Fatigue and shift work

JIANHUA SHEN 1, LEIGH C. P. BOTLY 2, SHARON A. CHUNG 1, ALISON L. GIBBS 3, SKENDER SABANADZOVIC 1 and COLIN M. SHAPIRO 1
1Sleep Research Unit, Department of Psychiatry, University Health Network and University of Toronto, 2Department of Psychology, University of Toronto and 3Department of Statistics, University of Toronto, Toronto, ON, Canada

Accepted in revised form 18 August 2005; received 15 March 2005

SUMMARY Shift work is a ubiquitous phenomenon and its adverse effects on workers’ physical and mental health have been documented. In the sleep literature, differentiating between the symptoms of fatigue and sleepiness, and developing appropriate objective and subjective measures, have become very important endeavors. From such research, fatigue and sleepiness have been shown to be distinct and independent phenomena. However, it is not known whether shift work differentially affects fatigue and sleepiness. In an attempt to answer this question, 489 workers from a major Ontario employer completed a series of subjective, self-report questionnaires, including the Fatigue Severity Scale (FSS) and the Epworth Sleepiness Scale. Workers were separated into four groups based on the frequency with which they are engaged in shift work (never, fewer than four times per month, 1–2 days per week, 3 days or more per week). The frequency of shift work was found to have a significant effect on subjective fatigue, but not on subjective sleepiness. Compared with the subjects who never had a shift schedule, those who worked in a shift for 3 days or more had significantly higher mean score of the FSS. In agreement with previous results, a low correlation was found between workers’ subjective fatigue and sleepiness scores, providing further support for the concept of fatigue and sleepiness as distinct and independent phenomena. Future research should address the possibility of using the FSS as an indicator when the frequency of shift work has become high enough to adversely affect work performance or cause health problems.

KEYWORDS epworth sleepiness scale, fatigue, fatigue severity scale, shift work, survey

INTRODUCTION Although fatigue is an omnipresent phenomenon frequently reported by patients in healthcare settings, its status as an independent symptom capable of producing significant distress and debility has not been fully recognized. This is in part due to the paucity of tools and treatment regimens available to adequately assess and manage fatigue (Shapiro, 1998). Chronic fatigue is a more commonly reported complaint in primary healthcare settings (20–25%) compared with excessive sleepiness (5–15%), and yet fatigue continues to be underemphasized (Shapiro, 1998). Fatigue can have an enormous impact on clinical populations, as it is a highly prevalent symptom that exacerbates the distress of patients with cancer (Glaus, 2001), depression (Fuhrer and Wessely, 1995), acquired immunodeficiency syndrome (Groopman, 1998), multiple sclerosis (Sheean et al., 1997) and renal failure (Heiwe et al., 2003). Unfortunately, there is no ‘gold-standard’ test for fatigue and a consensus is yet to be achieved in the literature with regard to an adequate definition.

Shift work is generally defined as a work schedule in which at least 50% of the work is required to be done after 8:00–16:00 hours. (Hedges and Sekscenski, 1979). In modern society, shift work has become a very common phenomenon. A recent European Union (EU) Survey on Working Conditions conducted in 2000 estimated that only 24% of the working populations of the 15 EU countries were engaged in ‘normal or standard’ day work, defined as work between...
The majority of workers were thus engaged in ‘non-standard’ work, including shift work and night work, part time work and weekend work (Costa, 2003). Shift work can have adverse effects on physical and mental health, as well as social relationships and activities. For instance, frequent shift work can result in a decoupling of the endogenous circadian pacemaker with environmental synchronizers, such as the light/dark cycle. This can lead to disruptions in the normal sleep–wake rhythm of shift workers, potentially causing sleep and fatigue problems (Costa, 2003). In particular, shift workers are vulnerable to work-related fatigue and/or sleepiness, which occurs as a result of insufficient restorative sleep due to the cumulative effects of chronic and acute sleep deprivation, and a mismatch between a person’s desired sleep–wake schedule and the output of the endogenous circadian pacemaker (Hossain et al., 2003). Shift work can thus cause high subjective sleepiness and fatigue, thereby increasing the possibility of falling asleep on the job and increasing the risk of workplace accidents (Akerstedt, 1988; Akerstedt et al., 2002).

It is important to distinguish between sleepiness and fatigue because etiology and treatment may differ (Hossain et al., 2003). Although fatigue and sleepiness are distinct symptoms, they share many characteristics with each other. Such similarity has contributed to both the difficulty of defining fatigue and the failure of healthcare workers to treat fatigue as an independent phenomenon worthy of assessment and treatment. Both fatigue and sleepiness are prevalent in the general population, especially in primary care settings, however they are frequently equated, and when fatigue alone is reported many healthcare professionals do not consider the complaint serious enough to warrant further assessment or treatment (Pigeon et al., 2003). Due to the use of common terminology to describe fatigue and sleepiness, such as tired, exhausted and worn-out, it has been difficult for patients and healthcare workers alike to differentiate between these two symptoms (Pigeon et al., 2003). In an attempt to aid the discrimination of sleepiness and fatigue, Pigeon et al. (2003) have proposed the operationalization of sleepiness as drowsiness, sleep propensity and decreased alertness, and fatigue as weariness, weakness and depleted energy.

Hossain et al. (2003) attempted to determine why some, but not all shift workers, experience high fatigue. They hypothesized that underlying sleep pathology may be the determining factor, causing high fatigue in affected shift workers by decreasing their fatigue threshold. They then investigated whether subjective fatigue severity, as measured by the Fatigue Severity Scale (FSS), could be used as an independent predictive measure to identify shift workers with underlying sleep pathology. Using the FSS, the 21 most-fatigued and 23 least-fatigued subjects were selected from a total sample of 195 underground mine workers. Polysomnographic data showed a significant difference in the percentage of sleep disorders present in the two groups. Seventy-one percent (15/21) of the most-fatigued subjects demonstrated significant sleep pathology (sleep apnea, periodic limb movements disorder, etc.) compared with only 13% (3/23) of the least-fatigued subjects. This finding is in accordance with the hypothesis that chronic high fatigue is a manifestation of underlying sleep pathology.

The purpose of the present study was to examine the effects of the frequency of shift work on subjective fatigue and sleepiness. Shapiro (2004) has suggested that shift work coupled by an underlying, but not necessarily detectable sleep disorder, has a multiplicative effect on fatigue. To test this shift work–fatigue hypothesis, a group of 489 workers from a major Ontario employer completed a series of questionnaires, the most important of which for this study were the FSS and Epworth Sleepiness Scale (ESS). The workers were then separated into four groups based on the frequency with which they engaged in shift work and their FSS and ESS scores compared. If the frequency of shift work encountered on the job does in fact exacerbate fatigue and sleepiness by disrupting sleep or aggravating underlying sleep problems, subjects with a higher frequency of shift work should report greater subjective fatigue and sleepiness than those who never or rarely engage in shift work. It was anticipated that a weak correlation would be found between subjects’ FSS and ESS scores.

**METHODS**

A total of 405 subjects were included in this study. Table 1 shows the demographic information of the subjects.

A battery of questionnaires was given by the investigators or sent by mail to the approximately 800 workers at a major Ontario employer. University Health Network Research Ethics Board approved the study. Participation in the study was entirely voluntary and informed consent was obtained from workers willing to participate. The battery of questionnaires included the FSS, ESS, Athens Insomnia Scale, Berlin Scale, Restless Leg Syndrome Questionnaire, Toronto Hospital Alertness Test and ZOGIM-A Alertness Scale. In addition to completing the questionnaires, subjects were asked to provide demographic and personal information, they were asked if they had been diagnosed with any sleep or medical disorders, and whether they were currently undergoing any medical treatment or taking any medications. Subjects also specified whether they exerted, ingested caffeine or had any sleep or fatigue problems. With regard to shift work, the definition of shift work was provided on the questionnaires, and the subjects indicated whether they engaged in shift work fewer than four times per month, 1–2 days per week, ≥3 days per week or never.

Only data obtained from the FSS and ESS have been analyzed and reported in this paper because its focus was

<table>
<thead>
<tr>
<th>Number</th>
<th>Mean age (± SD)</th>
<th>Age range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>353</td>
<td>42.55 (± 8.60)</td>
</tr>
<tr>
<td>Female</td>
<td>52</td>
<td>38.71 (± 9.03)</td>
</tr>
<tr>
<td>Total</td>
<td>405</td>
<td>42.05 (± 8.74)</td>
</tr>
</tbody>
</table>

specific to subjective fatigue and sleepiness. The FSS (Krupp et al., 1989) is a nine-item self-report questionnaire that measures subjective fatigue. Respondents indicated the degree to which fatigue symptoms intruded on various aspects of life by rating each item from 1 (no impairment) to 7 (severe impairment). The FSS has been shown to have adequate validity, high internal consistency, and to differentiate between patients and controls within the general population (Taylor et al., 2000). The ESS (Johns, 1991) is an eight-item self-report questionnaire that measures subjective sleepiness. On a scale from 0 (never) to 3 (high chance), respondents rated the likelihood of falling asleep in eight different situations in which dozing is relatively uncommon. Normal healthy adults typically yield a summed score of ≤8, whereas a summed score of ≥11 indicates hypersomnolence (Hossain et al., 2003). Johns (2000) has shown the ESS to be a better discriminator of daytime sleepiness than other objective tests of sleepiness, such as the Multiple Sleep Latency Test (MSLT).

SPSS statistical software (Version 12.0 for windows) (SPSS Inc., Chicago, IL, USA) was used to analyze the FSS and ESS questionnaire data from the workers. ANCOVA was used to evaluate the effects of shift work frequency on fatigue and sleepiness. To confirm that gender had no group effect on fatigue, one-way ANOVA was used to measure the group difference of FSS scores in male subjects only. The pairwise test, which is accompanied with ANCOVA, and the post hoc test of ANOVA were used to measure the difference of a variable between two groups. Pearson’s correlation test was used to evaluate the relationship between the scores of FSS and ESS.

**RESULTS**

A total of 489 workers filled out the questionnaires. Among them, 33 double scored the questionnaire batteries (after sending a copy of completed questionnaires by mail, these subjects completed an extra copy when the surveyors forwarded the questionnaires to them). A mean value of these doubled questionnaires was used for the analysis. Eighty-four subjects were excluded from the analyses, reducing the number of subjects to 405 (353 male, 52 female). Among these, 28 subjects were excluded from the analyses, which were used to measure the difference of a variable between two groups. Pearson’s correlation test was used to evaluate the relationship between the scores of FSS and ESS.

Table 2 Distributions of shift work condition, subject number, mean age, scores of mean Fatigue Severity Scale (FSS) and Epworth Sleepiness Scale (ESS) in various groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Shift work</th>
<th>Number (male, female)</th>
<th>Mean age (± SD)</th>
<th>Mean FSS score (± SD)</th>
<th>Mean ESS score (± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1*</td>
<td>Never</td>
<td>145 (113, 32)</td>
<td>43.9 (± 9.1)</td>
<td>3.7 (± 1.3)</td>
<td>9.6 (± 4.6)</td>
</tr>
<tr>
<td>2</td>
<td>&lt; 4 times month⁻¹</td>
<td>59 (53, 6)</td>
<td>44.0 (± 9.0)</td>
<td>3.9 (± 1.2)</td>
<td>9.8 (± 4.4)</td>
</tr>
<tr>
<td>3</td>
<td>1–2 days week⁻¹</td>
<td>110 (101, 9)</td>
<td>40.1 (± 7.7)</td>
<td>3.9 (± 1.2)</td>
<td>8.6 (± 4.6)</td>
</tr>
<tr>
<td>4</td>
<td>≥3 days week⁻¹</td>
<td>91 (86, 5)</td>
<td>40.3 (± 8.4)</td>
<td>4.3 (± 1.3)</td>
<td>9.5 (± 4.5)</td>
</tr>
</tbody>
</table>

*Control group.
frequency of shift work and subjective fatigue but not possible that a positive correlation be found between the is a distinct phenomenon, separate from subjective fatigue, it is was found in the present study. Given that subjective sleepiness shift work on subjective sleepiness, as measured by the ESS, turn increasing fatigue. No significant effect of frequency of shift work could increase fatigue: it may act directly on fatigue by reducing sleep quality and quantity, or it may act indirectly by which shift work increases fatigue can only be hypothes- ized. Hossain et al. (2003) found that the most-fatigued shift workers in their study had the worst sleep quality scores, marked by low oxygen saturation, reduced sleep efficiency and decreased total sleep time. There are various means by which shift work could increase fatigue: it may act directly on fatigue by reducing sleep quality and quantity, or it may act indirectly by first aggravating existing sleep problems or pathology, in turn increasing fatigue. No significant effect of frequency of shift work on subjective sleepiness, as measured by the ESS, was found in the present study. Given that subjective sleepiness is a distinct phenomenon, separate from subjective fatigue, it is possible that a positive correlation be found between the frequency of shift work and subjective fatigue but not sleepiness. As suggested by Hossain et al. (2003), subjective DISCUSSION

This study has found that the frequency with which workers engage in shift work has a significant effect on the severity of subjective fatigue experienced, as measured by the FSS. The more often workers engaged in shift work, the more severe was their rating of subjective fatigue. A correlation exists between frequency of shift work and fatigue; however, whether this correlation is also causal cannot be determined, and the means by which shift work increases fatigue can only be hypothesized. Hossain et al. (2003) found that the most-fatigued shift workers in their study had the worst sleep quality scores, marked by low oxygen saturation, reduced sleep efficiency and decreased total sleep time. There are various means by which shift work could increase fatigue: it may act directly on fatigue by reducing sleep quality and quantity, or it may act indirectly by first aggravating existing sleep problems or pathology, in turn increasing fatigue. No significant effect of frequency of shift work on subjective sleepiness, as measured by the ESS, was found in the present study. Given that subjective sleepiness is a distinct phenomenon, separate from subjective fatigue, it is possible that a positive correlation be found between the frequency of shift work and subjective fatigue but not sleepiness. As suggested by Hossain et al. (2003), subjective

fatigue, as measured by the FSS, may be a better predictive indicator than subjective sleepiness of underlying sleep problems and pathology.

It is evident that the control subjects in the current study experienced a higher degree of subjective fatigue than that experienced by normal healthy adults from Krupp et al.’s (1989) study. Subjects who engaged in shift work frequently (Group 4) in the current study reported fatigue severity scores (4.3 ± 1.3) that approached the severity of those reported by multiple sclerosis (4.8 ± 2.8), systematic lupus erythematosus (SLE) (4.7 ± 3.0) and sleep disorder (mean = 4.8) patients (see Fig. 1). This suggests that workers who engage in frequent shift work experience fatigue at a severity level almost as high as that experienced by patients with fatigue-causing diseases and disorders.

A weak correlation was found between subjects’ FSS and ESS scores in the present study. This provides further support for the concept of fatigue and sleepiness being dissociable and independent phenomena. As was demonstrated by Hossain et al. (2003), it is possible to experience a high degree of subjective fatigue, while at the same time experiencing only low levels of subjective sleepiness and vice versa. As an example, following long periods of physical exercise during the daytime it is common to feel fatigued, while it is less common to feel sleepy. Individual differences may exist in the ability to differentiate between the symptoms of fatigue and sleepiness. Those with high fatigue may be able to make the distinction better than others. Only a handful of studies (Aguillard et al., 1998; Chervin, 2000; Lichstein et al., 1997) other than that of Hossain et al. (2003) have investigated the association between fatigue and sleepiness in normal controls and sleep-disordered patients. Lichstein et al. (1997) found that sleep disorder subjects’ (n = 206) objective sleepiness scores, as measured by the MSLT, did not predict their subjective fatigue scores, as measured by the FSS. Similarly, Aguillard et al. (1998) found no significant correlation between sleep apnea patients’ (n = 32) objective sleepiness and fatigue scores, providing further support for the separation of fatigue and sleepiness as distinct symptoms. Chervin (2000) found that among female obstructive sleep apnea patients (n = 190), more chose fatigue (â‰¥40%) rather than sleepiness (â‰¥22%) as their one most significant symptom. There are several limitations to the present study that should be discussed. First, as previously mentioned, this study was correlational in nature, as subjects were not randomly assigned to the shift work groups. It is accurate to conclude that the frequency of shift work is positively associated with subjective fatigue severity; however, a causal link between these two factors can only be speculative. Secondly, self-report measures were the only type of measurement used and such measures can be subject to inadvertent reporting biases or intentional falsifications on the part of subjects. Inclusion of objective measurements would have enabled the subjective results to be corroborated. However, based on previous findings (Aguillard et al., 1998; Hossain et al., 2003; Lichstein et al., 1997), significant correlations between subjective and objective measures of sleepiness would not be expected.
Additional research using objective measures of sleepiness and novel measures of fatigue should be carried out to corroborate the subjective findings of the present study and to further examine the effects of shift work on fatigue and sleepiness. Polysomnographic data from workers is needed to determine whether more frequent shift work does in fact cause an increase in sleep fragmentation, a reduction in sleep quality and/or total sleep time or a worsening of any underlying sleep disorders. However, a better understanding of how subjective and objective measures differ from each other is also needed. Given that objective and subjective measures of sleepiness do not correlate highly with each other, it is reasonable to hypothesize that each is measuring a different aspect of sleepiness. The ESS has been purported to measure subjects’ estimates of the probability of falling asleep in various situations, i.e. their subjective sleep propensity, while the MSLT is thought to measure subjects’ true or objective sleep propensity. While one would hypothesize objective measures of sleepiness to be the most accurate, Johns (2000) has found the ESS to be a better discriminator of sleepiness than the MSLT. Perhaps this finding should be confirmed by additional studies to ensure its generalizability to different populations. An objective measure of fatigue comparable to the MSLT for sleepiness does not exist and thus corroboration of subjective fatigue measures is not possible.

The question of how shift work increases subjective fatigue has yet to be answered. It has been hypothesized that shift work may augment fatigue indirectly by disrupting sleep quality or aggravating any existing sleep problems or disorders (Hossain et al., 2003; Shapiro, 2004). However, additional research is needed to determine the actual means by which shift work exacerbates subjective fatigue. It is not clear why frequent shift work does not have a comparable effect on subjective sleepiness. If shift work increases fatigue indirectly by first affecting sleep, an increase in subjective sleepiness would be expected.

ACKNOWLEDGEMENTS

The authors acknowledge Ms Sabrina Haq for her outstanding contribution on data collection.

REFERENCES


