 (4.22)	5.73 (3.88)	7.26 (4.35)	p=0.03
EQ5D: mean (SD)	0.88 (0.21)	0.88 (0.25)	0.88 (0.17)	NS
Subjective Health Rating: mean (SD)	7.64 (1.58)	7.69 (1.47)	7.62 (1.67)	NS

NB* Correlation is significant at the 0.05 level. **. Correlation is significant at the 0.01 level. *. Correlation is significant at the 0.001 level. NS. Correlation is not statistically significant.**

Correlations between total LOISS scores and PSQI component scores (see Table 5.3) indicated that occupational impairment was most highly correlated with reported daytime dysfunction (r=0.62, p<0.001) and subjective sleep quality (r=0.46, p<0.001), although sleep duration and sleep efficiency were not significantly correlated with LOISS.

Table 5.3. Pearson product-moment correlations between global LOISS scores and component scores of PSQI.

PSQI component	Correlation Coefficient	p
Sleep quality	0.46	***
Sleep latency	0.18	*
Sleep duration	0.09	**NS**
Habitual sleep efficiency	0.15	**NS**
Sleep disturbance	0.27	**
Use of sleeping medication	0.27	**
Daytime dysfunction	0.62	***
NB* Correlation is significant at the 0.05 level. **. Correlation is significant at the 0.01 level. *. Correlation is significant at the 0.001 level. NS. Correlation is not statistically significant.**		

LOISS and health

Global LOISS scores were related to significantly higher ratings of health related limitation on the EQ5D along with a significant decrease in with subjective ratings of overall health (see Table 5.4).

Table 5.4. Pearson product-moment correlations between global LOISS scores and component/global scores on EQ5D and overall health rating.

Variable	Correlation Coefficient	p
Anxiety	**0.36**	**
Pain	**0.31**	**
Activity limitation	**0.39**	**
Self care limitation	**0.31**	**
Mobility limitation	**0.25**	**
EQ5D global score	**-0.41**	**
Global health rating	**-0.32**	**
NB. Correlation is significant at the 0.01 level.**		

Sub-group differences

Gender and age

For the estimation of population and sub-group norms, LOISS scores were calculated for the whole sample, for men and women separately, for the age bands 18-24, 25-34, 35-44, 45-54 and 55-65, and for sub-groups defined by PSQI scores above and below the cutpoint of 5 (above this threshold scores are consistent with 'clinically significant sleep disorder'), see Table 5.5. Overall, there were no significant gender effects on LOISS scores, although women reported slightly higher scores than males (Males: mean 12.02 ± 12.40, Females: mean 15.22 ± 14.25; $t(150)=-1.44$; $p=0.15$). Additionally, paired comparisons showed no gender differences in LOISS scores by PSQI-defined sleep status sub-groups. However, sleep related occupational impairment showed a marked and significant age gradient, with LOISS scores increasing steadily from the oldest age group to the youngest ($F(4,147)= 2.70$; $p <0.05$). Interestingly, total sleep time scores showed a reverse gradient, with sleep duration decreasing as age increased ($F(4, 146)=3.02$; $p<0.05$).

Table 5.5. LOISS scores and Total Sleep Time (TST) by age group

Age grouping	n	Mean LOISS (SD)	Mean TST ;minutes(SD)
18-24	17	18.76 (13.34)	432.35 (68.79)
25-34	39	16.82 (12.04)	416.92 (53.66)
35-44	38	13.11 (13.73)	389.21 (80.06)
45-54	33	11.94 (13.65)	375.00 (61.01)
55-65	25	7.92 (10.69)	390.00 (78.86)
Total	151	13.64 (13.05)	389.15 (70.16)

Similarly, PSQI scores also increased as age increased but this result was not statistically significant. The finding that sleep quality and quantity relate differently to age than sleep related occupational impairment may help to explain the relatively low (10%) shared variance between LOISS and PSQI reported earlier. These findings support results from the test-retest analysis in Chapter 4, which indicated that LOISS is not simply a proxy measure for sleep quality or quantity.

Table 5.6. LOISS scores by gender, age and sleep quality

	LOISS Scores (Mean ± SD)		
Grouping	All Participants (n=153)	Good Sleepers n=71 (PSQI ≤5)	Poor Sleepers n= 82 (PSQI >5)
All Participants	13.91 ± 13.56	9.27 ± 11.06	17.87± 14.30
Males	12.02 ± 12.39	6.5 ± 7.28	16.00 ± 13.82
Females	15.22 ± 14.24	10.91 ± 12.58	19.35 ± 14.64
18-24	19.24 ± 13.80	15.33 ± 16.13	23.62 ± 9.78
25-34	17.33 ± 12.55	8.85 ± 9.39	21.58 ± 11.86
35-44	13.39 ± 14.28	11.50 ± 11.92	15.10 ± 16.23
45-54	12.18 ± 14.23	7.79 ± 5.83	16.16 ± 17.21
55-65	8.04 ± 10.88	5.88 ± 10.06	11.89 ± 10.48

Sleep symptomology and LOISS

As reported, LOISS scores were positively correlated with daytime sleepiness (indicated by ESS scores); and were significantly higher in participants reporting clinically significant levels of excessive daytime sleepiness (26.71± 15.68) than those who did not (11.01 ± 11.22); $t(33.64) = -5.15$; $p<0.001$. Participants were identified as being at possible risk of obstructive sleep apnoea if they reported a score of >11 on the ESS (indicating clinically significant hypersomnia) and a BMI score of >25 (indicating obesity). Overall, 25 individuals (16%) met both criteria. Sleep related occupational impairment was significantly higher (LOISS mean

23.36±15.66 in this group than in those not at risk (LOISS mean 8.70±10.12) t(31.91) =-4.94, p<0.001).

To explore relationships between sleep disorder symptoms and occupational impairment, a further variable was calculated which split respondents into three groups based on symptom category;

i. Group 1. Good sleepers; PSQI (≥5) and ESS (<11) (n=127)

ii. Group 2. Insomnia symptoms without EDS; PSQ>5 and ESS <11 (n=8)

iii. Group 3. Poor sleepers with EDS; PSQI>5 and ESS >11 (n=20)

One-way ANOVA indicated a significant overall effect of symptom group on LOISS score F (2,149) =18.32, p<0.001 with good sleepers reporting significantly lower occupational impairment (LOISS mean= 8.84 ±10.41) than those with insomnia symptoms but no EDS (LOISS mean: 14.79±12.12, p<0.05), and poor sleepers with EDS (LOISS mean: 25.96 ± 16.44, p<0.001). Those with EDS reported significantly higher LOISS scores (26.71 ± 15.68) than those without (11.01 ± 11.22); t(33.51)= -5.02; p<0.001) suggesting that sleep occupational impairment relates differently to sleepiness and insomnia-related fatigue.

Job type and work hours

One way ANOVA indicated no significant group effect on LOISS scores for those working night shifts, regular daytime hours and variable daytime shifts (F(2,149)=1.95; p=0.15). There were no significant differences in sleep related occupational impairment for good and poor sleepers employed in blue and white collar professions (t (150)=1.59; p=0.11). Daytime sleepiness was higher in blue collar workers (mean ESS= 7.30 ± 3.98) compared to white collar (6.08 ± 4.37) with trend significance t (151)=1.78, p = 0.07) and there was no significant difference in PSQI scores between blue and white collar workers t (151)=1.49,

p=0.14). Respondents worked between 7 and 60 hours per week (mean 35.75 ±.84). LOISS scores were not correlated with number of work hours per week.

Use of arousal-altering substances

58% of all respondents utilising stimulant substances to "reduce feelings of sleepiness" in the past month (e.g. coffee, energy drinks, caffeine tablets), while 39% had utilised depressants substances "to help them sleep" (including alcohol, pharmaceuticals, herbal remedies and warm drinks e.g. Horlicks before bedtime). LOISS scores were significantly higher in i) those reporting using any kind of stimulant to counterbalance sleepiness in the past month (mean LOISS= 17.40 ± 14.40) than those who did not (mean LOISS=8.41 ± 8.55); ($t(146.34) = -4.82$, $p<0.01$; and ii) those reporting using any kind of depressant to aid sleepiness at bed time (mean LOISS 17.84 ± 15.48) compared to those who did not (mean LOISS 10.86 ±10.32), $t(93.87) = -3.01$, $p<0.01$.

10% of respondents reported consumption of medicines in the previous 4 weeks to help them sleep (6% female; 4% male). Those who reported using stimulants to counteract daytime sleepiness reported significantly higher levels of daytime sleepiness and poorer sleep quality than those who did not (mean ESS = 7.37 ±4.4 vs. mean ESS 5.68±3.80, $t(152) =-2.51$, $p<0.01$; and mean PSQI=7.19 ±3.48 vs. PSQI 5.37±2.37, t (152=-3.80, $p<0.001$). Those who used depressant substances as sleep aids reported significantly poorer sleep quality (PSQI) than those who did not (mean PSQI 7.23 ±3.63 vs. 5.94 ±2.86, $p<0.05$) but there was no significant difference in ESS scores between depressant users and non users.

Comment

This Chapter reported demographics, sleep and occupational data in an uncontrolled population sample. The LOISS showed good reliability and internal consistency, with similar outcomes to the pilot data collected in Chapters 3 and 4. Global LOISS scores indicated that sleep related occupational impairment is

related to poor sleep quality and daytime dysfunction in a sample of employed adults. Interestingly, global LOISS was not correlated with sleep duration and sleep efficiency, suggesting that sleep related occupational impairment may be more closely related to dissatisfaction with sleep quality and perceived resulting consequences than sleep quantity.

LOISS scores did not differ in participants in terms of work hours, shift pattern and white/blue collar workers, increasing the usability of the scale as a universal screening and outcome measure and supporting the decision made to remove role-specific scale items (e.g. using a computer) in Chapter 3.

LOISS scores were sensitive to specific sleep outcomes, correlating with the daytime dysfunction and subjective sleep quality components of the PSQI. When categorised into specific sleep-symptom groups, participants reporting daytime sleepiness (ESS>10) had higher LOISS scores than those with insomnia-type symptoms (PSQI>5; ESS≤10). This indicates that LOISS scores relate differently to sleepiness compared with the fatigue reported by people with insomnia. Both of these clinical sub groups reported significantly higher LOISS scores than good sleepers.

The relationship between sleep related occupational impairment and behaviours associated with disordered sleep was supported by data on the use of stimulant and depressant aids to encourage sleep or counteract sleepiness. ESS, PSQI and LOISS scores were all higher in those using any of these substances in the past month indicating that i) arousal altering substances were used frequently in the sample to counteract sleepiness/sleeplessness; ii) use of arousal altering substances were ineffective at counteracting sleepiness/ sleeplessness in the sample as both sleepiness and poor sleep quality were reported more highly in users than non users; and iii) LOISS is sensitive to the use of sleep aids as a proxy measure for sleepiness/sleeplessness.

There were no gender differences in levels of sleep related occupational impairment. In the overall sample, LOISS scores decreased with age indicating reduced sleep-related occupational impairment among older workers.

Interestingly, although total sleep time and sleep quality (PSQI) decreased with age, as seen previously in the literature (Buysse et al., 1989; Morgan & Closs, 1999), sleep related occupational impairment decreased with increasing age. This finding will be discussed further in the discussion in Chapter 8. A potential limitation of this study was the low response rate. The electoral register does not include information about employment status, meaning that the random sample would have included those in Nottingham who were retired (11.7%; Census 2001: ONS, 2003), full time students (4.3%; Census 2001: ONS; 2003) and on income support benefits (19.3%; Claimant count July 2010: ONS, 2010). This potentially excludes 35.3% of the sample who were sent initial letters (an estimated 1587 individuals). This calculation results in a conservative 6.4% response rate. The low response rate may be attributable to a number of factors. Firstly, only the edited electoral register is available for purchase by third parties so the sampling frame only includes those who have opted to have their details on the open register. Secondly, letters were sent to named participants and it is possible that people had moved house without the register being updated. Nevertheless, the final sample size was adequate to deliver statistical power and delivered LOISS data consistent with that collected for pilot analyses in earlier Chapters.

On average, respondents slept under 7 hours per night and reported a mean score above the clinical cut point for poor sleep (>5) on the PSQI which may reflect sampling bias in respondents to the survey. To provide norms from a non-biased sample of workers, the following Chapter (Chapter 6) will describe the application of LOISS in a cross-sectional analysis of >1000 adults from workforces in the UK. To expand upon results indicating a relationship between LOISS and daytime sleepiness, Chapter 7 will describe the application of LOISS in a clinical sample of patients with newly diagnosed Obstructive Sleep Apnoea (characterized by excessive daytime sleepiness).

In conclusion, this Chapter has successfully utilised LOISS to provide sleep related occupational impairment norms in a random sample of working adults. LOISS outcomes corresponded with scores from pilot data in earlier Chapters,

demonstrated ability to distinguish between good and poor sleepers and provided meaningful descriptive data from a random population sample.

6. Workforce survey

Introduction

This Chapter describes a survey of the UK workforce which draws together, and develops, four separate themes from the work already presented in this thesis. First, as discussed in Chapter 1, both DSM-IV and ICSD-2 place diagnostic emphasis on relationships between sleep quality and workplace performance. Second, as concluded both from the introductory review and the research described in Chapters 2 and 3, the traditional emphasis on easily quantified variables such as frequency of workplace injuries, absenteeism or job satisfaction (e.g. Kling et al., 2010; Leger et al., 2006) inadequately captures the complex relationship between sleep quality and occupational performance. Third, as argued in Chapter 2, despite their evident utility in occupational health assessments, scales designed to capture work-related aspects of health and wellbeing cannot easily be adapted to focus on sleep-related aspects of workplace dysfunction. Two such scales, the Work Limitations Questionnaire (WLQ; Lerner et al., 2001) and the Work Ability Index (WAI; Tuomi & Oja, 1998) are among the most used scales in occupational health, but neither directly addresses the construct of sleep disorder. How such scales perform in relation to the newly designed LOISS is not known. And fourth, the complexity of the relationship between sleep quality and occupational performance is clearly illustrated by age-specific results reported in Chapter 5, which showed that, while sleep quality tends to decrease with increasing age, sleep related occupational impairment (as measured by LOISS) appears to be lowest among older workers. This latter finding has particular significance in relation to the changing age structure of the working population.

Demographic changes, together with changes in pension policy, life expectancy and employment practices, are now reflected in the increasing age of the working population. In the UK, as elsewhere in Europe, there are now twice as many

workers aged 50 and over than those aged 25 years or younger (Ilmarinen, 2001). The increasing age of the workforce presents new challenges for government, employers, and occupational health services. An improved understanding of the levels and correlates of sleep-related occupational impairment could, therefore, make a significant contribution not only to occupational health per se, but also to our understanding of workforce quality of life in the context of an ageing population. To date, however, no studies have used a metric specifically designed to capture sleep related occupational performance, such as LOISS, in a large UK workforce sample which spans the adult age ranges. The present Chapter describes a research collaboration, and secondary analyses, designed to both meet this need and further develop the utility and psychometric profile of the LOISS instrument.

Research Objectives

Through collaboration with the ESRC funded "Working Late" programme (see below), the present analyses resulted from a cross-sectional survey originally designed to assess age-related health and wellbeing within a representative sample of the UK workforce. Integrating LOISS into the "Working Late" survey protocol provided an opportunity to characterise sleep-related occupational impairment in this sample. The specific research objectives were:

i. To describe, using total LOISS scores, sleep-related occupational impairment in relation to age, gender, and occupational variables (in particular, employment status and industry) in a representative sample of the UK workforce;

ii. To evaluate LOISS in relation to absenteeism, the most frequently assessed measure of occupational performance in sleep research; and

To assess relationships between LOISS scores and the Work Ability Index (WAI; Tuomi & Oja, 1998).

Method

Working Late : Strategies to Enhance Productive and Healthy Environments for the Older Workforce is a collaborative research project funded by the New Dynamics of Ageing programme supported by 5 UK Research Councils (ESRC, EPSRC, BBSRC, MRC and AHRC). The programme is divided into a number of inter-linked research activities ("Work Packages"), with Work Package 3.2 focusing on the evaluation of workplace exercise interventions, with outcomes including physical activity, body weight, body composition, general health, job satisfaction and mental well being. Following negotiations with the Working Late Principal Investigator (Professor Cheryl Haslam), it was agreed that LOISS would be included among the workplace assessments in this work package. The data reported here were collected as part of the baseline assessment of employees participating in the Work Package 3.2 lifestyle intervention across 10 organisational sites in the UK.

Organisations, many of which had previously participated in research projects, were drawn from a range of industries within England and Scotland. Since these organisations effectively self-selected (i.e. responded positively to an invitation to participate), they may be regarded as a convenience sample. Recruitment for employee participation began in July 2010, lasted until November 2010, and was open to any employee (aged 18+) of the 10 organisations involved. All employees in the participating organisations were sent an email from a nominated contact at their place of work inviting them to take part in the project. Participants were offered a health screen and feedback on their health outcomes. Those who agreed and provided informed consent were then asked to complete a paper survey. Participants then entered 1-year workplace physical activity intervention initiative

with follow-up assessments at 6 months and 1 year. All data reported here were collected at the baseline (pre-intervention) phase, and are therefore equivalent to the outcomes from a cross sectional survey.

Baseline Assessments

The baseline questionnaire was designed to cover the key areas addressed by the study research questions, and took approximately 20-30 minutes to complete. Specifically, the questionnaire addressed the following domains:

Demographic information

Participants reported age, gender, ethnicity, marital status and highest educational attainment.

General occupational information

Participants reported job title, employer information, company and role tenure, contracted hours per week, contract type and income;

Occupational impact of sleep quality

Sleep related occupational impairment was assessed using the 19 item LOISS (Kucharczyk et al., 2011) . Possible outcomes range from 0 to 76 with higher scores indicating higher levels of occupational impairment;

Sleep and activity

Total sleep time was evaluated using an amended version of the Domain-Specific Sitting Scale (Marshall, Miller, Burton, & Brown, 2010). The scale asks respondents to estimate how much time they spend sitting in 5 scenarios on a typical workday

or non-workday e.g. watching television, travelling. For this research an additional question was added asking respondents to estimate the time spent sleeping in hours and minutes on a typical workday and a typical non workday.

Work ability and health

The Work Ability Index (WAI; Tuomi & Oja, 1998) was used to capture perceived work ability in relation to overall health status. Work ability is conceptualised as an individual's perceived capability to manage their work demands and perform all of their work duties. The scale asks respondents to rate their ability at work in relation to the physical and mental demands of their job, and their work ability now compared with lifetime best in addition to collecting data on absenteeism and health conditions. Respondents were asked to report their number of current diagnosed health problems from a list including mental and physical conditions. The WAI provides a global score which can be categorised into 4 current work ability categories. The WAI provides a global score which can be categorised into 4 current work ability categories (response format; Excellent/Good/Moderate/Poor).

Data analysis

Questionnaire data were entered into IBM SPSS Statistics Data Editor 19 file for analysis. All data are reported as mean ± standard deviation unless otherwise stated. Statistical significance was set at $p<0.05$. SPSS Syntax was used to calculate global scores for surveys. Multivariate analyses were conducted using appropriate general linear models. Effect sizes were estimated using the eta squared (η^2) or r statistic and summarised as small medium or large effect sizes according to Cohen's *d* and suggested conversion guidelines (Cohen, 1988; Cohen, 1992). To assess the internal consistency reliability of LOISS, Cronbach's alpha and split-half coefficients were estimated using reliability procedures in SPSS.

Results

A total of 1111 individuals completed the baseline survey questionnaire. Missing data points were automatically deleted pairwise by SPSS so n scores may vary over the course of discussion depending on which variable are being analysed.

Overall characteristics of participants are shown in Table 6.1. A total of 1054 participants aged 18-65 (567 men, mean age = 42 years; 483 women, mean age 41.7 years) completed the LOISS in full. Since less than 5% of respondents had missing data points on LOISS, no missing data values were imputed. Mean LOISS scores overall were 12.2 ± 10.9; range 0-61, with 20% of all respondents scoring in the highest two thirds of the LOISS range (21-61). Respondents had been employed by their current organisation for an average of 179.4 months ± 135.0 (approximately 15 years) although this ranged from 1 month to 45 years. Role tenure was considerably shorter, with a mean of 4.3 years (52.81 months, ± 56.04). Occupational categories were grouped based on standard occupational classifications (Office of National Statistics, 2000). As cell sizes for some of the occupational categories were very low, occupational types were collapsed into three categories: professional occupations; intermediate occupations and lower skilled occupations (Table 6.1).

The alpha reliability for the 19 item LOISS was 0.94, with a split-half reliability coefficient of 0.93.

Table 6.1. Sample characteristics

Variable	Total	Male	Female	p
Sample size: n (%)	1111	594	500	
Age of sample: mean (SD)	41.95 (10.41)	42.24 (10.44)	41.66 (10.30)	NS
Contract type: n (%)				***
Full time permanent:	949 (86.6%)	553 (93.6%)	396 (78.4%)	
Part time permanent	120(10.9%)	19 (3.2%)	95 (18.8%)	
Temporary role	27 (2.5%)	19 3.2%)	6 (1.2%)	
Workday sleep, minutes: mean (SD)	428.20 (55.03)	425.12(54.20)	431.69(55.94)	*
Non workday sleep, minutes: mean (SD)	470.95 (66.18)	467.45 (64.52)	475.18(68.14)	NS
Job type: n (%)				***
High skill	501 (45.3%)	336 (56.4%)	165(32.4%)	
Medium skilled	222 (20%)	123 (20.6%)	99 (19.4%)	
Low skill	383 (34.7%)	137 (23%)	246(48.2%)	
Age Groupings: n (%)				NS
18-24	64 (6.0%)	32	32	
25-34	224 (20.4%)	97	127	
35-44	284 (25.9%)	137	147	
45-54	406 (37.1%)	189	217	
55-65	116 (10.6%)	45	71	
NB. Total Ns may vary due to missing data. Significance results refer to Chi-squared comparisons for categorical group comparisons. Independent T- tests were used for Mean, SD comparisons. *=p<0.05, ***=p<0.001. NS= not statistically significant.				

Age, sleep duration and occupational impairment

While reported sleep durations for work days showed no significant age effects, sleep durations for non-work days showed a significant age gradient, declining by

62 minutes from the age group 18-24 (mean estimated TST=516.3 minutes ± 69.4) to the age group 54-65 (mean estimated TST= 453.68 minutes ± =56.7; main effect $F(1,4)=17.93$, $p<0.001$). However, despite the evidence of an age related decline in sleep quantity, LOISS scores indicated a reduction in sleep-related occupational impairment with increasing age with a small effect size. This trend was mainly due to the male respondents (LOISS scores as age increased: $r= -0.16$, $r^{2=} 0.02$, $p<0.01$) while scores remained stable, and below the overall mean score for female workers in age groups between 25-65 (See Figure 6-1).

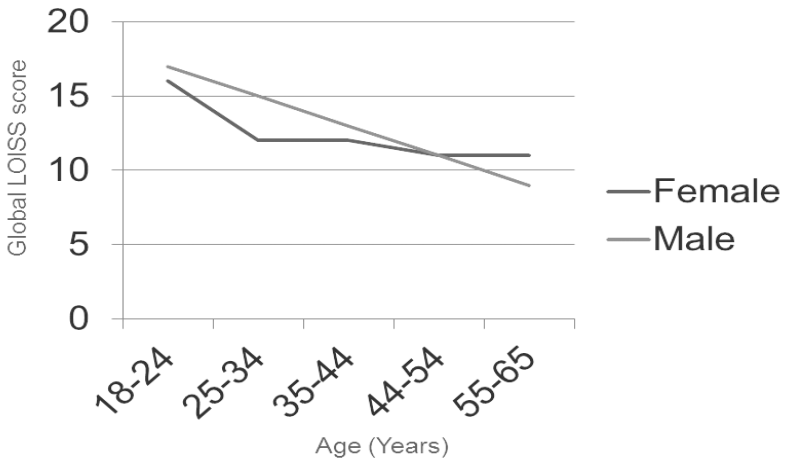

Figure 6-1. Mean Global LOISS scores by age category and gender.

This relationship between increased age and decreased occupational impairment in males remained significant after controlling for workday and non-workday sleep duration, current health conditions, Work Ability Index score and monthly hours worked, again with a small effect size ($r= -0.15$, $r^2 =0.02$, $p<0.001$). There were no significant differences in global LOISS scores between men and women, or between occupational categories.

LOISS and Workability

Global LOISS scores were correlated with global WAI scores, showing a modest though significant shared score variance of 18% (r= -.43, p<0.001). Figure 6-2 shows that mean global LOISS scores were lower as self-reported work ability increased (see Table 6.2 for mean LOISS and SD) with similar trends for males and females reporting moderate to excellent work ability scores. Males with poor work ability scored higher on LOISS (mean= 38.40 ± 6.73) than females (mean 27.0 ± 20.56) with poor work ability although the difference was not significant; t (7)=-1.18, p=0.27. One-way ANOVA found that LOISS scores in the four work ability conditions differed significantly in the sample overall F(3, 965) = 58.61, p<0.001.

Table 6.2. Mean LOISS score by Work Ability Index category

WAI category	LOISS mean (SD)
Excellent	8.66 (8.43)
Good	12.83 (10.07)
Moderate	20.97 (13.69)
Poor	33.33 (14.74)

Planned post-hoc comparisons with Bonferroni adjustment found significantly higher LOISS scores at the p< 0.001 level across all decreasing work ability category interactions apart from moderate – poor comparisons (p=0.002) .

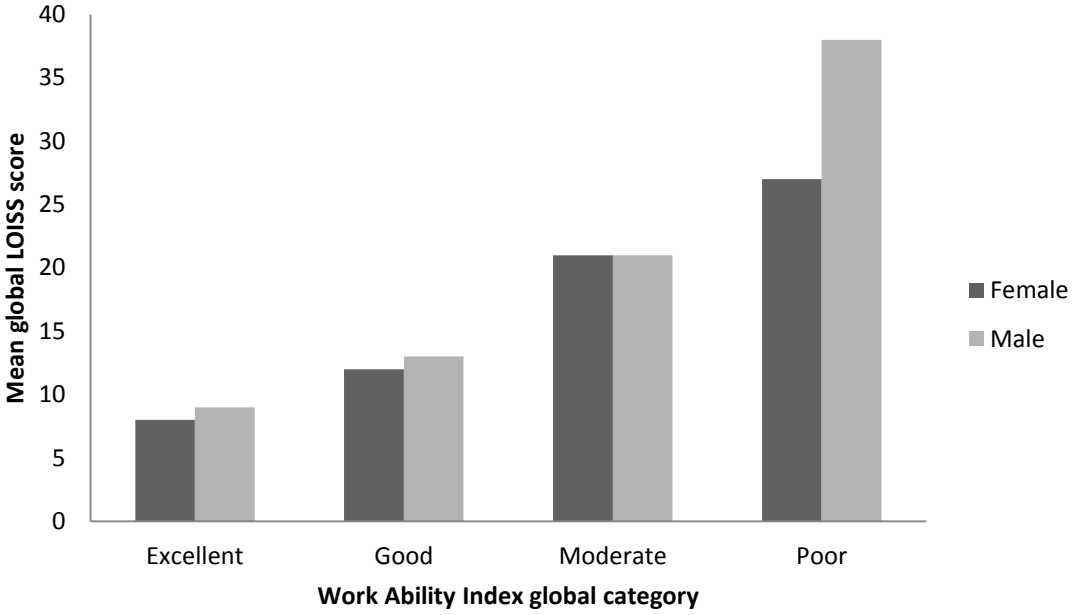

Figure 6-2 Global LOISS scores and Work Ability Index category

Individual LOISS items were correlated against global work ability scores to assess the validity of each item against a validated work impairment scale. Table 6.3 shows that all LOISS items were negatively correlated with WAI, showing a decrease in perceived work ability scores as sleep related occupational impairment increased.

Table 6.3. Pearson product-moment correlation between individual item LOISS scores and mean global WAI score.

LOISS scale item	Mean WAI r
Arrive at work on time	-.21**
Do work without taking unauthorised rests or breaks	-.29**
Concentrate on more than one task at a time	-.34**
Do work carefully	-.36**
Maintain your stamina throughout the day	-.35**
Focus on the more complex task related to your job	-.35**
Speak to people face to face	-.27**
Do your work without making mistakes	-.33**
Finish the work day on time	-.24**
Feel you have done what you are capable of doing	-.31**
Control your irritability at work	-.28**
Gain satisfaction from your work	-.35**
Handle the workload	-.31**
Easily read or use your eyes when working	-.26**
Keep your mind on your work	-.31**
Stay awake at work	-.26**
Learn new tasks or skills	-.33**
Do more than just enough work	-.29**
Work fast enough	-.33**
Global LOISS	**-.43****

** correlation significant at p<0.01 level.

20% of the sample (n=223) reported sleeping less than 6 hours per night. Chi square analysis was carried out to assess relationships between demographic variables of gender, age, occupational category, contract type and self-reported short (<6 hours) or "normal" sleep (≥6 hours).

No significant relationships were found for gender or age. However, 25.2% of lower skilled occupations reported less than 6 hours sleep per night compared to

16.3% for Professionals and 19.4% for intermediate skilled professions. The x^2 value for occupational category and sleep time was 10.76 with an associated probability value of $p<0.01$, DF=2. Cramer's V was identified as 0.98 indicating that nearly 10% of the variation in sleep time was explained by occupational type.

Furthermore, contract type also had a significant relationship with sleep time. 41% of workers on temporary contracts reported sleeping under 6 hours per night compared to 17.5% and 19.8% for full and part time permanently contracted workers respectively. (x^2=7.70, $p<0.05$, DF=2). A Cramer's V statistic of 0.84 indicated that 8% of the variation in sleep hours was explained by job contract.

LOISS and absenteeism

Overall, 54% of the sample reported no whole day sickness absences at all in the previous 12 months. Mean LOISS scores were significantly correlated with days of sick leave in the past 12 months ($r = -.09$ $r^2= 0.01$, $p<0.01$, with a small effect size according to Cohen's d). However, this relationship was not significant when controlling for the presence of a physical or mental health condition.

Confirmatory factor analysis

In Chapter 3 principal components factor analysis was conducted on the 19 item LOISS and the resulting solution identified two principal components accounting for 59.21% (eigenvalue = 10.97) of the variance for the factor labelled "Performance" and 5.31% (eigenvalue = 1.00) variance for the factor labelled "Vitality" (see Table 3.5). To assess the statistical fit of this model, confirmatory factor analysis was conducted with LISREL 8.8 (Jöreskog & Sörbom, 1989). Following guidelines from Howitt & Cramer, (2011), the fit of the model was assessed in terms of Normal Weighted Least Squares Chi-Square, Root Mean Square Error of Approximation (RMSEA), the Non-Normed Fit Index (NNFI) and

the Comparative Fit Index (CFI). The analysis was conducted with both unrelated and related factor models to compare the best fit of each model. Neither model provided a good fit to the data. For both models, Chi Square was significant, RMSEA was greater than .05 and NNFI and CFI were less than 0.95. Exploratory factor analysis was conducted again using identical methodology described in Chapter 3. Principal components extraction followed by Varimax rotation was conducted. Coefficients below 0.40 were excluded from the analysis. This analysis identified a single factor structure for LOISS which accounted for 51.2% of the score variance (eigenvalue=9.73). Subsequently, the two-factor structure of LOISS is rejected and LOISS outcomes can now be classified as a unitary construct.

Comment

The present Chapter described sleep related occupational impairment in a large sample of UK workers. The results supported findings identified in Chapter 6 of a relationship between increased age and decreased sleep-related occupational impairment and this relationship remained significant despite evidence of decreased sleep duration as age increased. This important finding will be further unpacked in the major discussion in Chapter 8. No age or occupational category differences were observed in LOISS scores, supporting findings identified in the earlier analyses of more modest sample sizes. In contrast, there were clear variations in sleep duration across occupational category and contract type which indicates that sleep related occupational impairment is not clearly related to sleep quantity. Construct validity of the LOISS was further supported by comparisons with the Work Ability Index (WAI; Tuomi & Oja, 1998). Although a neat relationship between increasing sleep-related impairment (LOISS) and decreasing overall work ability (WAI) was demonstrated, the two scales shared just 18% of the variance in scores. Subsequently, as Chapters 2-5 have previously established that LOISS is not a proxy measure for sleep quality (PSQI; Buysse et al., 1989) it can now be concluded that LOISS is not a proxy for overall work ability.

A further aim of this Chapter was to evaluate LOISS in relation to absenteeism, the most frequently assessed measure of occupational performance in sleep research. Although mean LOISS scores were correlated with absenteeism in the past 12 months, this was no longer significant when controlling for other mental or physical health conditions. This finding is supported by the literature review reported in Chapter 1 which found little evidence for a relationship between insomnia and absenteeism when controlling for other health conditions, and further demonstrates the need for more comprehensive assessment of occupational impairment in research, rather than a focus on quantifying workplace absenteeism. This being said, it is acknowledged that the absenteeism in this study was a self-reported measure and could be open to response bias. A limitation of this research is the potential response bias of those opting in to a workforce survey. Nevertheless, for the first time in this research programme overall, respondents were not recruited for a survey solely focused on sleep and sleep related occupational performance (as stated, this data was taken from health and well-being survey), and results showed similar patterns to those reported in earlier Chapters. In conclusion, the data reported in this Chapter support the use of LOISS as a tool for providing a cross-sectional analysis of sleep-related occupational impairment in a workforce sample.

7. Clinical validation study

Introduction

In previous Chapters (1-4) the need for and development of a metric to capture the occupational impact of variations in sleep quality have been argued and described. Subsequent Chapters (5 & 6) then focused on the performance of the resulting scale (the LOISS) as a screening and survey tool. However, an implicit assumption in the development of any patient-reported outcome (PRO; Food and Drug Administration, 2006) is that in addition to providing a profile of clinical status in cross-sectional studies, it will also be sensitive to change following an effective intervention. The present Chapter, therefore, considers the use of LOISS as a formal measure of clinical outcome. Since LOISS was designed to capture variations in occupational performance arising from both insomnia and hypersomnia (excessive daytime sleepiness) symptoms, the assessment of patients diagnosed with Obstructive Sleep Apnoea (OSA) before and after continuous positive airway pressure (CPAP) therapy offered a robust test of the scale's sensitivity to change.

Obstructive Sleep Apnoea (OSA) is a disorder characterised by episodes of complete (apnoea) or partial (hypopnoea) upper airway obstruction occurring during sleep. Upper airway narrowing and subsequent OSA are largely caused by excess soft tissue present in the neck area (particularly in obese or overweight individuals). Research has consistently shown that increased body weight increases the risk of OSA (Ong, O'Driscoll, Truby, Naughton, & Hamilton, 2012). It is estimated that 40% of obese men and women have OSA (Young, Peppard, & Gottlieb, 2002) and that obesity is present in 70% of OSA patients (Malhotra &

White, 2002). In non-obese individuals, OSA can also be caused by reduced neck muscle tone, and structural abnormalities (Dempsey et al., 2002; Schwab et al., 1995).

A recent international review estimated that OSA affects 2-4% of adults in the general population (Ohayon, 2011). Collapse of the upper airway causes decreased blood oxygen saturation and results in brief arousals (10-30 seconds on average) from sleep as the individual wakes to gasp for air; oxygen saturation levels return to baseline following resumed breathing, but this cycle of desaturation-reoxygenation can continue many times throughout a sleep period (Young et al., 2002). The long term negative health effects of OSA have been widely documented; periods of hypoxia (low oxygen levels) stimulate the sympathetic nervous system causing an increase in heart rate and blood pressure which in turn increases the risk of cardiovascular disorders (Shamsuzzaman, Gersh, & Somers, 2003). Normal sleep architecture becomes fragmented due to frequent arousals, particularly during rapid eye movement (REM) sleep and slow wave sleep (SWS). Either as a consequence of the intermittent hypoxia or the disruption to slow wave or "deep" restorative sleep, people with OSA typically present with excessive daytime sleepiness (EDS) and fatigue, in addition to associated impairments in cognitive performance (Cheshire, Engleman, Deary, Shapiro, & Douglas, 1992), vigilance (Young, Blustein, Finn, & Palta, 1997), and quality of life (Akashiba et al., 2002).

These links between OSA and daytime psychophysiological dysfunction have clear implications for occupational performance, with the decreased productivity reduced vigilance, reduced job satisfaction and increased occupational accidents (Ulfberg, Carter, Talbäck, & Edling, 1996; Ulfberg, Carter, & Edling, 2000) associated with OSA raising both economic and public health concerns. (Leger, Bayon, Laaban, & Philip, 2012) recently reviewed the economic impact of OSA and concluded that OSA patients have a clearly elevated risk of absenteeism and workplace accidents when compared with those people without OSA, and

highlighted a need for assessment of patients at work before and after treatment. In a longitudinal study of Finnish public sector employees, OSA at baseline (n=766) was associated with a 1.7 - 2.7 fold excess risk of permanent work disability after 6 years compared to those with no OSA at baseline. This risk remained significant when controlling for comorbidities (Sjösten et al., 2009). In a detailed evaluation of the economic costs of sleep disorders in Australia, Hillman, Murphy, Antic, & Pezzullo, (2006) estimated direct costs of AUS $313 million (approximately £199 million at the time of writing) due to associated conditions including work related injuries and motor vehicle crashes in 2004. Additionally, excessive daytime sleepiness and its associated outcomes present safety concerns for employed OSA patients and their work colleagues. A large body of research has focused on OSA symptoms (EDS) in transport and industrial workers due to the potential risk of accidents caused by sleepy drivers (for review see Philip & Akerstedt, 2006). Sassani et al., (2004) estimate that OSA related motor vehicle collisions in the USA cost $15.9 billion and 1,400 lives in the year 2000 (approximately £10 billion at the time of writing). It remains the case, however, that few studies have looked at either the costs, or the nature of sleep related occupational functioning in jobs outside of the transport industry. Nevertheless, among those in employment, impaired occupational performance, is proposed as diagnostic features of OSA in ICSD-2 (American Academy of Sleep Medicine, 2005) and is informally assessed by clinicians as part of OSA evaluation (e.g. the UK (NHS Clinical Knowledge Summaries (CKS), 2012)) suggests that, in assessing patients with possible OSA, clinicians should “Ask about the effects of daytime sleepiness on driving and employment”).

Treatment of OSA

The Adult Obstructive Sleep Apnoea Task Force of the American Academy of Sleep Medicine (Epstein et al., 2009) recommend that OSA is evaluated by a sleep specialist using a number of measures including; self-reported sleep-history and

daytime sleepiness (e.g. using the Epworth Sleepiness Scale; ESS; (Johns, 1991); a score of 10 or more indicates clinically significant daytime sleepiness), reports of snoring and hypoxia from the individual, or their bed partner; physical observations, e.g. Body Mass Index, narrowed airway; and an overnight sleep study using either Polysomnography (an overnight recording taken in clinic to evaluate a number of physiological signals) or in less complex cases, overnight testing using a portable monitor which records airflow, respiratory effort and blood oxygenation (Epstein et al., 2009). A diagnosis of OSA is made if the number of obstructive events e.g. apnoeas, hypopneas and respiratory arousals exceeds 15 events per hour OR greater than 5 obstructive events in patients reporting any additional OSA symptoms including excessive daytime sleepiness, unrefreshing sleep, self or partner reports of loud snoring or hypoxia, or fatigue etc. (American Academy of Sleep Medicine, 2005). Guidance provided by the National Institute for Health and Clinical Excellence (NICE) now recommends Continuous Positive Airway Pressure (CPAP) as the first line treatment for OSA (National Institute for Health and Clinical Excellence, 2008). In the UK, CPAP is provided by an NHS sleep or respiratory medicine service following an evaluation and GP referral. A CPAP machine is a small electrical device which delivers lightly pressurized air via a flexible tube to a mask worn by the patient. The pressure of the air keeps the patient's airway open while they are sleeping, minimising arousals caused by oxygen desaturation in order to stabilise sleep architecture and minimise subsequent EDS. If adhered to, CPAP therapy has been shown to have highly effective outcomes on both objective (oxygen desaturation, blood pressure, EDS) and subjective measures (subjective sleepiness, cognitive functioning) within two weeks of use Lamphere et al., 1989; Ferini-Strambi et al. 2003). NICE guidelines recommend that patients use CPAP every time they sleep in order for it to be effective (National Institute for Health and Clinical Excellence, 2008) and research has suggested that higher rates of CPAP compliance were associated with greater reductions in arousals and respiratory disturbance (Stepnowsky & Dimsdale, 2002).

Discontinuing therapy for one night following an initial successful treatment period has shown to cause significant relapse resulting in an increase in apnoeic incidents, (Kribbs et al., 1993) increased EDS (Sforza & Lugaresi, 1995) and increased incidents of dangerous driving (Filtness, Reyner, & Horne, 2011) suggesting that the impact of CPAP therapy is acute in both its treatment and withdrawal response. Mulgrew et al., (2007) administered the Work Limitations Questionnaire (Lerner et al., 2001) to 428 OSA patients and reported that increases in reported EDS were correlated with decrements in Time Management, Mental-Interpersonal and Work Output components of the scale. At two year follow up, those who continued use of CPAP reported improvements in each of these areas. There was no improvement in patients who had discontinued therapy. Severe OSA patients (AHI>20) have shown significant improvements in concentration on new tasks, learning new tasks and completing monotonous tasks following CPAP treatment (Ulfberg, Jonsson, & Edling, 1999) and more recent research has focused on dose-response of CPAP treatment in improving daytime and workplace functioning (Weaver, Maislin, Dinges, et al. 2007).

In the clinical management of OSA patients, self-report measures are utilized as both diagnostic and outcome tools. EDS is routinely measured using the ESS (Johns, 1991) as a diagnostic tool and a clinical outcome measure. As discussed previously, EDS poses a safety risk to workers in hazardous environments or long distance drivers so a clinician would generally record patient occupation details during the consultation. It is a legal requirement of the clinician to report any new diagnoses of apnoea to the Driver and Vehicle Licensing agency (DVLA) and a patients drivers license is suspended until sleepiness is improved by treatment. In this way, sleep related occupational impairment symptoms are routinely explored both as a correlate of excessive daytime sleepiness (with the degree of occupational impairment indicating the severity of OSA), and as an outcome following treatment with CPAP (with improved occupational performance indicating the success of treatment). Such assessments, however, tend to be informal and unstandardized. Although informal enquiries in clinical practice may have the benefit of immediate clinical and diagnostic utility, they do not allow for

comparisons across clinicians and may provide a poor and insensitive estimate of clinical improvement compared to a validated outcome questionnaire (Boynton & Greenhalgh, 2004). The NHS stresses the importance of using standardised Patient Reported Outcome Measures (PROMs; Department of Health., 2009) but this initiative has, to date, only been applied as a method of post-operative satisfaction assessment.

As discussed in the previous Chapters, the Loughborough Occupational Impact of Sleep Scale (LOISS; (Kucharczyk et al., 2011) has been designed specifically to assess the nature and severity of occupational impairment associated with sleep disorders. The 19 question scale, developed in collaboration with sleep disorders (insomnia and OSA) patients and clinicians, and already subjected to rigorous psychometric analyses, has proved both reliable and valid as a research tool. The present study aims to evaluate the performance of the scale when administered alongside routine clinical assessments for OSA in an NHS sleep medicine service in the UK. Since the ultimate aim is to enhance patient assessment by replacing informal and unstandardized enquiries with formal standardised questionnaires, the study represents a scientific development within sleep medicine.

Primary objectives

i. To assess change in occupational performance, as measured by the LOISS questionnaire, before and after CPAP treatment in patients recently diagnosed with Obstructive Sleep Apnoea;

ii. To assess covariation between occupational performance, as measured by the LOISS questionnaire, and the clinical outcomes of daytime sleepiness and treatment adherence, before and after the provision of CPAP to patients recently diagnosed with Obstructive Sleep Apnoea.

Secondary objectives

i. To assess the acceptability of LOISS questionnaires among patients attending an NHS sleep clinic for the assessment of OSA.

ii. To assess the predictive validity of LOISS scores prior to CPAP treatment.

Method

Background

To assess the validity and reliability of the LOISS as a clinical outcome instrument, a study was designed in which LOISS assessments were conducted (and compared) at both the diagnostic interview (pre-CPAP treatment), and at the 1 month follow-up (post CPAP treatment). A judgement of the clinical usefulness of LOISS was based on:

i. The ability of LOISS to reflect clinical severity at the diagnostic assessment;

ii. The ability of LOISS to reflect overall clinical improvements;

iii. The ability of LOISS to reflect the patients' adherence to CPAP treatment.

In order to further establish whether the LOISS instrument met a clinical need, and could be practically integrated into routine (NHS) clinical settings, questionnaire completion was integrated into routine service and included with usual assessments and patients were recruited from an opportunity series of eligible patients. Evaluation included planned comparisons with all other clinical metrics.

Since questions on the occupational impact of Obstructive Sleep Apnoea are already routinely asked before and after CPAP treatment, we did not anticipate significant ethical problems with the administration of a questionnaire which simply standardises these questions. However, the need to intercept NHS patients during (and extend, by approximately 10-20 minutes, the time spent attending) sleep laboratory clinic visits did present as a design concern. To address these

issues, the approach to recruitment aimed to minimise inconvenience to patients, while allowing adequate time to explain the questionnaire and obtain written consent. The study ran on a treatment as usual basis and did not interfere with standard procedures for OSA patients. General treatment procedure following a GP referral of suspected OSA takes place over 4 visits to the sleep laboratory:

i. Visit 1 for clinical assessment and preparation for sleep monitoring at home.

ii. Visit 2 for diagnosis and treatment discussion between clinician and patient.

iii. Visit 3 for provision of CPAP machine.

iv. Visit 4 (between 4 and 10 weeks later) when compliance with and the impact of treatment with CPAP is assessed.

The study used a repeated measures design in which participants meeting the inclusion criteria were asked to complete the LOISS before treatment at Visit 3, then again at their Visit 4 follow up appointment.

Recruitment

Newly diagnosed sleep apnoea outpatients attending the University Hospitals of Leicester (UHL) Sleep Laboratory for CPAP treatment were serially recruited to take part in the study. Ethical approval was obtained by the Nottingham Research Ethics Committee 1.

Inclusion criteria of participants:

i. Aged 18-65

ii. Currently in paid employment

iii. A “first time” diagnosis of sleep apnoea

iv. No other clinically diagnosed sleep disorders e.g. restless legs syndrome, narcolepsy.

v. Eligible for treatment with CPAP

vi. Able to understand written/spoken English

vii. Able to provide informed consent

After initial assessment at Visit 1, patients meeting a clinical diagnosis of Obstructive Sleep Apnoea were invited back to the hospital to discuss their diagnosis and treatment with Continuous Positive Airway Pressure with their clinician. Participants meeting the inclusion criteria were given the information sheet (see appendix) by the clinician to take home along with the usual advice and information leaflets provided to patients at this visit. Patients were informed that they were eligible to take part in a brief questionnaire study and that they could read the information sheets and decide whether to opt in at their next appointment. At Visit 3, patients were fitted for equipment used in Continuous Positive Airway Pressure treatment by the usual technicians at the sleep laboratory. After their appointment, they were approached by the researcher who asked if they had read the information sheet provided to them by the clinician at Visit 2 and/or were interested in hearing about the study.

Data collection-Time 1

Prior to providing consent, participants were informed that all data would remain confidential and would be anonymised by a study number throughout the analyses and of their right to withdraw either themselves and/or their data from the study

at any time without needing to give a reason. All participants were assured that none of the information they provided would be communicated back to their employers in any way. All data were kept on a password protected PC to which only the researcher had access. All data were stored in accordance with the guidelines set out by the Data Protection Act, 1998. Interested patients were taken to a private room within the sleep laboratory where they read the information sheet if they hadn't already, had the opportunity to ask questions and then gave consent to take part (see Appendix).

Self-report and objective measures

The consenting participants completed a short collection of questionnaires (see appendix) which measured subjective reports of sleepiness, occupational impact of sleep and occupational information. The procedure of taking consent and completing questionnaires took no longer than 20 minutes. Participants were advised that the researcher would be present at their next appointment to administer the second questionnaire.

General employment

Participants reported job title; nature of business; contracted hours per week; and work schedule (daytime only "9-5" type work/ variable shifts daytime only/variable shifts including night time work, mode of transport to work and an estimation of the difficulty of getting to work using an alternative form of transport.

Occupational impact of sleep quality

Sleep related occupational impairment was assessed using the 19 item LOISS (Kucharczyk et al., 2011) . The score ranges from 0 to 76 with higher scores indicating higher levels of occupational impairment.

Subjective sleepiness

Subjective sleepiness was assessed using the 8 item ESS (Johns, 1991). Possible scores range from 0 to 24 with a score exceeding 10 indicating excessive daytime sleepiness.

Demographics and clinical data

Demographic information and clinical data (recorded by clinician at diagnosis) were accessed from patient medical records. This information included: age; apnoea-hypopnea index (AHI); Body Mass Index (BMI); and Clinician ratings of OSA severity (mild, moderate or severe). The clinical recording of this information followed guidelines from the International Classification of Sleep Disorders (American Academy of Sleep Medicine, 2005) for newly diagnosed OSA patients.

OSA severity criteria are characterised as follows:

i. *Mild:* Associated with mild sleepiness. Most of the habitual sleep period is free of respiratory disturbance (AHI<15 events per hour). The apnoeic episodes are associated with mild oxygen desaturation or benign cardiac arrhythmias.

ii. *Moderate:* Associated with moderate sleepiness. AHI>15 and <30. The apnoeic episodes can be associated with moderate oxygen desaturation or mild cardiac arrhythmias.

iii. *Severe:* Associated with severe sleepiness. AHI>30. Most of the habitual sleep period is associated with respiratory disturbance, with severe oxygen desaturation or moderate to severe cardiac arrhythmias.

Data collection- Time 2

Using standard procedures, participants were called back to the sleep laboratory for a follow up appointment (Visit 4) to assess any issues with the CPAP equipment. Participants attended the clinic for these follow up appointments an average of 32.09 ± 7.17 days after initial CPAP provision and completed the LOISS and ESS for the second time. An additional question was added which asked participants to give a general estimation of their occupational functioning now, as compared with their functioning before starting CPAP treatment (response format: Very improved/Slightly improved/About the same/Slightly worse/A lot worse).

Adherence data

At Visit 4, objective usage data was downloaded from the patients' CPAP equipment by sleep laboratory staff as (as recommended by the Department of Health., 2009). This included AHI, average hours of CPAP use per night, days of CPAP usage in the past week which exceeded 4 hours, and days of CPAP usage exceeding 4 hours in the past 30 days. This data was collected from patient notes by the researcher (EK) following the appointment.

Statistical Analyses

All analyses were conducted in IBM SPSS Statistics Data Editor 19 and data and are reported as mean ± standard deviation unless otherwise stated. Statistical significance was set at $p<0.05$ Effect sizes were estimated using the eta squared (η^2) or r statistic and summarised as small medium or large effect sizes according to Cohen's *d* and suggested conversion guidelines (Cohen, 1988; Cohen, 1992)

Baseline analysis

Respondents were divided into 3 groups of OSA severity based upon the clinical criteria outlined above; mild OSA (AHI <15), moderate OSA (AHI>15 and <30) and severe OSA (AHI>30). Relationships between LOISS, BMI, age, EDS and OSA severity were analysed using one way ANOVA. Independent t-tests were used to compare ESS and LOISS scores at baseline and following treatment.

LOISS and daytime sleepiness

LOISS scores were correlated against ESS scores to assess relationships between sleep related occupational impairment and excessive daytime sleepiness. Participants were also grouped in terms of their self reported subjective sleepiness dependent on ESS score (<5, 6-11, 12-17, 18-24). A comparison of mean LOISS scores per sleepiness group was conducted using one way ANOVA. Multiple regression analysis assessed the independent contributions of ESS to LOISS scores. Gender and occupational differences were also assessed.

Follow up analyses

Multiple regression modelling was used to identify predictors of sleep related occupational impairment change scores between baseline and follow up. Correlational analyses of LOISS and ESS change scores assessed the shared variance in these measures. Baseline to follow up change scores in LOISS global and individual item scores, ESS and AHI were also analysed. Gender and occupational differences in change scores were also analysed using independent t-tests.

Treatment efficacy

A sub analysis of participants with clinically significant EDS (ESS>10) at baseline was analysed separately to calculate the percentage of these people who were able to reduce their daytime sleepiness to sub clinical levels (ESS<11) following CPAP therapy. Mean hours of CPAP use per night were used to assess outcome in EDS for those using their CPAP equipment above the recommended guidelines of at least four hours per night on average.

Results

Participant characteristics

Of the 39 eligible participants given information about the study, 3 people declined and 4 people did not complete the survey at Time 2 leaving a total N of 32 with baseline and follow up data. Participant characteristics and OSA severity can be seen in Table 7.1. Participants were predominantly male (n = 25); predominantly white-collar (67%), severely obese (as indicated by BMI) and were predominantly classified as having severe OSA. Participants worked an average 36.68 ± 15.12 hours per week and 57% worked regular daytime hours. Only 6.1% (n=2) of the sample were professional drivers, 89.7% of the sample used a car to get to work and 61.5% of these drivers would find it “Very Difficult” to get to work using an

alternative method of transport. Participants classified as having "Severe OSA" had an average of 23.62 apnoea- hypopnea episodes per hour more than Moderate OSA participants and 45.89 more than those with Mild OSA, during the overnight polysomnography assessment conducted as part of routine diagnosis ($F(2,28)=52.06$, $p<0.001$).

Table 7. 1 Baseline participant characteristics

Characteristic	All Participants n=32	Mild OSA n=7	Moderate OSA n=9	Severe OSA n=16
	(Mean± SD unless otherwise stated)			
Men, %	76.5	50	88.9	81.3
White collar, %	67.7	85.7	50.0	68.8
Age, years	51.31 ±7.41	53.29±4.65	51.89±10.47	50.13±6.54
BMI, kg/m²	35.27 ± 7.26	36.83±10.06	34.22±6.58	35.09±6.33
AHI, no/per hour	29.91 ± 17.33	10.55±3.09	22.27±3.92	45.89±11.50
ESS	12.50 ± 5.30	10.43±5.26	14.67±4.98	12.72±5.10
LOISS	19.59 ± 18.45	14.25±14.84	12.78±15.48	26.53±20.23

Baseline sleep related occupational impairment

LOISS scores were significantly higher in white collar (28±18.42) compared with blue collar workers (3.8 ±3.19, $t(21.19)=5.71$, $p<0.001$). Mean global LOISS scores were correlated with number of apnoeic episodes per hour, $r = 0.44$, $r^2= 0.19$, $p=<0.05$, with a small effect size, although one-way ANOVA showed no significant differences in ESS, BMI, AGE and LOISS scores overall between those classified as having Mild, Moderate OSA or Severe OSA (although planned comparisons showed a trend significance for higher LOISS scores as AHI increased; $p=0.08$).

Relationship between sleepiness and occupational impairment

In the sample overall, sleep related occupational impairment measured by LOISS was significantly correlated with subjective daytime sleepiness measured by ESS ($r=.56$, $r^2=0.30$, $p= 0.01$; with a small effect size). LOISS scores were calculated for each of the subjective sleepiness groups created using ESS scores outlined previously. One way ANOVA showed a significant difference in LOISS scores by sleepiness group rating, ($F (3, 27) =4.55$, $p<0.01$) with LOISS scores increasing as sleepiness ratings increased (see Figure 7-1). This pattern was largely due to the responses of white collar workers in the sample. Blue collar workers showed lower LOISS and ESS scores than white collar workers overall and a displayed a stable pattern of low level occupational impairment, independent of sleepiness rating (although the low sample size of blue collar workers (n=10) means that these results should be treated with caution).

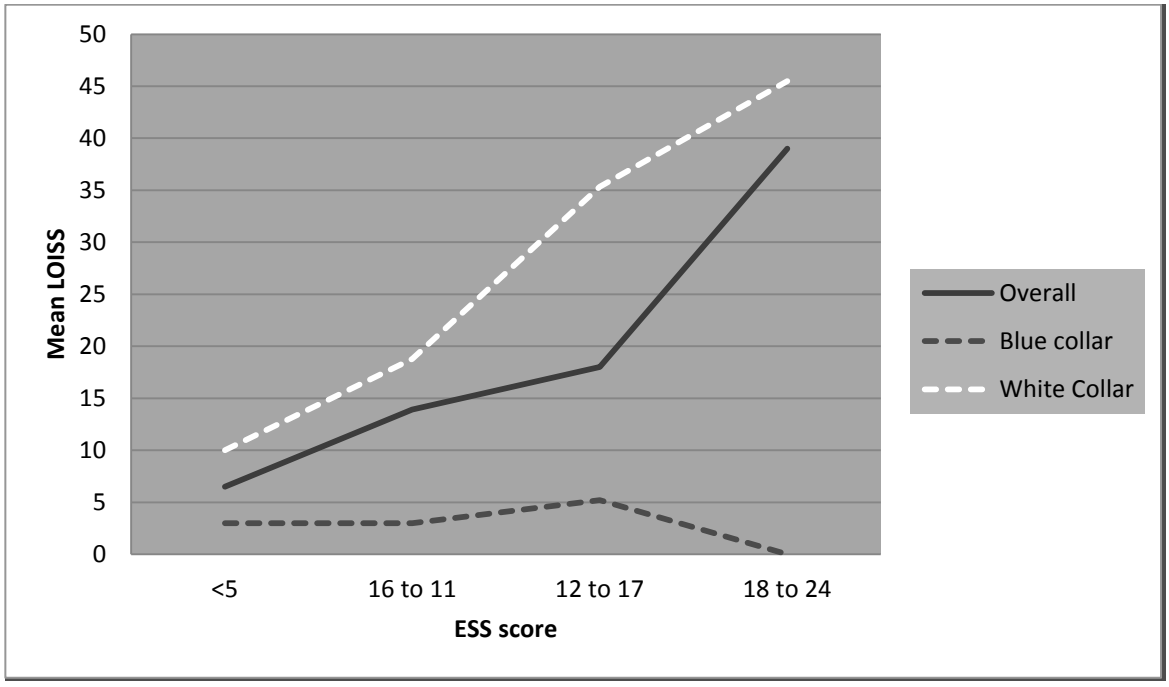

Figure 7-1. Effect of subjective sleepiness (ESS) on LOISS score shown for the overall sample and for blue and white collar workers.

Multiple regression analysis was conducted to assess the independent effect of subjective sleepiness and other variables on LOISS scores. A regression model was inputted, using age, gender, BMI, AHI, hours of work per week and ESS as independent variables using the Enter method and mean global LOISS as the dependent variable (see Table 7.2 for information on the predictor variables). The model was significant overall ($F(6, 21) = 3.67$, $p<0.05$, $r= 0.51$), with the independent variables predicting 37% (adjusted r^2) of the variance in LOISS scores. Within the model, subjective sleepiness (ESS $r^2= 0.31$ $t=2.77$, $p<0.01$; B= 0.50 95% CI= 0.20-2.63) and AHI index score ($r2=0.17$, $t=2.2$, $p< 0.05$; B= .37, 95% CI= 0.23-0.75) were the only significant predictors of LOISS score suggesting a relationship between both subjective and objective clinical excessive daytime sleepiness and increased sleep related occupational impairment in this sample.

Table 7.2. Unstandardised and standardised regression coefficients for variables entered into the model

Variable	B	SE B	β	t	sig
Gender	11.35	7.96	-.27	-1.42	.17
Work hours per week	.075	.26	.05	.29	.78
Age (years)	.261	.41	.11	.64	.53
AHI	.374	.17	.36	2.22	.039
BMI	-.786	.42	-.34	-1.89	.073
ESS	1.66	.60	.50	2.77	.011

N.B. Dependent Variable: Mean global LOISS score

Follow up

At follow-up, the group as a whole showed significant improvements from baseline in; mean ESS scores 7 ± 5 ($p<0.001$); mean LOISS scores 10 ± 2 ($p<0.001$); and mean AHI 6 ± 4 ($p<0.001$). Table 7.3 shows change scores in ESS, LOISS and AHI

following treatment with CPAP. Mean hours of CPAP use per night was 4.69 ± 2.22 and there was no significant difference in hours of CPAP use per night between OSA severity categories.

Table 7. 3 Change scores in subjective sleepiness, occupational impairment and apnoea-hypopnea index following CPAP treatment.

	Overall sample	*Blue Collar*	*White Collar*
LOISS T2-T1	-9.78 ± 15.01	-0.64 ± 5.14	-15.95 ±15.42
ESS T2-T1	-5.71 ± 4.84	-5.80 ± 5.28	-5.92 ± 4.75
AHI T2-T1	-23.23 ±15.83	-24.04 ± 16.70	-23.45 ± 16.38

In a multiple regression model adjusted for age, both ESS and average hours of CPAP usage/day were significant predictors of LOISS scores at follow up (r^2 =0.36, F(3,22)=5.70, p<0.01). Bivariate correlations between ESS and LOISS (baseline to follow-up) change scores (r=-.47, r^2=0.22, p<0.01) indicate a modest but significant degree of shared variance in these indices of treatment improvement with a small effect size. Blue collar workers showed a less dramatic LOISS change score than white collar workers (0.64 ±5.14 vs. 15.89 ± 14.88), t (22.81) =3.98, p<0.001 although both groups showed a very similar improvement in AHI from baseline. Independent t-test comparisons indicated no significant gender differences in LOISS change score or AHI change score.

Figure 7-2 shows a pattern of relative overall LOISS item score reduction in the sample following treatment. Largest reduction in scores were seen in LOISS item 5 "Maintain stamina at work" (1.12 point score reduction) and LOISS item 16 "Stay awake at work" (0.89 score reduction) . Mean reduction for all LOISS item scores was 0.58. Bivariate correlation of these particularly "sensitive" LOISS items found that reduced stamina at work (LOISS 5) was correlated with increased daytime sleepiness (r=0.55, r^2= 0.30, p<0.01) but not with age, gender or AHI. Similarly,

staying awake at work (LOISS 16) was correlated with ESS (r= 0.61, r^2= 0.37, p<0.001) and AHI (r=0.37, r^2 = 0.14, p<0.05) but not with age or gender.

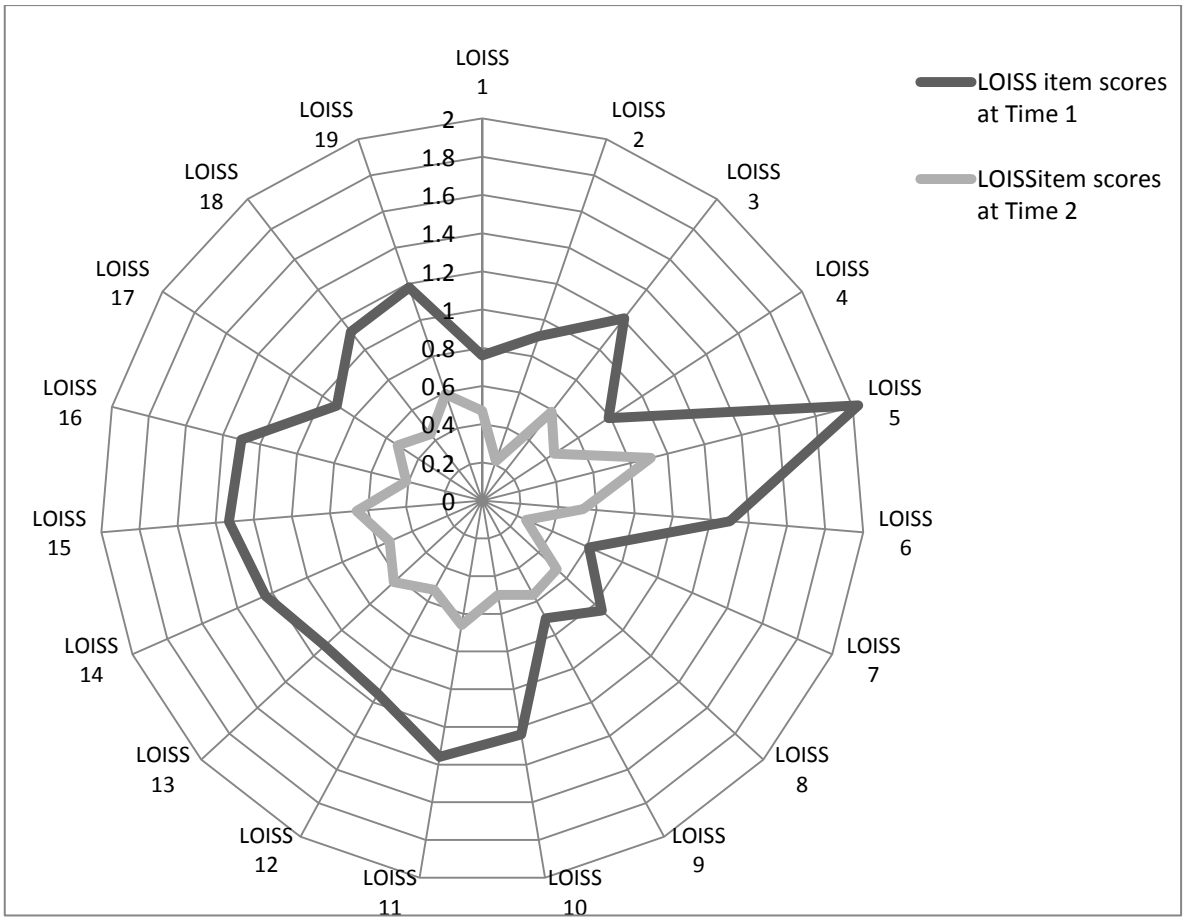

Figure 7-2. Radial diagram showing mean LOISS item scores at Time 1 and Time 2. Concentric values represent mean LOISS items scores. ***LOISS item key: LOISS1= Arriving at work on time; LOISS2= Working without taking rests or breaks;LOISS3=Concentrating on multiple tasks;LOISS4=Do work carefully;LOISS5= Maintain stamina;LOISS6= Focus on complex tasks;LOISS7= Speak to people face to face;LOISS8=Avoid making mistakes;LOISS9=Finish the work day on time;LOISS10= Doing what you are capable of doing;LOISS11=Controlling irritability at work;LOISS12=Gain satisfaction from work;LOISS13=Handle the workload;LOISS14=Read or use eyes whilst working;LOISS15=Keep your mind on your work;LOISS16= Stay awake at work; LOISS17= Learn new tasks or skills; LOISS18= Do more than "just enough" work; LOISS19= Work fast enough.***

One way ANOVA with planned comparisons found that the sleepier people were at baseline, the greater the reduction in LOISS scores following successful treatment with CPAP, F(3, 27) = 3.12, P<0.05) Those scoring in the highest range of 18-24 on the ESS at baseline showed a reduction of - 21.50 ± 7.8 on LOISS compared to the

least sleepy group (ESS<5) and -17.21 ±7.32) and -17.37 ±7.70 for the groups scoring 6-11 and 12-17 on the ESS respectively.

Treatment efficacy

A small proportion of OSA patients do not report EDS (Young et al., 1993). To avoid floor effects by including individuals with "normal" ESS scores (<11) at baseline when assessing the efficacy of CPAP treatment at reducing daytime sleepiness, a sub-analysis was conducted using only those participants who showed abnormal levels of daytime sleepiness (indicative of classic OSA) at baseline.

At baseline, 36.4% of respondents did not report daytime sleepiness exceeding the threshold value of 10 on the ESS and they were subsequently excluded from the analyses in this section. Of the 73.6% of patients remaining who reported severe EDS at baseline, 80% reported daytime sleepiness which had reduced to within the normal range (ESS>10) following CPAP treatment.

Table 7.4 shows CPAP adherence data and ESS scores-treatment for those reporting EDS at baseline. CPAP use among those whose subjective sleepiness score had reduced to the normal range following treatment was an average of 3.17 hours longer per night than those who still reported excessive sleepiness (5.79 hours v 2.62 hours).

Table 7.4 CPAP use and ESS scores post-treatment in participants reporting ESS>10 at baseline

Compliance to CPAP (Mean, SD)	ESS Time 2 <11 (n= 10)	ESS Time 2 >10 (n=3)
Average hours p, night	5.79 ± 1.86	2.62 ± 2.62
Nights with use >4 hours in past week	5.90 ± 2.18	0.67 ±1.16
Nights with use >4 hours in past month	22.20 ± 10.28	5.0 ± 8.66

Comment

Although occupational impairment is widely accepted to be a probable consequence of OSA, these impairments are informally assessed in clinical practice. Limited research has investigated sleep related occupational impairment in OSA patients (e.g. Mulgrew et al., 2007). The study presented here, therefore, is the first to use a questionnaire developed specifically to capture *sleep related* occupational impairment. Sleep related occupational impairment was more severe in respondents employed in white collar roles than blue collar, although the small representation of blue collar workers in the sample means that these results should be treated with caution. The largely sedentary nature of white collar work could allow more opportunity for EDS and subsequent occupational dysfunction in these respondents than the blue collar workers in the sample, whose work is likely to be more physical with less opportunity to succumb to sleepiness. A larger study with a more representative employee sample would be necessary to investigate this further as many of the relationships showed a small effect size. Furthermore, despite similar reductions in AHI from baseline to follow up in blue and white collar workers, white collar workers reported more profound improvements on LOISS than blue collar workers. Potentially this could be explained by as yet unexplored occupational-type differences in the experience of OSA.

Severity of OSA as measured by number of apnoeic or hypopnoeic obstructions per hour was correlated with increased occupational impairment (as measured by LOISS), although further investigation of LOISS scores by categories of OSA severity failed to reach statistical significance, suggesting that objective measures of clinical OSA severity may not be an accurate indicator of resulting occupational impairment. On the other hand, increased subjective daytime sleepiness was shown to be correlated with increasing occupational impairment in white collar workers, suggesting that occupational impairment is more common in those who experience more severe excessive daytime sleepiness.

Overall, CPAP was shown to be a successful therapy for OSA, considerably reducing AHI and reducing ESS scores to sub clinical sleepiness ratings. Mean scores, globally and for each individual item (Figure 7-2) on LOISS were reduced following therapy with the greatest improvement in stamina and staying awake at work. Furthermore, results indicated that greater compliance to CPAP significantly predicted a reduction in occupational impairment at follow up. Mean scores at follow up were consistent with those reported in an earlier sample of 122 “good sleepers” screened for insomnia by the Pittsburgh Sleep Quality Index (PSQI ≤5; Buysse et al., 1989) and daytime sleepiness by a score of <10 on the ESS (Johns, 1991; Kucharczyk et al., 2011) . Decreased daytime sleepiness and decreased occupational impairment at follow up were significantly correlated but the low level of shared variance suggests that LOISS goes beyond outcomes of EDS and can offer additional information to that offered by the ESS. These results suggest that the formal assessment of sleep related occupational impairment could usefully augment standard clinical pre-post metrics.

LOISS was a practical addition to the standard clinical metrics administered in this NHS sleep medicine service, and showed changes in occupational performance consistent with changes in clinical status.

8. Discussion

The literature review presented in Chapter 1 identified the need for a standardised assessment of sleep-related occupational impairment. In response to this need, the research programme described in this thesis set out to achieve the following research objectives;

i) To develop a prototype scale suitable for use as an assessment and an outcome measure of sleep-related occupational impairment (Chapter 2).

ii) To pilot, validate and refine the prototype scale in samples of UK workers (Chapters 3-4).

iii) To use the final scale as an assessment measure in a UK workforce sample (Chapters 5-6).

iv) To test the utility of the final scale as a clinical outcome measure (Chapter 7).

Each chapter provided a summary comment on the presented findings but the discussion to follow will bring together the findings from the research programme as a whole in two sections. The first section of this discussion will critique the development of the LOISS instrument (Chapters 2-4). The second section will then consider what a specialised instrument like LOISS can tell us about the dynamics of the occupational impact of sleep quality (Chapters 5-7).

LOISS Development

Chapters 2 and 3 reported on the development of the 19 item LOISS which was subsequently tested in clinical population and convenience samples of working adults in the UK. The LOISS was developed through stages recommended by the FDA (Food and Drug Administration,) for the development of a patient-reported outcome measure. This "bottom-up" process of item generation was a strength in the methodology and ensured that the final (LOISS) scale was influenced by: existing metrics and the relevant literature; the input of both people with sleep problems and good sleepers; and academics and clinicians with expertise in this area. LOISS was subject to rigorous reliability checks during the development process and throughout the research programme; internal consistency, as indexed by Cronbach's alpha, (range: α=0.94-0.97) repeatedly indicated homogeneity of survey items across a range of worker samples. Similarly, high split-half reliability coefficients (range: r = 0.84-0.94) support the assumption that LOISS items were measuring the same construct. Analyses of test-retest reliability described in Chapter 4 indicate that LOISS scores are stable across time points, with change consistent with normal variations in sleep quality. Mean scores decreased by 1.56 points on the LOISS from T_1 to T_2, and the difference was not statistically significant. Although LOISS scores remained stable over time, PSQI scores indicated a significant (although modest) improvement in sleep quality (a mean 0.56 score decrease, $p<0.05$), potentially suggesting that sleep related occupational impairment is a more stable construct than self-reported sleep quality as measured by PSQI. In terms of validity, the input of people with sleep problems and sleep professionals ensured the face and content validity of LOISS. The shared variance of LOISS and the Work Ability Index in Chapter 6 (which doesn't exceed 18%) is evidence supporting the construct validity of LOISS, although it is acknowledged that the present body of research has been unable to correlate subjective reports of sleep related occupational impairment with objective measures of performance in the workplace.

Nevertheless, the development process ensured that the LOISS covers a breadth of occupational consequences which capture a full range of occupational experiences. Highly specific items relating to workplace tasks such as using a computer screen or answering the telephone were excluded from the 40 item pool in Chapter 2 in order to broaden the application of the scale to workers from a range of employment settings. The demonstrated face validity of the resulting scale among workers from a wide range of industries (as demonstrated by response and completion rates in the workplace surveys) appears to justify this decision.

From the perspective of occupational health, a possible criticism of the scale is that work-related deficits which may match LOISS items will be overlooked if those deficits are not perceived by the respondent to be contingent upon sleep quality. Whilst accepting the general point of possibly erroneous attributions, it is possible to argue that such contingency is both common and meaningful in a range of self-report measures in both sleep and occupational research. For example, degraded social, physical and motivational dysfunctions are all contingent upon "my fatigue... " in the Fatigue Severity Scale (Krupp, LaRocca, Muir-Nash, & Steinberg, 1989) while the Work Limitation Questionnaire (Lerner et al., 2001) assumes that the deficits quantified are accurately attributed to "…ongoing or permanent medical conditions".

In the present studies focus groups enabled individual experiences of sleep quality to influence item development. It is interesting, therefore, that sleep related absenteeism (as opposed to punctuality) was not identified as an issue by any participants in any groups, which may indicate a need to re-evaluate the status of this most commonly measured index of sleep related occupational performance at the population (i.e. organisational) level. One possibility is that absenteeism related to chronic sleep disorder may reach significant levels only when audited over months or years in large occupational populations, but nevertheless is not an event which characterizes the experience of sleep disorder for most individuals. Given this discrepancy between population and personal findings, it is recommended that a single global item addressing absenteeism might still be used in personal assessments where workforce screening is undertaken. However, the

evidence presented here strongly suggests that LOISS offers a more sensitive index of sleep related occupational performance at both the personal and corporate levels.

The breadth of impact of sleep quality on workplace efficiency can be judged by the novel areas of impact identified in this program. Of the 19 items in the final LOISS scale, 11 were generated from the focus groups and literature review, addressing areas not covered by the WLQ, SIP or the IPQ including punctuality, mood regulation, sustained attention, job satisfaction, and fatigability. This need to augment generic health measures to capture sleep-related occupational impairment is increasingly being acknowledged in the outcome literature (e.g. (Rosekind et al., 2010), providing support for the approach adopted here. It is also important to note that the relatively low level of variance shared between LOISS and PSQI scores ($r = 0.56$, $r^2 = 0.31$; $p<0.01$ in Chapter 2 and similar in Chapters 3 and 4) indicates that the items which contribute to LOISS are not simply providing a proxy measure for sleep quality. The exploratory factor analysis in Chapter 2 indicated that impairments might be broadly divided into workplace functionality ('performance') and stamina throughout the working day ('vitality'). However, the high internal consistency of the total scale, together with the low eigenvalue for the smaller factor may not be robust. Confirmatory factor analysis on the larger sample size in Chapter 6 was able to indicate that the impact of sleep quality on workplace performance measured by LOISS can be regarded as a unitary construct. A single factor was extracted in the confirmatory factor analysis which accounted for 51.2% of score variance. From the literature review in Chapter 1 it is evident that results obtained from assessing of individual components of "occupational impact" are heterogeneous across studies. In contrast, LOISS has shown consistent outcomes in terms of gender, age and occupational norms across samples, supporting the conceptualisation of sleep-related occupational impairment as a unidimensional construct.

The LOISS is the first sleep specific metric designed for assessing occupational impairment at an individual level, and has potential applications in clinical, economic and research evaluations. Furthermore, the measure has been designed

for use across different sleep disorders, increasing its potential utility. Nevertheless, the limitations of the present analyses, and the need for further development should be acknowledged. Chapter 7 clearly indicated that the LOISS is responsive to a change following CPAP treatment for OSA with occupational impairment reducing with increased CPAP use. This dose-response outcome supports the utility of LOISS in clinical practice and future work could involve a short-form version of the scale for greater time-efficiency. While the instrument appears sensitive to differences (e.g. "good" v "poor" sleepers as defined by PSQI scores), it was beyond the scope of the present research programme to assess the scale's sensitivity to change in people with insomnia symptoms (e.g. pre-post therapy), a topic which will provide the content for additional studies. The further development of the scale must also include attention to item-response theory analysis within specific clinical populations, particularly insomnia, obstructive sleep apnoea and restless legs syndrome. It is clear when considering symptomatology of clinical sleep problems that scores on some questions (e.g. "Stay awake at work") are more likely to attract positive responses from those showing symptoms of hypersomnia.

At the time of writing, the LOISS is the only published metric specifically designed to capture sleep related occupational impairment (Kucharczyk et al., 2011). The need for such a scale, and such an approach to assessment, has been emphasised in the sleep literature throughout this research programme, with authors continuing to improvise or augment existing measures for use in occupational impact assessment (Buxton et al., 2012; Kierlin, Olmstead, Yokomizo, Nicassio, & Irwin, 2012) . However the LOISS, a measure designed in line with FDA guidelines (Food and Drug Administration,2006), and piloted in varied samples can provide a more robust understanding of sleep related occupational impairment, thus better meeting the current needs of sleep research.

What LOISS tells us about sleep-related occupational impairment

Analysis of focus group data in Chapter 2 showed that irrespective of the origin of sleep deficits, loss of sleep appears to have a generic impact on occupational impairment which can be captured by LOISS, in much the same way that the PSQI (D. Buysse et al., 1989) is able to assess sleep quality across varied populations. The workforce data reported in Chapter 5 indicated that 20% of all respondents scored in the highest two thirds of the LOISS range (21-61) indicating that sleep-related occupational impairment is widely experienced among UK adults. LOISS scores were positively correlated with ESS, WAI and PSQI (D. Buysse et al., 1989; Johns, 1991; Tuomi & Oja, 1998) although the low levels of shared variance indicate that LOISS measures a construct which cannot be captured by these existing metrics alone. Sleep related occupational impairment appears to be better conceptualised as a unidimensional construct rather than the individual workforce impairments (e.g. absenteeism, workplace accidents, job satisfaction, etc.) as historically assessed in the literature (Chapter 1). One of the major advantages of conceptualising and measuring sleep-related occupational impairment as a homogenous construct is that it allows for trends and individual differences in data to be more easily identified and reported. Thus, from the surveys conducted here, consistent demographic patterns emerged for LOISS scores which have not previously attracted research attention in the sleep-work literature. The section to follow will unpack these trends.

Demographic patterns in LOISS Scores

From the survey data reported in Chapters 2-7, LOISS score distributions clearly illustrate three demographic trends. Specifically, sleep related occupational impairment: shows no consistent gender difference; tends to be higher among white-collar workers; and shows an ageing gradient, declining with increasing age.

Gender

LOISS consistently showed no difference between males and females in the data reported. Although the existing sleep literature has addressed gender differences in sleep quality and quantity, there is very little data which shows gender differences in occupational outcomes, with gender differences receiving little attention in the sleep-work literature reported in Chapter 1. Nevertheless, the international epidemiological literature does show a greater prevalence of insomnia symptoms in women generally (Morgan, 2012), while increased levels of sleep symptoms and daytime impairments are likely to be emphasised by women at particular life stages e.g. menopause (Bolge et al., 2010; Groeger et al., 2004). Taken together, then, the marked and historically robust gender difference in reported sleep quality coupled with the absence of consistent gender differences in sleep-related occupational impairment: a) supports the conclusion that LOISS is not simply a proxy for sleep quality, but also; b) strongly indicates the operation of a complex pathway between the experience of poor sleep quality, and performance at work. This theme is developed below.

Job Status

LOISS did not differ between white and blue collar workers in the chapters which reported non-clinical data; this supports the use of LOISS across workforces and is supported by the de-emphasis on occupational type reported in the literature reviewed in Chapter 1. However, in the clinical sample of OSA patients (Chapter 7), blue collar workers scored significantly lower on LOISS than their white collar counterparts. This is possibly due to a number of mechanisms, time on task fatigue in white collar roles, physiological differences in manual and desk based work or socioeconomic factors associated with employment status. It is acknowledged that white collar workers were better represented than blue collar in the data reported, possibly due to sampling method. A future agenda for research would be

to compare sleep related occupational impairment in specific blue and white collar roles.

Ageing

In both the population and workforce surveys (Chapters 5 and 6) increasing age was correlated with a decrease in LOISS scores despite age related decreases in sleep quality and quantity. This could be attributable to a number of factors. It is possible, for example, that workers with the most impaired sleep-related occupational performance exit the workforce earlier, so the present results reflect a "survival bias" in favour of the older individuals with fewer sleep-related occupational impairments (see Welford, 1977). This conclusion is supported by research reported in Chapter 1 showing that insomnia at baseline predicted later disability pension and early exit from the workforce (see Salo et al., 2010; Sivertsen et al., 2006; Sivertsen et al., 2009). It is also possible that older workers will gravitate towards jobs which better match their changing abilities. For example, if a person knows that they are unsuccessful at a particular task due to sleep-related fatigue, they may choose alternative employment (or an alternative role in the same organisation) which mitigates this decrement. Such a process, if successful, could result in improved performance efficiency despite declining sleep quality. This theory on job task preference is supported by the focus group quotes reported in Chapter 2.

Finally, it should also be recognised that the relationship between increasing age, sleep quality, and sleep-related occupational impairment is likely to be influenced by the known capacity of ageing individuals to minimise performance decrements by deploying effective compensatory strategies, a phenomenon first noted over 50 years ago (Murrell, Powesland, & Forsaith, 1962). This conclusion is supported by more recent evidence showing that job performance (in terms of productivity measures) tends to increases with age (see Waldman & Avolio, 1986) for meta-analysis), while the prevalence of work-related accidents tends to decrease with

age, reflecting the greater experience and skill of older workers (Chau et al., 2007). It follows, therefore, that increased "on the job" experience, and perhaps greater caution, can compensate for age-related loss of capacity, although further research is needed identify the role of sleep and fatigue in this complex phenomenon. Nevertheless, the present findings from large workplace surveys using LOISS make a useful contribution to the understanding the performance capacity of older UK workers. Such results are particularly salient in light of the 2011 abolition of the Default Retirement Age act in the UK (Department of Work and Pensions., 2012) meaning that the British workforce will be working well into later life. An interesting direction for future research, therefore, would be a longitudinal cohort study of sleep, sleep related occupational impairment and occupational outcomes in later life.

Results from workplace surveys support the utility of LOISS as a purpose-designed metric for capturing variations in sleep-related occupational performance at the personal and population levels. Results strongly indicate that LOISS outcomes do not simply reflect (and serve as a proxy for) sleep quality or daytime fatigue. Rather, the results indicate that sleep quality and occupational performance are linked by a complex interaction of biopsychosocial factors which probably include chronotype, personality, and the efficiency of compensatory strategies.

Limitations

The literature reviewed in Chapter 1 was limited to studies addressing insomnia symptoms in daytime workers. Although the review clearly identified the need to develop a metric which captures and explores the occupational impact of sleep quality at the individual level, it is acknowledged that generalisation would be increased by extending the review criteria to include shift workers and broader sleep symptomology. These limitations extend to the recruitment of focus group participants, where people with any other sleep disorder than self reported insomnia and clinically diagnosed sleep apnoea were excluded. Nevertheless,

consistent mean LOISS scores across heterogeneous populations sampled in Chapters 3-6 support the generalised application of the scale.

Although the factor analysis reported in Chapter 3 LOISS indicated a two factor structure, later confirmatory analysis indicated a that LOISS measures unidimensional construct. It is acknowledged that the item reduction strategy of removing items with low item-total correlations may have influenced this outcome.

Responses to the population survey reported in Chapter 5 and convenience samples reported in Chapters 2 and 3 may have been biased towards those with sleep problems who identified with the sleep related occupational impact construct outlined in recruitment advertisements. Additionally, it is acknowledged that the gift vouchers offered to participants in Chapters 2 and 5 may have influenced recruitment responses. The University has since reviewed ethical procedures on research incentives and these are no longer advertised when recruiting.

The work presented in this thesis has relied largely on subjective data (with the exception of clinical outcomes in OSA presented in Chapter 7). Future directions could include assessments of the impact of sleep on objectively assessed occupational tasks, although this was beyond the scope of the current research. Sleep was also measured subjectively throughout the thesis. It is acknowledged that objectively measured sleep (using actigraphy or polysomnography) could provide more rigorous objective sleep parameters by which to compare LOISS scores. Additionally, assessment of sleep related occupational impairment using LOISS pre and post treatment for insomnia (pharmacological or behavioural) could provide insight into the scale's sensitivity to change, in addition to providing insight into efficacy of treatment in improving workplace functioning.

Conclusion

The work presented here supports the usability, validity, reliability, and application of the Loughborough Occupational Impact of Sleep Scale in clinical and non-clinical populations. The LOISS meets the stringent requirements for a Patient Reported Outcome Measure. Namely, a 5 stage iterative process including; Hypothesis of conceptual framework; Adjustment of conceptual framework; Collection of data and drafting instrument; Confirmation of conceptual framework; and Assessment of measurement properties and Modification of the instrument, in line with FDA recommendations (Food and Drug Administration, 2006) and best psychometric practice.

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APPENDIX A

Chapter 2: Recruitment posters

Information sheet

Consent form

Debrief sheet

DO YOU HAVE

INSOMNIA, TROUBLE SLEEPING OR SLEEP APNOEA?

Are you in full time daytime employment ?

Could you spare an hour of your time to take part in an informal group discussion about sleep and occupation with other people with sleep problems?

Your responses will be kept confidential.

If you would like to know more about the study, please e-mail E.Kucharczyk@lboro.ac.uk or call me on 01509 223049.

Please note, you need to be over 18 years of age to take part and not doing shift work. The study will take place in a comfortable setting at Loughborough University, one of the leading sleep research centres in the UK.

Are You A

GOOD SLEEPER?

Are you in full time daytime employment ?

Could you spare an hour of your time to take part in an informal group discussion about sleep and occupation with other people who generally sleep well?

Your responses will be kept confidential.

If you would like to know more about the study, please e-mail E.Kucharczyk@lboro.ac.uk or call me on 01509 223049.

Please note, you need to be over 18 years of age to take part and not doing shift work. The study will take place in a comfortable setting at Loughborough University, one of the leading sleep research centers in the UK.

Information Sheet

Exploring the Occupational Impact of Sleep Quality

Investigator: Erica Kucharczyk

Contact email: E.kucharczyk@lboro.ac.uk Telephone: 01509 223049

Please take time to read the information below which describes the aims of the study and what will happen to the information that is collected.

Research has suggested that people reporting poor sleep also report significant deficits in daytime functioning at work. Loughborough University is conducting research into the ways people feel that poor sleep may affect them in the workplace. We are particularly interested in how sleep plays a role in your working life ,what areas of work are affected by poor sleep and what strategies people use to cope with work after a poor nights sleep.

To find out more, we are organising a series of group discussions ('Focus Groups') which will be held on the Loughborough University campus. These groups will include local people from different employment backgrounds who report poor sleep(about 7 per group), and will run for about 1 hour. During this time a member of the research team will introduce points for discussion and invite views and comments from those attending. All discussions will be conducted privately in a comfortable 'sitting room' environment.

Each meeting will be recorded on minidisk from which a transcript will be produced and securely stored on a PC. We will then analyse this transcript and note relevant views, points and issues which arose during the course of the discussion. A detailed report will then be prepared describing the findings from this work. Anonymous information from this study may be used in further research in this area.

To protect your anonymity, the minidisk recordings will be erased within one year of the transcript being produced. Furthermore, the transcript will not identify any of the participants by name, so all views and comments will remain anonymous.

Transport costs to and from the university will be paid for each person taking part in the focus group. Tea, coffee and biscuits will be available throughout the discussion. Each participant will receive a £15.00 Marks and Spencer gift voucher.

Participation in the Focus Group is, of course, entirely voluntary. Participants are free to leave at any time during the discussion if they wish to discontinue taking part.

If you would like to discuss any aspect of this work, or you participation in it, please ask. We will be pleased to answer any questions.

Consent Form

Exploring the Occupational Impact of Sleep Quality

Principal Investigator- Erica Kucharczyk;

Contact email: E.kucharczyk@lboro.ac.uk Telephone: 07845 697628

Thank you for reading the attached information sheet about the focus group study. Please read through the bullet points below and sign at the bottom of the sheet to indicate that you've given consent to take part.

- I have read the attached information sheet on this study. I have been able to ask questions about the study.
- I know how to contact Erica Kucharczyk (the researcher) if I have any further questions about the study
- I understand that my participation is voluntary and that I can leave at any time or withdraw my data.
- I give permission to be tape recorded and for my data to be used in future research as long as I am identified by a pseudonym (alternative name).

Name of participant…… Date…….. Signature……

Name of researcher…… Date……..Signature……..

Debrief Sheet

Thank you for taking part in this study. Your participation is greatly appreciated. The dialogue from the conversation will now be typed up and analysed by the researcher. You will be identified in the transcription using a pseudonym and all recorded conversations and consent sheets will be kept securely in a locked filing cabinet that only the researcher has access too.

If you wish to contact the researcher Erica Kucharczyk, you can do so on 01509 223049 or by email on **E.kucharczyk@lboro.a.uk**.

If you wish to talk to anybody about your sleep, contact your GP for further support.

If any issues have arisen which have caused you any distress, you can contact The Samaritans on 08457 90 90 90 for confidential advice.

APPENDIX B

Chapter 3: Recruitment advert/information sheet

Consent form (also used in Chapters 4-6)

Recruitment advert

Loughborough University is conducting research into the ways people feel that poor sleep may affect them in the workplace. We are particularly interested in how sleep plays a role in your working life and different areas of work which may be affected.

If you are aged 18-65, in full time employment and would like to take part, please follow the link to www.surveymonkey.com/LOISS to complete a survey on sleep and work. Your responses will be anonymised and all data will be stored securely.

The survey should take around 15 minutes to complete.

If for any reason you are not happy with how this research was conducted, Loughborough University has a policy relating to Research Misconduct and Whistle Blowing which is available online at http://www.lboro.ac.uk/admin/committees/ethical/Whistleblowing(2).htm. Alternatively, we can explain this over the telephone (01509 223049).

Informed consent form

<Insert Name of Research Proposal>

(to be completed after Participant Information Sheet has been read)

The purpose and details of this study have been explained to me. I understand that this study is designed to further scientific knowledge and that all procedures have been approved by the Loughborough University Ethical Advisory Committee.

- I have read and understood the information sheet and this consent form.
- I have had an opportunity to ask questions about my participation.
- I understand that I am under no obligation to take part in the study.

I understand that I have the right to withdraw from this study at any stage for any reason, and that I will not be required to explain my reasons for withdrawing.

I understand that all the information I provide will be treated in strict confidence and will be kept anonymous and confidential to the researchers unless (under the statutory obligations of the agencies which the researchers are working with), it is judged that confidentiality will have to be breached for the safety of the participant or others.

I agree to participate in this study.

Your name _____

Your signature _____

Signature of investigator _____

Date _____

APPENDIX C

The Pittsburgh Sleep Quality Index (Buysse et al 1989): used in Chapters 2-5

Loughborough University

The Pittsburgh Sleep Quality Index

Instructions:

The following questions relate to your usual sleep habits **during the past month *only***. Your answers should indicate the most accurate reply for the *majority* of days and nights in the past month. Please answer all the questions.

1. During the past month, when have you usually gone to bed at night?

   usual bed time_____

2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night?

   number of minutes_____

3. During the past month, when have you usually got up in the morning?

   usual getting up time_____

4. During the past month, how many hours of *actual* sleep did you get at night? (This may be different than the number of hours you spend in bed).

   hours of sleep per night_____

For each of the remaining questions, tick (✓) the one best response. Please answer *all* questions.

5. During the past month, how often have you had trouble sleeping because you……

(a) Cannot get to sleep within 30 minutes

Not during the past month	Less than once a week	Once or twice a week	three or more times a week

During the past month, how often have you had trouble sleeping because you……

(b) Wake up in the middle of the night or early morning

Not during the past month	Less than once a week	Once or twice a week	Three or more times a week

(c) Have to get up to use the bathroom

Not during the past month	Less than once a week	Once or twice a week	three or more times a week

(d) Cannot breathe comfortably

Not during the past month	Less than once a week	Once or twice a week	three or more times a week

(e) Cough or snore loudly

Not during the past month____	Less than once a week_____	Once or twice a week_____	three or more times a week____

(f) Feel too cold

Not during the past month____	Less than once a week_____	Once or twice a week_____	three or more times a week____

(g) Feel too hot

Not during the past month____	Less than once a week_____	Once or twice a week_____	three or more times a week____

(h) Had bad dreams

Not during the past month____	Less than once a week_____	Once or twice a week_____	three or more times a week____

(i) Have pain

Not during the past month____	Less than once a week_____	Once or twice a week_____	three or more times a week____

(j) Other reason(s) you have had trouble spleeping (please describe)_____
_____
_____

How often during the past month have you had trouble sleeping because of this?

Not during the past month____	Less than once a week_____	Once or twice a week_____	three or more times a week____

6. During the past month, how would you rate your sleep quality overall?

Very good _____
Fairly good _____
Fairly bad _____
Very bad _____

7. During the past month, how often have you taken medicine (prescribed or " over
the counter") to help you sleep?

Not during the past month____	Less than once a week_____	Once or twice a week_____	three or more times a week____

8. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

Not during the past month____	Less than once a week_____	Once or twice a week_____	three or more times a week____

9. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?

No problem at all _____

Only a very slight problem _____

Somewhat of a problem _____

A very big problem _____

10. Do you have a bed partner or roommate?

No bed partner or roommate_____

Partner/roommate in other room_____

Partner in same room, but not same bed_____

Partner in same bed_____

11. How often do you feel tired during the following times during the day?

Morning:

0	1	2	3
most days	often	occasionally	never

Afternoon:

0	1	2	3
most days	often	occasionally	never

Evening:

0	1	2	3
most days	often	occasionally	never

Thank-you for completing the questionnaire

APPENDIX D

The Epworth Sleepiness Scale (Johns 1991) : Used in Chapters 2-5 & 7.

Loughborough University

The Epworth Sleepiness Scale

How likely are you to doze off or fall asleep in the following situations, in contrast to just feeling tired? This refers to your usual way of life in recent times. Even if you have not done some of these things recently, try to work out how they would have affected you.

Use the following scale to choose the most appropriate number for each situation:

0 - would never doze

1 - slight chance of dozing

2 - moderate chance of dozing

3 - high chance of dozing

Situation/Chance of Dozing

Sitting and reading	
Watching TV	
Sitting, inactive in a public place (e.g. Cinema)	
As a passenger in a car for an hour with out a break	
Lying down to rest in the afternoon when given a chance	
Sitting and talking to someone	
Sitting quietly after lunch without alcohol	
In a car, while stopped for a few minutes in traffic	

APPENDIX E

40-item prototype Loughborough Occupational Impact of Sleep Scale :used in Chapters 2 & 3.

Loughborough University

The Loughborough Occupational Impact of Sleep Scale (LOISS)

Quality of sleep can influence our ability to perform in the workplace. The following questions relate to ways in which your work performance may have been affected by your sleep **during the past 4 weeks**. Please Indicate (✓) how often each item applied to you. Answer **all** the questions.

During the past 4 weeks, how often did the quality of your sleep make it difficult for you to:

		Difficult all of the time	Difficult most of the time	Difficult some of the time	Difficult a little bit of the time	Never difficult /Not Applicable
1.	Wake up for work on time?					
2.	Work the required number of hours?					
3.	Arrive at work on time?					
4.	Get going easily at the beginning of the workday?					
5.	Balance your work with your free time?					
6.	Do your work without taking unauthorised breaks or rests?					
7.	Keep working effectively during the afternoon?					
8.	Concentrate on more than one task at a time?					
9.	Keep to a routine or schedule?					
10.	Be creative?					
11.	Prioritise easy and difficult tasks effectively?					
12.	Do work carefully?					
13.	Maintain your stamina throughout the day?					
14.	Speak to people on the telephone?					

15.	Focus on the more complex tasks related to your job?					
16.	Think clearly when working?					
17.	Concentrate on your work?					
18.	Contribute to team work?					
19.	Speak to people face to face?					
20.	Do your work without making mistakes?					
21.	Finish the workday on time?					
22.	Be assertive with people you encounter in the workplace?					
23.	Feel you have done what you are capable of doing?					
24.	Control your irritability at work?					
25.	Always answer your telephone when it rings?					
26.	Gain satisfaction from your work?					
27.	Remember to meet deadlines?					
28.	Handle the workload?					
29.	Work without losing your train of thought?					
30.	Easily read or use your eyes when working?					
31.	Get through the day without caffeinated drinks?					
32.	Start on your job as soon as you arrive at work?					
33.	Keep your mind on your work?					
34.	Stay awake during a shift?					
35.	Control your temper around people when working?					
36.	Focus on a computer screen?					
37.	Learn new tasks or skills?					
38.	Do more than “just enough” work?					
39.	Work fast enough					
40.	Contribute to meetings					

THANK YOU

Appendix F

The Loughborough Occupational Impact of Sleep Scale (Kucharczyk et al. 2011): used in Chapters 3-7.

The Loughborough Occupational

Impact of Sleep Scale (LOISS)

Instructions:

Quality of sleep can influence our ability to perform in the workplace. The following questions relate to ways in which your work performance may have been affected by your sleep **during the past 4 weeks**. Please indicate (✓) how often each item applied to you. Answer **all** the questions.

During the past 4 weeks, how often did the quality of your sleep make it difficult for you to:

		Difficult all of the time	Difficult most of the time	Difficult some of the time	Difficult a little bit of the time	Never difficult/ Not applicable to my job
1.	Arrive at work on time					
2.	Do work without taking unauthorised rests or breaks					
3.	Concentrate on more than one task at a time					
4.	Do work carefully					
5.	Maintain your stamina throughout the day					
6.	Focus on the more complex task related to your job					
7.	Speak to people face to face					
8.	Do your work without making mistakes					

9.	Finish the work day on time					
10.	Feel you have done what you are capable of doing					
11.	Control your irritability at work					
12.	Gain satisfaction from your work					
13.	Handle the workload					
14.	Easily read or use your eyes when working					
15.	Keep your mind on your work					
16.	Stay awake at work					
17.	Learn new tasks or skills					
18.	Do more than just enough work					
19.	Work fast enough					

Thank you for completing the questionnaire.

 Developed by Kucharczyk E[1], Morgan K[1], David B[1], Hall A [2].
[1] Loughborough University. [2] University Hospitals Leicester.

APPENDIX G

Chapter 4: Information sheet

Sleep and Work Survey

What is the purpose of the study?

Research suggests that quality of sleep can influence our ability to perform in the workplace. The Loughborough Occupational Impact of Sleep Scale (LOISS) has recently been developed to look at the relationship between sleep quality and work performance. We are interested in using the LOISS to look at occupational performance over time. This is an online survey which records your responses anonymously and takes no more than 10 minutes to complete. You will be sent a link for the survey, then in two weeks time, you will be sent a link to another survey (which will also take less than 10 minutes to complete).

Who is doing this research and why?

This study is part of a student research project funded by Loughborough University. The lead researcher is Charanpreet Sohal, assisted by Erica Kucharczyk and supervised by Professor Kevin Morgan.

Are there any exclusion criteria?

Participants should be aged 18+ and in paid employment.

Once I take part, can I change my mind?

Yes! After you have read this information and asked any questions you may have you will be sent the link to the questionnaire within the next few days and can give informed consent to take part. However if at any time, before, during or after the research you wish to withdraw from the study please just contact the main investigator. You can withdraw at any time, for any reason and you will not be asked to explain your reasons for withdrawing.

Will I be required to attend any sessions and where will these be?

No.

How long will it take?

The questionnaire should take no more than 10 minutes to complete at each time point- so your total time contribution should be around 15-20 minutes.

What personal information will be required from me?

We will collect demographic information such as age, gender and occupational type as well as asking questions about your sleep and your occupational performance.

Are there any risks in participating?

No.

Will my taking part in this study be kept confidential?

All data gathered during the study will be kept confidential in line with the Loughborough University data protection policy. Your name will not be required on the questionnaire or be used to identify you in the study.

What will happen to the results of the study?

The results will form part of a final year undergraduate project for Charanpreet Sohal and will contribute to part of a PhD thesis for Erica Kucharczyk.

I have some more questions who should I contact?

Please contact Charanpreet Sohal at C.K.Sohal-08@student.lboro.ac.uk or Erica Kucharczyk at E.kucharczyk@lboro.ac.uk.

What if I am not happy with how the research was conducted?

The University has a policy relating to Research Misconduct and Whistle Blowing which is available online at http://www.lboro.ac.uk/admin/committees/ethical/Whistleblowing(2).htm.

APPENDIX H

Chapter 5: Recruitment letter

The East Midlands Work and Sleep Survey:

Loughborough University

East Midlands Work and Sleep Survey

Dear (Name)

The Sleep Research Centre at Loughborough University is conducting a survey into how sleep quality can affect our ability to perform well at work. Your name has been selected at random from the Nottingham City Electoral Roll, and we are writing to invite you to consider taking part. Participation is, of course, entirely voluntary, and any information you provide will be treated as confidential.

If you are currently in paid employment and would like to take part all you need to do is read and return the enclosed FREEPOST card. You don't need to fill anything in at this stage. When we receive your card we will post the questionnaire to you which you can return to us in the FREEPOST envelope provided.

Alternatively, you can complete the survey online at a secure website by typing **http://**www.surveymonkey.com/worksleep into your internet browser. You will need to enter the password "**sleep**" to access the survey. When prompted, please enter your unique study number ******.

Everyone who returns the questionnaire by post or completes it online by June 30th will be entered into a prize draw with an opportunity to win a *Love2Shop* gift voucher (accepted in 20,000 top UK stores) worth £50, £20 or £10.

The questionnaire will take approximately 15 minutes to complete. If you agree to take part, you will be assigned an individual number so that your name will not appear on the questionnaire. All returned questionnaires will be destroyed before October 2010. If, after returning the questionnaire, you change your mind, then you can also withdraw your responses from the research. All you need to do is contact us and provide your individual number (so keep it safe). You will not be asked to explain your reasons for withdrawing.

If you have any questions about this research, we will be pleased to respond. You can contact Erica Kucharczyk either by email at e.kucharczyk@lboro.ac.uk or telephone 01509 223049.

If for any reason you are not happy with how this research was conducted, Loughborough University has a policy relating to Research Misconduct and Whistle Blowing which is available online at http://www.lboro.ac.uk/admin/committees/ethical/Whistleblowing(2).htm. Alternatively, we can explain this over the telephone (01509 223049).

We do hope you will agree to help us.

Yours sincerely

Professor Kevin Morgan

The Clinical Sleep Research Unit

Loughborough University

East Midlands

Work and Sleep Survey

Please complete ALL questions and return

in the FREEPOST envelope provided.

THANK YOU

Loughborough University

Loughborough Sleep Research Centre

Please answer the following questions about you, your health and your occupation.

All responses will be kept confidential.

About you

Please tick (✓) the appropriate boxes where indicated :

1. Are you :

Male ☐ Female ☐

2. What is your age? _____

3. How much do you weigh? _____ (kg/stones/pounds)
Delete as applicable.

4. How tall are you? _____ (feet/metres/cm)
Delete as applicable.

5. What is your ethnic background?

i) White – British, Irish, Other White background ☐

ii) Mixed – White and Black Caribbean, White and Black African, White and Asian, other mixed background ☐

iii) Asian or Asian British- Indian, Pakistani, Bangladeshi, other Asian background ☐

iv) Black or Black British – Caribbean, African, Other Black background ☐

v) Chinese or other ethnic group – Chinese, any other ☐

YOUR OCCUPATION

6. What is the full title of your job ?

_____

7. How would you describe your industry, business or workplace? (e.g. engineering, insurance, hospital, school)

_____

8. How many hours do you usually work per week? ☐

9. Would you describe your work as:

Day time work (e.g. 9am – 5pm) ☐

Shift work – day time only ☐

Shift work – including nights ☐

10. Would you describe yourself as:

An Employee ☐ Self-Employed ☐

YOUR HEALTH

By placing a tick (✓) in one box in each group below, please indicate which statements best describe your own health state today.

11. **Mobility**

I have no problems in walking about ☐

I have some problems in walking about ☐

I am confined to bed ☐

12. **Self-Care**

I have no problems with self-care ☐

I have some problems washing or dressing myself ☐

I am unable to wash or dress myself ☐

13. **Usual Activities** (*e.g. work, study, housework, family or leisure activities)*

I have no problems with performing my usual activities ☐

I have some problems with performing my usual activities ☐

I am unable to perform my usual activities ☐

14. **Pain/Discomfort**

I have no pain or discomfort ☐

I have moderate pain or discomfort ☐

I have extreme pain or discomfort ☐

15. **Anxiety/Depression**

I am not anxious or depressed ☐

I am moderately anxious or depressed ☐

I am extremely anxious or depressed ☐

16. How would you rate your health today?

To help you say how good or bad your health state is, here is a scale (from 0 to 10) on which the best state you can imagine is 10 and the worst state you can imagine is 0. Please circle the number that best applies to you.

0 1 2 3 4 5 6 7 8 9 10

Worst imaginable health state

Best imaginable health state

About your sleep quality

Instructions:

The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all the questions.

17. During the past month, when have you usually gone to bed at night?

usual bed time _____

18. During the past month, how long (in minutes) has it usually taken you to fall asleep each night?

number of minutes _____

19. During the past month, when have you usually got up in the morning?

usual getting up time _____

20. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spend in bed).

hours of sleep per night _____

21. During the past month, how often have you had trouble sleeping because you…

For each of the remaining questions, tick (✓) the most relevant response. Please answer all questions.

	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
Cannot get to sleep within 30 minutes				
Wake up in the middle of the night or early morning				
Have to get up to use the bathroom				
Cannot breathe comfortably				
Cough or snore loudly				
Feel too cold				
Feel too hot				
Had bad dreams				

Have pain				

If there are any other reason(s) you have had trouble sleeping please describe:

22. If you provided other reasons for having trouble sleeping in the box above, please indicate how often this has affected your sleep over the past month.

Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
☐	☐	☐	☐

23. During the past month, how would you rate your sleep quality overall?

Very good	Fairly good	Fairly bad	Very bad
☐	☐	☐	☐

24. During the past month, how often have you taken medicine (prescribed or “over the counter”) to help you sleep?

Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
☐	☐	☐	☐

25. During the past month, how often have you had trouble staying awake while driving, eating meals or engaging in social activity?

Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
☐	☐	☐	☐

26. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?

No problem at all	Only a very slight problem	Somewhat of a problem	A very big problem
☐	☐	☐	☐

27. Do you have a bed partner or roommate?

No bed partner or room-mate	Partner or room-mate in other room	Partner in same room, but not same bed	Partner in same bed
☐	☐	☐	☐

28. How often do you feel tired during the following times during the day? (Please tick (✓) one box for each time of day)

	Most days	Often	Occasionally	Never
Morning				
Afternoon				
Evening				

29. Over the past month have you consumed any of the following to help you sleep? Please tick all that apply.

Alcohol ☐

Medicines purchased from a pharmacy e.g. Nytol ☐

Medicines purchased from the internet ☐

Herbal tablets or compounds e.g. valerian, Nytol Herbal ☐

Herbal teas e.g. camomile ☐

Milk drinks e.g. Horlicks, milk, hot chocolate ☐

Is the anything else you consume to help you sleep? (Please specify)

30. Over the past month have you consumed any of the following to reduce feelings of sleepiness? Please tick all that apply.

Caffeinated drinks e.g. tea, coffee ☐

“Energy” drinks, e.g. Red Bull ☐

High sugar drinks e.g. cola ☐

Sugary snack e.g. chocolate, sweets ☐

Over the counter stimulants e.g. Pro Plus ☐

Is the anything else you consume to reduce daytime sleepiness? (Please specify)

31. How likely are you to doze off or fall asleep in the following situations, in contrast to just feeling tired? This refers to your usual way of life in recent times. Even if you have not done some of these things recently, try to work out how they would have affected you.

	I would never doze	I would have a slight chance of dozing	I would have a moderate chance of dozing	I would have a high chance of dozing
Sitting & reading				
Watching TV				
Sitting, inactive in a				

public place (e.g. cinema)				
As a passenger in a car for an hour without a break				
Lying down to rest in the afternoon when given the chance				
Sitting and talking to someone				
Sitting quietly after lunch without alcohol				
In a car, while stopped for a few minutes in traffic				

Instructions:

Quality of sleep can influence our ability to perform in the workplace. The following questions relate to ways in which your work performance may have been affected by your sleep **during the past month**. Please Indicate (✓) how often each item applied to you. Answer **all** the questions.

During the past month, how often did the <u>quality of your sleep</u> make it difficult for you to…

	Difficult all of the time	Difficult most of the time	Difficult some of the time	Difficult a little bit of the time	Never difficult/ Not Applicable
Arrive at work on time					
Do work without taking unauthorised rests or breaks					
Concentrate on more than one task at a time					
Do work carefully					
Maintain your stamina throughout the day					
Focus on the more complex task related to your job					

Speak to people face to face					
Do your work without making mistakes					
Finish the work day on time					

During the past 4 weeks, how often did **the quality of your sleep** make it difficult for you to:

	Difficult all of the time	Difficult most of the time	Difficult some of the time	Difficult a little bit of the time	Never difficult/Not applicable to my job
Feel you have done what you are capable of doing					
Control your irritability at work					
Gain satisfaction from your work					
Handle the workload					
Easily read or use your eyes when working					

Keep your mind on your work					
Stay awake at work					
Learn new tasks or skills					
Do more than just enough work					
Work fast enough					

Appendix I

Chapter 6: The Walking Works Wonders questionnaire

Walking Works Wonders questionnaire

www.walkingworkswonders.com

Working late is a study being carried out by Loughborough University's Work and Health Research Centre. The project aims to help ensure that individuals are able to maintain their ability to work by looking at how the health of people in the workplace can be improved and maintained. This is important as many people now have to work much later in their lives than ever before.

This questionnaire asks a number of questions about your current job role, activity, wellbeing and your feelings towards work. As an employee taking part in our **Walking Works Wonders** activity initiatives, the purpose of this questionnaire is to periodically measure your progress. This information will be used along with your physiological measurements (weight, body fat, blood pressure, heart rate, etc.) and the record from your pedometer which we hope you will be regularly updating at: www.walkingworkswonders.com

The questionnaire takes approximately 20 minutes to complete. Please read each question carefully before answering. There are no right or wrong answers, so please respond freely and honestly as we are interested in your own experiences and opinions. If you have more than one job, please complete the questionnaire in relation to your job where your employer is participating in the Walking Works Wonders initiative.

Information provided will be held only by Loughborough University, used for the purposes of this research and will conform to the requirements of the Data Protection Act 1998. Your information will be stored against a reference number, not your name, to ensure complete anonymity. We will not share individual responses with your employer, and summary information will not be shared in anyway that could be used to reveal your identity.

If you have any questions about this survey, please contact:

Mr Aadil Kazi [A.Kazi@lboro.ac.uk] 01509 228484
Ms Myanna Duncan [M.Duncan@lboro.ac.uk] 01509 223942

I understand that I am under no obligation to take part in the study. I understand that I have the right to withdraw from this study at any stage for any reason. I understand that all the information I provide will be treated in strict confidence and will be kept anonymously.

Please tick to show that you agree to participate in this research: ☐

SECTION 1: ABOUT YOU

Please note that we are asking you to provide your name so that we can track your progress over the course of the **Walking Works Wonders** initiative. All your responses will be kept strictly confidential to the researchers and we will not share any individual responses with your employer. Your responses will be stored electronically against an identification number and not your name.

Name _____

Please enter your email address so that we can provide you with access to log into the **www.walkingworkswonders.com** website. You will then be able to record your pedometer data and get feedback on your step count data. Only employees from participating organisations will be allowed access to the site.

Email Address _____

As stated, the following questions are anonymous; answers will not be used to identify individuals. We would first like to ask some background information about you. This information is very useful as it will help us look for patterns within and between organisations.

Please tick or write the answer that best applies to you in the space provided.

1.1 Gender: ☐ Male ☐ Female

1.2 Age: _____ years

1.3 What is your marital status?

☐ Single ☐ Separated
☐ Married ☐ Divorced
☐ Cohabiting ☐ Widowed

1.4 Ethnicity (please tick only one)

a) White	British	☐	b) Mixed	White and Black Caribbean	☐
	Irish	☐		White and Black African	☐
	Any other White background	☐		White and Asian	☐
				Any other Mixed background	☐
c) Asian or	Indian	☐			
Asian British	Pakistani	☐	d) Black or	Caribbean	☐
	Bangladeshi	☐	Black British	African	☐
	Chinese	☐		Any other Black background	☐
	Any other Asian background	☐			

e) Any other ethnic background, please specify: _____

f) Ethnic background not known ☐

1.5 What is the highest educational qualification you hold?

☐ CSE or equivalent / GCSE (Grades D – G)
☐ O-level or equivalent / GCSE (Grades A – C)
☐ AS/A-level or equivalent
☐ Degree or equivalent
☐ Post-graduate degree or equivalent
☐ Vocational qualifications (e.g. BTEC, NVQ)
☐ No formal qualifications
☐ Other (please specify):

_____

SECTION 2: ORGANISATIONAL INFORMATION

The following questions relate to your current employment and job role. This is so we can look at how wellbeing differs across different job roles and work sectors. If you have more than one job, please complete the questionnaire in relation to your job where your employer is participating in the Walking Works Wonders initiative.

2.1 Name of employer? _____

2.2 What is the name of the department or group that you work in?

_____

2.3 What is your job title? _____

a) If you are married or cohabiting, what is your partners' occupation / job title?

_____

2.4 Is your job:

☐ Permanent Full-time
☐ Permanent Part-time
☐ Permanent Job-share
☐ Fixed-term/temporary contract

2.5 How many hours does your employer expect you to work in a typical 7-day week?
If it varies, estimate the average _____hours

2.6 About how many hours altogether did you work in the past 4 weeks (28 days)?
(For example, 40 hours per week for 4 weeks = 160 hours; 35 hours per week for 4 weeks = 140 hours.) **Round to the nearest hour.** _____hours

2.7 How long have you worked for this organisation? _____years _____months

2.8 How long have you worked in this current job role? _____years _____months

2.9 What type of organisation do you work for? (please tick only one)

☐ Banking
☐ Computing & I.T
☐ Construction
☐ Education
☐ Energy & Utilities
☐ Engineering
☐ Financial
☐ Health & Social Work
☐ Hospitality
☐ Local Government
☐ Manufacturing
☐ Public Defence
☐ Retail
☐ Telecoms
☐ Transport

☐ Other (please state): _____

2.10 What is your annual income from your job, before taxes?

☐ £5,000 - £9,999
☐ £10,000 - £14,999
☐ £15,000 - £19,999
☐ £20,000 - £24,999
☐ £25,000 - £29,999
☐ £30,000 - £34,999
☐ £35,000 - £39,999
☐ £40,000 - £44,999
☐ £45,000 - £49,999
☐ £50,000 - £54,999
☐ £55,000 - £59,999
☐ £60,000 - £64,999
☐ £65,000 - £69,999
☐ £70,000 – £74,999
☐ More than £75,000

SECTION 3: LIFESTYLE INFORMATION

For this section we are interested in information about your lifestyle and your current physical activity levels. This will allow us to look at what types of physical activity people typically engage in.

3.1 Are you a smoker? ☐ Yes ☐ No

a) If yes, how many cigarettes per day? _____cigarettes per day

3.2 If no, have you smoked in the past? ☐ Yes ☐ No

a) If yes, how long ago did you quit? _____years _____months

3.3 During the last 7 days, on how many days did you do <u>vigorous</u> physical activities like heavy lifting, digging, aerobics, or fast bicycling?
Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

_____**days per week** ☐ No vigorous physical activities (go to question 3.4)

a) How much time did you usually spend doing **vigorous** physical activities on one of those days?

_____hours per day _____minutes per day

3.4 During the last 7 days, on how many days did you do <u>moderate</u> physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis?
Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time. **Do not include walking**.

_____**days per week** ☐ No moderate physical activities (go to question 3.5)

a) How much time did you usually spend doing **moderate** physical activities on one of those days?

_____hours per day _____minutes per day

3.5 During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

_____**days per week** ☐ No walking (go to question 3.6)

a) How much time did you usually spend **walking** on one of those days?

_____hours per day _____minutes per day

3.6 Are you satisfied with the amount of physical activity/exercise you do?

☐ Yes ☐ No

3.7 Are you planning to increase the amount of physical activity/exercise you do?

☐ Yes ☐ No (go to question 3.8)

a) If yes, are you planning to increase the amount of physical activity/exercise you do within the next 6 months?

☐ Yes ☐ No (go to question 3.8)

b) If yes, are you planning to increase the amount of physical activity/exercise you do within the next month?

☐ Yes ☐ No (go to question 3.8)

3.8 Have you recently increased your levels of physical activity/exercise?

☐ Yes ☐ No (go to question 3.9)

a) If yes, did you make this change… ☐ within the last 6 months

☐ more than 6 months ago

3.9 Have you ever worn a pedometer? (a pedometer is a small device used to measure your daily step count and is usually worn on your waistband)

☐ Yes ☐ No

3.10 Please estimate how much time you spend <u>sitting</u> in each of the following activities on a typical <u>working</u> day and a typical <u>non-working</u> day (weekend day or day off)

	Work Day		Non-Work Day	
	Hours	Mins	Hours	Mins
a) While travelling to and from places				
b) While at work				
c) While watching television				
d) While using a computer at home				
e) In your leisure time NOT including television (e.g. visiting friends, movies, dining out, etc.)				

3.11 Please estimate how much time you spend <u>sleeping</u> or <u>lying down</u> on a typical <u>working</u> day and night, and a typical <u>non-working</u> day and night (weekend or day off)

	Work Day		Non-Work Day	
	Hours	Mins	Hours	Mins
a) Sleeping at night (or trying to sleep)				
b) Lying down with your feet up (e.g. resting,watching TV)				

3.12 How often do you usually participate in the following activities:	Never/rarely	Occasionally	Most of the time	All of the time	Not applicable
a) Climb the stairs instead of using the lift or the escalator	☐	☐	☐	☐	☐
b) Park your vehicle away from your destination so you have to walk further	☐	☐	☐	☐	☐
c) Walk or cycle to destinations that are within a 5 minute drive from where you live, rather than drive	☐	☐	☐	☐	☐
d) Get off the bus stop early to add a walk	☐	☐	☐	☐	☐
e) Walk to talk to a colleague instead of using e-mail or the telephone	☐	☐	☐	☐	☐
f) Move about whilst talking on the telephone	☐	☐	☐	☐	☐

SECTION 4: PHYSICAL ACTIVITY AT WORK

For this section we are interested in how physically active you are at work. This will allow us to look at how physical activity differs across different job roles, work sectors and organisations.

4.1 How far do you travel to work?

☐ Under 1 mile ☐ 1-5 miles ☐ 6-10 miles ☐ 11-19 miles ☐ 20 miles or more

4.2 How do you normally travel to and from work? (please tick only one)

☐ Car (driver or passenger) ☐ Cycle ☐ Motorbike ☐ Public transport (e.g. bus, train) ☐ Walk ☐ Work at home

☐ Other (please state):_____

4.3 In a usual week, do you perform any <u>standing</u> activities while at work?

☐ Yes ☐ No

a) If yes, for how many hours on a typical workday?

_____hours _____minutes per day

4.4 In a usual week, do you perform any <u>walking</u> activities while at work?

☐ Yes ☐ No

a) If yes, for how many hours on a typical workday?

_____hours _____minutes per day

4.5 In a usual week, do you perform any <u>heavy labour</u> activities while at work?

☐ Yes ☐ No

b) If yes, for how many hours on a typical workday?

_____hours _____minutes per day

SECTION 5: WORK ABILITY

Work ability is your capability to manage your work demands and perform all of your work duties. These questions aim to explore how your overall health affects your work ability.

5.1 Are the demands of your work primarily;

☐ Mental ☐ Physical ☐ Both mental and physical

5.2 Current work ability compared with the lifetime best

Assume that your work ability at its best has a value of 10 points. Please circle the points you would give your current work ability (over the past 4 weeks) (1 means that you cannot currently work at all).

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
completely unable to work											work ability at its best

5.3 Work ability in relation to the demands of the job

a. How do you rate your current work ability with respect to the physical demands of your work?

Very poor	Rather poor	Moderate	Rather good	Very good
☐	☐	☐	☐	☐

b. How do you rate your current work ability with respect to the mental demands of your work?

Very poor	Rather poor	Moderate	Rather good	Very good
☐	☐	☐	☐	☐

5.4 Estimated work impairment due to diseases

Do you have an illness or injury that is a hindrance to you current job? (Please tick only one)

☐ In my opinion, I am entirely unable to work
☐ Because of my disease, I feel I am able to do only part-time work
☐ I must **often** slow down my work pace or change my work methods
☐ I must **sometimes** slow down my work pace or change my work methods
☐ I am able to do my job, but it causes some symptoms
☐ There is no hindrance/**I have no diseases**

5.5 In the past year (12 months), how many whole days have you been off work because of a health problem (disease or health care or for health examination)?

_____days

5.6 In the past 4 weeks (28 days), how many whole days have you been off work because of a health problem (disease or health care or for health examination)?

_____days

5.7 In the past year (12 months), how many whole days have you gone to work despite feeling that you should have taken sick leave due to your state of health?

_____days

5.8 In the past 4 weeks (28 days), how many days did you come in early, go home late, or work on your day off? (please enter a whole number only)

_____days

5.9 Own prognosis of work ability two years from now

Do you believe that, from the standpoint of your health, you will be able to do your current job two years from now?

☐ Unlikely ☐ Not Certain ☐ Relatively Certain

5.10 Number of <u>current</u> health conditions. In the following list, please mark your current conditions, diseases or injuries that have been **diagnosed** by a physician.	**Yes**	**No**
a) Injury from accident If yes, please describe ……	☐	☐
b) Musculoskeletal disease (e.g. back pain, upper or lower back disorders, sciatica) If yes, please describe ……	☐	☐
c) Cardiovascular disease (e.g. high blood pressure, heart disease, heart attack) If yes, please describe ……	☐	☐
d) Respiratory disease (e.g. chronic bronchitis, chronic sinusitis, asthma) If yes, please describe ……	☐	☐
e) Mental disorder (e.g. depression, tension, anxiety, insomnia, mental disturbance) If yes, please describe ……	☐	☐
f) Neurological and sensory disease (e.g. migraine, epilepsy, hearing/visual) If yes, please describe ……	☐	☐
g) Digestive disease (e.g. gall stones, liver/pancreatic disease, gastric ulcer) If yes, please describe ……	☐	☐
h) Genitourinary disease (e.g. urinary tract infection, fallopian tube/prostatic infection) If yes, please describe ……	☐	☐
i) Skin disease (e.g. allergic rash, eczema) If yes, please describe ……	☐	☐
j) Tumour (e.g. benign tumour, malignant tumour/cancer) If yes, please describe ……	☐	☐
k) Endocrine and metabolic diseases (e.g. obesity, diabetes, thyroid disease) If yes, please describe ……	☐	☐
l) Blood diseases (e.g. anaemia) If yes, please describe ……	☐	☐
m) Birth defects If yes, please describe ……	☐	☐
n) Other disorder or disease (not previously mentioned) If yes, please describe ……	☐	☐

5.11 Mental Resources	**Never**	**Rather Seldom**	**Some times**	**Rather Often**	**Often**
a) Have you recently been able to enjoy your regular daily activities?	☐	☐	☐	☐	☐
b) Have you recently been active and alert?	☐	☐	☐	☐	☐
c) Have you recently felt yourself to be full of hope for the future?	☐	☐	☐	☐	☐

5.12 On a scale from 0 to 10 where 0 is the worst job performance anyone could have at your job and 10 is the performance of a top worker, how would you rate (please circle):

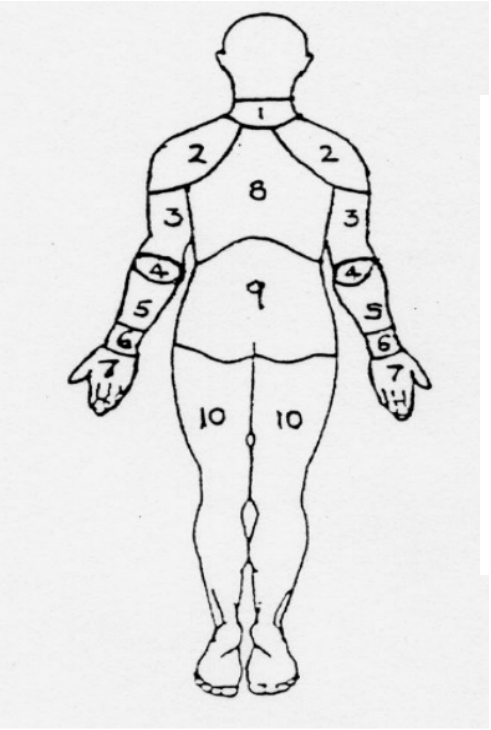
	worst performance										**top performance**
a) The usual performance of most workers in a job similar to yours?	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
b) Your usual job performance over the past year or two?	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
c) Your overall job performance on the days you worked during the past 4 weeks (28 days)**?**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

SECTION 6: PAIN / DISCOMFORT RATING

6.1 Have you felt any pain or discomfort in the last 7 days?

☐ Yes ☐ No (go to Section 7: Sleep Quality)

6.2 If yes, please indicate on the diagram below where you have felt pain or discomfort in the last 7 days.



1. Neck
2. Shoulders
3. Upper arms
4. Elbows
5. Forearms
6. Wrist
7. Hand
8. Upper Back
9. Lower Back
10. Legs

6.3 For each body part where you have indicated feeling discomfort, please mark a number on the scales below to show how much pain or discomfort you have felt (1 being minimal discomfort and 7 being extreme discomfort).

If you have not experienced any pain or discomfort, leave this section blank.

	Minimal discomfort						Extreme discomfort
1. Neck	1	2	3	4	5	6	7
2. Shoulders	1	2	3	4	5	6	7
3. Upper arms	1	2	3	4	5	6	7
4. Elbows	1	2	3	4	5	6	7
5. Forearms	1	2	3	4	5	6	7
6. Wrist	1	2	3	4	5	6	7
7. Hand	1	2	3	4	5	6	7
8. Upper back	1	2	3	4	5	6	7
9. Lower back	1	2	3	4	5	6	7
10. Legs	1	2	3	4	5	6	7

SECTION 7: SLEEP QUALITY

Quality of sleep can influence our ability to perform in the workplace. The following questions relate to ways in which your work performance may have been affected by your sleep **during the past 4 weeks**. Please indicate how often each item applied to you. Answer **all** the questions.

During the past 4 weeks, how often did the <u>quality of your sleep</u> make it difficult for you to:

	Difficult all of the time	Difficult most of the time	Difficult some of the time	Difficult a little bit of the time	Never difficult/ Not applicable
1) Arrive at work on time on time	☐	☐	☐	☐	☐
2) Do work without taking unauthorised rests or breaks	☐	☐	☐	☐	☐
3) Concentrate on more than one task at a time	☐	☐	☐	☐	☐
4) Do work carefully	☐	☐	☐	☐	☐
5) Maintain your stamina throughout the day	☐	☐	☐	☐	☐
6) Focus on the more complex task related to your job	☐	☐	☐	☐	☐
7) Speak to people face to face	☐	☐	☐	☐	☐
8) Do your work without making mistakes	☐	☐	☐	☐	☐
9) Finish the work day on time	☐	☐	☐	☐	☐
10) Feel you have done what you are capable of doing	☐	☐	☐	☐	☐
11) Control your irritability at work	☐	☐	☐	☐	☐
12) Gain satisfaction from your work	☐	☐	☐	☐	☐
13) Handle the workload	☐	☐	☐	☐	☐
14) Easily read or use your eyes when working	☐	☐	☐	☐	☐
15) Keep your mind on your work	☐	☐	☐	☐	☐
16) Stay awake at work	☐	☐	☐	☐	☐
17) Learn new tasks or skills	☐	☐	☐	☐	☐
18) Do more than just enough work	☐	☐	☐	☐	☐
19) Work fast enough	☐	☐	☐	☐	☐

SECTION 8: YOUR WELLBEING

Over the past 4 weeks, to what extent have you been able to do the following?	More so than usual	Same as usual	Less than usual	Much less than usual
1) Have you been able to concentrate on whatever you are doing?	☐	☐	☐	☐
2) Have you felt that you were playing a useful part in things?	☐	☐	☐	☐
3) Have you felt capable of making decisions about things?	☐	☐	☐	☐
4) Have you been able to enjoy your normal day-to-day activities?	☐	☐	☐	☐
5) Have you been able to face up to your problems?	☐	☐	☐	☐
6) Have you been feeling reasonably happy, all things considered?	☐	☐	☐	☐

	Not at all	No more than usual	Rather more than usual	Much more than usual
7) Have you lost much sleep over worry?	☐	☐	☐	☐
8) Have you felt constantly under strain?	☐	☐	☐	☐
9) Have you felt that you couldn't overcome your difficulties?	☐	☐	☐	☐
10) Have you been feeling unhappy and depressed?	☐	☐	☐	☐
11) Have you been losing self-confidence in yourself?	☐	☐	☐	☐
12) Have you been thinking of yourself as a worthless person?	☐	☐	☐	☐

SECTION 9: YOUR FEELINGS ABOUT WORK

To what extent do you agree with the following statements?	Strongly disagree	Disagree	Slightly disagree	Neither	Slightly agree	Agree	Strongly agree
1) All in all, I am satisfied with my job	☐	☐	☐	☐	☐	☐	☐
2) In general, I don't like my job	☐	☐	☐	☐	☐	☐	☐
3) In general, I like working here	☐	☐	☐	☐	☐	☐	☐
4) I am quite proud to be able to tell people who it is I work for	☐	☐	☐	☐	☐	☐	☐
5) I sometimes feel like leaving this employment for good	☐	☐	☐	☐	☐	☐	☐
6) I'm not willing to put myself out just to help the organisation	☐	☐	☐	☐	☐	☐	☐

To what extent do you agree with the following statements?	Strongly disagree	Disagree	Slightly disagree	Neither	Slightly agree	Agree	Strongly agree
7) Even if the firm were not doing too well financially, I would be reluctant to change to another employer	☐	☐	☐	☐	☐	☐	☐
8) I feel myself to be part of the organisation	☐	☐	☐	☐	☐	☐	☐
9) In my work I like to feel I am making some effort, not just for myself but for the organisation as well	☐	☐	☐	☐	☐	☐	☐
10) The offer of a bit more money with another employer would not seriously make me think of changing my job	☐	☐	☐	☐	☐	☐	☐
11) I would not recommend a close friend to join our staff	☐	☐	☐	☐	☐	☐	☐
12) To know that my own work had made a contribution to the good of the organisation would please me	☐	☐	☐	☐	☐	☐	☐
13) I feel a sense of personal satisfaction when I do this job well	☐	☐	☐	☐	☐	☐	☐
14) My opinion of myself goes down when I do this job badly	☐	☐	☐	☐	☐	☐	☐
15) I take pride in doing my job as well as I can	☐	☐	☐	☐	☐	☐	☐
16) I feel unhappy when my work is not up to my usual standard	☐	☐	☐	☐	☐	☐	☐
17) I like to look back on the day's work with a sense of a job well done	☐	☐	☐	☐	☐	☐	☐
18) I try to think of easy ways of doing my job effectively	☐	☐	☐	☐	☐	☐	☐
19) I often think about quitting	☐	☐	☐	☐	☐	☐	☐
20) I will probably look for a new job in the next year	☐	☐	☐	☐	☐	☐	☐
	Not at all	Unlikely	Slightly unlikely	Neither	Slightly likely	Likely	Extremely likely
21) How likely is it that you will actively look for a new job in the next year?	☐	☐	☐	☐	☐	☐	☐

Thank you for taking the time to complete this questionnaire. All the information provided will be valuable in helping to evaluate the Walking Works Wonders activity initiatives.

APPENDIX J

Chapter 7: Information sheet

Consent form

Participant Information Sheet

Study Title: **Assessing the utility of the Loughborough Occupational Impact of Sleep Scale(LOISS) in the clinical management of Obstructive Sleep Apnoea (OSA):a practice-based study.**

We would like you to take part in our research study. Before you decide we would like you to understand why the research is being done and what it would involve for you. You can take this information sheet home and read it. At your next appointment, one of our team will be present to go through the information sheet and answer any questions you may have. If you want to ask any questions before your next visit please contact the Chief Investigator, Erica Kucharczyk by email, telephone or post using the contact details at the end of this form.

Talk to others about the study if you wish. Part 1 of this information sheet will tell you the purpose of this study and what you will need to do if you take part. Part 2 gives you more detailed information about the conduct of the study. Ask us if anything is not clear.

Part One

What is the purpose of the study?

Obstructive sleep apnoea symptoms have been shown to impact workplace functioning by increasing the likelihood of absenteeism, accidents and injury as well as reducing cognitive functioning. This study will use a short questionnaire to observe occupational functioning before and after treatment with Continuous Positive Airway Pressure (CPAP; standard NHS treatment) in newly diagnosed Obstructive Sleep Apnoea patients. Should you choose to take part, all you would need to do is complete a short questionnaire (taking 5-10 minutes to complete) at your CPAP treatment set-up appointment and then complete the same questionnaire again at your CPAP follow up appointment. Your decision to opt out or take part in the study will not affect your treatment in any way and will not be recorded in your medical notes.

Who is doing this research and why?

The Sleep Research Centre at Loughborough University and The Sleep Laboratory at Leicester General Hospital set up the Occupational Impact of Sleep Quality research programme in 2008. As part of this research, a new questionnaire has been developed called the Loughborough Occupational Impact of Sleep Scale (or "LOISS" for short) which measures sleep related occupational functioning in people with sleep disorders. This research aims to gather information about occupational functioning in people with Obstructive Sleep Apnoea before and after treatment with Continuous Positive Airway Pressure. The research will help to raise understanding and awareness of the workplace needs of individuals with Obstructive Sleep Apnoea. The results from

this study will form part of a doctoral programme for the Chief Investigator, Erica Kucharczyk and will be supervised by Professor Kevin Morgan of Loughborough University and Dr Andrew Hall of The Sleep Laboratory at Leicester General Hospital

Why have I been invited?

You have been invited to take part in this study because **a)** your Clinician has identified you as having a new diagnosis of Obstructive Sleep Apnoea **b)** you are currently in paid employment **c)** you are aged between 18 and 65 and **d)** you have not been diagnosed with any other sleep disorder. We are aiming to recruit 120 other individuals who meet the same criteria.

Do I have to take part?

It is entirely up to you to decide to join the study. We will provide information about the study on this sheet and the Chief Investigator will be present at your next appointment to go through the study information again. If you agree to take part, we will then ask you to sign a consent form. You are free to withdraw at any time without giving a reason. This would not affect the standard of care you will receive.

What will happen to me if I take part?

To take part you only need to attend your standard sleep clinic outpatient appointments at Leicester General Hospital.

How long will it take?

Your involvement in the study would take place at two time points. At your next appointment where you will be set up with your CPAP treatment, the Chief Investigator will be present to go through the information sheet and answer any questions you may have with no obligation to take part. If you do choose to take part you will sign a consent form and then complete the short questionnaire. This should take 5-10 minutes to complete.

At your next standard outpatients appointment (your sleep technologist will arrange this with you), you will need to fill in the same questionnaires again which should take an additional 5-10 minutes at the end of your appointment. In total the study will take just 10-20 minutes of your time plus any time in which you may wish to ask questions of the researcher.

What will I be asked to do?

Following your CPAP set-up appointment you will be given a questionnaire by the Chief Investigator to complete following your outpatient appointment. The Chief Investigator will be present again to answer any questions you may have.

What are the possible disadvantages and risks of taking part?

There are no risks to participating in the study. All of your treatment will remain the same whether you choose to take part in the study or not. The only deficit to you will be 15-20 minutes of your time .

What are the possible benefits of taking part?

There are no clinical benefits to you taking part as you will receive the same treatment whether you choose to take part or not. However, the information we get from this study will help to improve our understanding of Obstructive Sleep Apnoea in employed persons.

What if there is a problem?

Any complaint about the way you have been dealt with during the study will be addressed. This detailed information is given in Part 2.

Will my taking part in the study be kept confidential?

Yes. We will follow ethical and legal practice and all information about you will be handled in confidence.

If the information in Part 1 has interested you and you are considering participation, please read the additional information in Part 2 before making any decision.

Part Two

What happens if I don't want to carry on with the study?

After you have read this information and asked any questions you may have at your next appointment we will ask you to complete an Informed Consent Form indicating that you would like to take part. However if at any time, before, during or after the sessions you wish to withdraw from the study please just contact the main investigator, Erica Kucharczyk by email, post or telephone using the contact details at the end of this form.

You can withdraw at any time, for any reason and you will not be asked to explain your reasons for withdrawing.

What if there is a problem?

If you have a concern about any aspect of this study, you should contact the researchers using the contact details at the end of this form, who will do the best to answer your questions. If you remain unhappy and wish to complain formally, Loughborough University has a policy relating to Research Misconduct and Whistle Blowing which is available online at http://www.lboro.ac.uk/admin/committees/ethical/Whistleblowing(2).htm.

What personal information will be required from me?

The Chief Investigator will ask you questions about your job type, working hours and occupational functioning in relation to your sleep. Your age, gender, body mass index and severity of your sleep apnoea will be provided by your clinician from your medical records.

Will my taking part in this study be kept confidential?

All responses you give in the course of the study will be kept confidential. You will be assigned an individual study number which will be used instead of your name on any documents or databases throughout the study. All data will either be kept in a locked cabinet or a password protected computer which only the Chief Investigator will have access to. Any raw data (paper questionnaires) will be destroyed when the study finishes (September 2011). Computerised data will be held for up to 10 years to allow for analysis and writing of articles using the data. No names will be held on file and you will not be identifiable in the dataset.

What will happen to the results of the research study?

The results from the study will form part of the Chief Investigator's doctoral thesis. The findings from the study may be published in a medical journal or presented at a conference. No individual information which could identify individual participants will be reported at any point. If you would like a summary of results from the study after the data has been analysed please contact the Chief Investigator, Erica Kucharczyk using the contact details at the end of this form.

Who is organising and funding the research?

The research is being funded by Loughborough University and jointly organised by Loughborough University and the Sleep Laboratory at Leicester General Hospital.

Who has reviewed the study?

All research is looked at by independent groups of people, called a Research Ethics Committee, to protect your interests. This study has been reviewed and given favourable opinion by 'Nottingham 1' Research Ethics Committee.

Further information and contact details

If you have any more queries about this research please contact the Chief Investigator, Erica Kucharczyk by email, telephone or post:

Postal address: The Sleep Research Centre, Wavy Top Building, Loughborough University, Loughborough, Leicestershire, LE11 3TU. Email: E.kucharczyk@lboro.ac.uk. Tel: 01509 223049.

Consent form

Title of Project: Assessing the clinical utility of the Loughborough Occupational Impact of Sleep Scale "LOISS" in Obstructive Sleep Apnoea management.

Name of researcher: Erica Kucharczyk

Please initial box

1. I confirm that I have read and understand the information sheet dated…….. (version……) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my medical care or legal rights being affected. ☐

3. I understand that relevant sections of my medical notes and data collected during the study may be looked at by individuals from Loughborough University, from regulatory authorities or from the NHS Trust, where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records. ☐

4. I agree to take part in the above study. ☐

_____	_____	_____
Name of participant	Date	Signature
_____	_____	_____
Name of person taking consent	Date	Signature

When completed, 1 for patient; 1 for researcher site file; 1 (original) to be kept in medical notes