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How sleep is related to fatigue

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Objectives. It is evident that sleep patterns have direct effects on fatigue. However, the multidimensionality of fatigue may imply that complex patterns of relationships exist between fatigue and sleep characteristics. We aimed to study the correlations between fatigue and quantitative and qualitative sleep measurements, while taking into consideration depression and somatization which are known to affect both sleep and fatigue. We predicted that sleep quality, unattained by the effects of somatization and depression, would affect perceived fatigue more than the quantitative characteristics of sleep.

Design. Employing a cross-sectional design, hypotheses were addressed using multiple hierarchical regression analyses according to established methods.

Methods. Data were gathered from a targeted, randomly selected adult sample ($N = 278$) by means of subjective sleep reports, a mental health inventory, somatization inventory, several fatigue questionnaires and a demographic questionnaire.

Results. Fatigue was significantly predicted by depression scores, somatization levels and subjective sleep quality, but not quantitative sleep characteristics such as sleep latency, nocturnal awakenings and early morning arousals. Depression levels were positively and significantly related to all aspects of fatigue except physical fatigue and fatigue that responds to rest and sleep. Physical fatigue was correlated with somatization, but not depression.

Conclusions. The data further our understanding of the multifaceted nature of human fatigue and underline the greater importance of perceived sleep quality, compared to other sleep characteristics, in predicting fatigue.

Fatigue is a universal complaint, affecting most people at one time or another (Kirk *et al.*, 1990). In the past, most studies have regarded fatigue as a unitary concept and reported data based on a single question. Although there may be a single construct underlying the

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various terms adopted by patients to describe physical fatigue (which can be distinct from mental fatigue), wide variations may result if only a single symptom is assessed (David, Pelosi, & MacDonald, 1990; Wessely & Powell, 1989). Bensing, Hulsman, and Schreurs (1999) argued that fatigue could only be adequately understood through a multicausal model which included biomedical and psychosocial factors. Recently, fatigue questionnaires have been developed in order to capture the multidimensional character of fatigue: the fatigue assessment instrument (FAI; Schwartz, Jandorf, & Krupp, 1993) and the Multidimensional Fatigue Inventory (MFI; Smets, Garssen, Bonke, & de-Haes, 1995). Research using the FAI (Schwartz *et al.*, 1993) and the MFI (Smets *et al.*, 1995) has supported the notion that fatigue is a multidimensional concept (de Rijk, Schreurs, & Bensing, 1999; Watt *et al.*, 2000). We have recently studied the conceptual structure of fatigue complaints (Lavidor, Weller, & Babkoff, 2002). In this study, the significant intercorrelations among seven fatigue measures identified from three fatigue questionnaires (Masuda, Nozoe, Matsuyama, & Tanaka, 1994; Montgomery, 1983; Schwartz *et al.*, 1993) were low-to-medium, ranging from $r = .21$ to $r = .48$. This pattern of results supports the contention that the perception of fatigue in the normal adult population is not unidimensional, but is rather multidimensional (Schwartz *et al.*, 1993; Smets *et al.*, 1995).

The multidimensionality of fatigue may imply that complex patterns of relationships exist between fatigue and other variables known to be associated with reports of pathological fatigue. The variables that we tested in the current work are sleep characteristics, depression and somatization, while the main issue was sleep–fatigue correlations.

Clearly, many people perceive sleep and fatigue as closely related. When working women with fatigue complaints were asked about the cause of their tiredness (Stewart, Abbey, Meana, & Boydell, 1998), the respondents attributed their fatigue mainly to a combination of home and outside work (63.4%) and poor sleep (38.2%). Improved sleep quality decreased fatigue complaints among the elderly (Cooke, Kreydatus, Atherton, & Thoman, 1998) and among a younger sample, even when the additional sleep was only a 20 min nap (Hayashi, Watanabe, & Hori, 1999). However, the direct effects of sleep patterns on fatigue should not be taken for granted. First, even in extreme cases of fatigue, such as chronic fatigue syndrome (CFS), the causal link between sleep and fatigue is not always clear. While most studies reported sleep disturbances in people who suffer from CFS (Fischler, 1999), when CFS patients without psychiatric disorders were compared to psychiatric outpatients with chronic depressive disorders, matched in age and gender, the CFS group had significantly less sleep complaints than the depressed group (Morriss, Wearden, & Battersby, 1997). Moreover, Sharpley, Clements, Hawton, and Sharpe (1997) have shown that patients with 'pure' CFS tend to complain of unrefreshing sleep, but only a minority had showed clearly abnormal sleep patterns. Second, in some studies no causal relation between sleep characteristics and fatigue for the healthy population was established (Hyyppa, Kronholm, & Alanen, 1997; Lewis & Wessely, 1992).

There are many methods of measuring sleep characteristics, via subjective reports or objective polysomnography recordings. The subjective measures can reflect quantitative (duration, latency to fall asleep etc.) and qualitative (sleep quality) aspects of sleep. Both types should be studied, as they represent different aspects of sleep characteristics that are not always correlated. Jean-Louis, Kripke, and Ancoli-Israel (2000), for instance, in a laboratory experiment with healthy adults, have shown that sleep duration was not associated with sleep quality. These discrepancies between subjective sleep quality and

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quantitative sleep measures are important since they may lead to subjective insomnia (Perlis, Giles, Bootzin *et al.*, 1997).

The independence of sleep quantity and sleep quality implies that they may differ in their associations with psychological variables. Indeed, subjective sleep reports of healthy college students revealed that measures of health and well-being were more strongly related to the quality rather than the quantity of sleep (Pilcher & Ott, 1998). As for fatigue, Pilcher, Ginter, and Sadowsky's (1997) study employed subjective sleep logs among healthy young adults, and showed that sleep quality was better related to sleepiness than sleep quantity. However, Alapin *et al.* (2000), for a wider age range sample, reported that both sleep quality and quantity were related to fatigue.

In the light of the above review, the research question we investigated in the current study was the effects of sleep characteristics on fatigue in the general, non-patient population. We aimed to look at the multiple natures of both fatigue and sleep, which may be expressed in complex correlations. In particular, we predicted that sleep quality may be more related to fatigue than sleep quantity, since sleep quality was found to be more related to psychological and health variables (Pilcher & Ott, 1998).

In addition to the sleep measures as predictors of fatigue, we examined the effects of other predictors, which are known to affect both sleep and fatigue: depression and somatization.

It is well established that depression is significantly related to sleep characteristics for participants with major depression (Perlis, Giles, Buysse *et al.*, 1997) and healthy participants from the general population (Habte-Gabr *et al.*, 1991). As for depression and fatigue, depression may be more positively related to fatigue than biological factors, as reported by Hyyppa, Lindholm, Lehtinen, and Puukka (1993). Fatigue was related to depression levels in healthy, normal populations in some studies (Walker, Katon, & Jemelka, 1993), but not others (Fuhrer & Wessely, 1995).

Somatization is another construct that has been reported to be associated with both fatigue and sleep. Significant correlations between sleep characteristics and somatization have been found for CFS patients (Evengard, Schacterle, & Komaroff, 1999), participants with sleep disorders (Saletu *et al.*, 2000) and healthy participants drawn from the general population (Kim *et al.*, 2001). As for fatigue, some researchers have classified it as a somatic complaint (Lloyd, 1989). Under such a classification, fatigue and somatic complaints clearly overlap. However, other researchers have separated the two concepts. Several studies have demonstrated that among patients with CFS, somatization disorder may be found, but is not a mandatory part of CFS (Wood, Bentall, Göpfert & Edwards, 1991). In a sample of 100 adults with a chief complaint of chronic fatigue, somatization disorder was diagnosed in only 15 patients (Manu, Lane, & Matthews, 1989).

As noted above, different aspects of sleep might interact with psychological variables. An example of this interaction which is relevant to somatization and depression was reported by Frisoni *et al.* (1992), suggesting that higher levels of somatization and depression were associated with poorer sleep quality, but not with frequency of nocturnal awakenings.

The current study aimed therefore to assess the effects of sleep characteristics, somatization and depression (as predictors) on fatigue in a healthy sample. Since depression and somatization are often highly correlated with sleep patterns (for people who suffer from clinical depression: Manber & Armitage, 1999; for a healthy population: Frisoni *et al.*, 1992), we first examined the intercorrelations between the predicting variables. The planned regression analyses then investigated the sleep

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characteristics relations with fatigue, when the possible correlations with somatization and depression were considered. We hypothesized that sleep quality would have a stronger association with fatigue when compared to other sleep measures.

Method

Procedure

The survey sample was selected by a simple random sampling technique (Lazerwitz, 1968) of households from the joint phone book (white pages) of two adjacent cities (population 121,700 and 45,800) in the Tel Aviv metropolitan area (Central Bureau of Statistics [Israel], 1997).

Each household from the 660 sampled addresses received a letter explaining the research project and informing the recipient that a research assistant would call in a few days to ask for their agreement to participate and to schedule a meeting to administer the questionnaire. The respondent's anonymity was assured. No monetary compensation was offered. Of the 660 approached households, 278 individuals (42.1%) provided complete or nearly complete questionnaires, used in the data analysis. The data therefore represent Hebrew-speaking adults willing to participate in the study, and do not include people either hospitalized or living in institutions. For each household from the sampled addresses, all adults aged 20–70 and living at the same address were also approached.

Measures

The survey questionnaire was divided into five sections. Basic demographic data were recorded (without name or other identification) in the first section. Part 2 examined fatigue and included the three following questionnaires:

(1) The 5-item Tiredness Questionnaire (Montgomery, 1983), containing a checklist of five symptoms. The instructions directed participants to mark which of these symptoms they generally experience. The alpha coefficient for these five items was .87, thus we computed the fatigue score by summing the five items. This fatigue score was labelled 'Tiredness'.

(2) The 29-item FAI, designed by L. B. Krupp (Schwartz *et al.*, 1993). The participants rated their degree of agreement with statements 'regarding your fatigue', experienced during the last two weeks. Fatigue is defined explicitly as 'a sense of tiredness, lack of energy or total body give-out'. A factor analysis performed on our dataset identified the four factors originally defined by Schwartz *et al.* (1993), accounting for 39% of the total variance of the answers. The factors were:

   I. Fatigue severity (e.g., 'I am easily fatigued');
   II. Situation specific (e.g., 'stress brings on my fatigue');
   III. Psychological consequences of fatigue (e.g., 'When I am fatigued, I have difficulty concentrating'); and
   IV. Fatigue that responds to rest/sleep (the perceived potential of rest or sleep to decrease fatigue, e.g., 'Resting lessens my fatigue').

   The four subscales exhibited good-to-excellent internal consistency ($\alpha = .72–.89$) and test–retest reliabilities. Therefore, we computed average scores for each participant on these four fatigue factors.

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(3) The Masuda Fatigue Questionnaire (Masuda *et al.*, 1994), containing a checklist of 20 symptoms. The instructions directed participants to mark which of these symptoms they had experienced during the last month. The first 10 items represent symptoms of mental fatigue (e.g., difficulty in concentration, irritability, decline in sexual desire). Due to the satisfactory reliability of these items ($\alpha = .82$) we computed the fatigue score 'mental fatigue' by averaging the first 10 items. The other 10 items are symptoms of physical fatigue (e.g., physical pain, poor digestion, tiredness of the eyes, stiffness of the neck and shoulders). The alpha coefficient for these items was .84, thus we computed the 'physical fatigue' factor by averaging the last 10 items.

These fatigue factors were the dependent variables of the current study, and were therefore named 'measures' rather than 'factors'. The three fatigue questionnaires were translated from English into Hebrew by the back translation method (Brislin, 1980). A total of 20 social science students provided translations into Hebrew and, after elaborate and detailed discussion, a consensus version was constructed which aimed at literal translation; only minimal deviations were made for cross-cultural adaptation. Next, two bilingual psychologists translated the Hebrew version back into English. Finally, small adjustments were made in the final Hebrew version for a few words whose translation did not match the original.

The third and fourth parts of the questionnaire examined depression and somatization. Depression was assessed by the Hebrew version of the Mental Health Inventory (MHI; Florian & Drory, 1990) on a Likert 1–5 scale. The original MHI was developed by Veit and Ware (1983) in order to assess mental health in a normal, non-patient population. Due to the satisfactory reliability of the 7 depression items ($\alpha = .89$), we averaged them to compile a depression score for each participant.

Somatization was assessed by the Bradford Somatic Inventory (BSI; Mumford *et al.*, 1991). The BSI consists of 44 somatic symptoms (e.g., backache, nausea, loss of appetite and allergy). The principal use of the BSI is in exploratory research on somatization in the general population, and it is not a diagnostic instrument. The questions all refer to the previous month, and not to symptoms experienced before that time. The BSI was translated from English to Hebrew by the back translation method described above (Brislin, 1980). Several items were omitted due to cultural differences or lack of Hebrew concepts, thus the Hebrew version of the BSI included 38 somatic symptoms. The respondent was asked to indicate whether he or she experienced each symptom (during the previous month), and if so to rate the degree to which he or she suffered from the symptom on a 1–7 scale, also indicating if it was a chronic experience. The reliability of the responses was high ($\alpha = .93$), so we assigned a score to each respondent in terms of the number of symptoms he or she reported. This score was significantly correlated with the perceived severity of the symptoms ($r = .81$, $p < .0001$). The chronicity measure was not calculated since participants hardly selected the 'chronic experience' answer (2.2% of all answers).

The last part of the questionnaire was a sleep questionnaire (Fichten *et al.*, 1995) that contained 10 retrospective questions describing different aspects of a usual night's sleep. This questionnaire has high test–retest stability ($r = 0.85$, $p < 0.0001$ for two successive reports; see Babkoff, Weller, & Lavidor, 1996), but low validity when compared to objective polysomnographic data (Baker, Maloney, & Driver, 1999). The

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questions used in this report were subjective estimates of

(1) usual sleep latency in minutes,
(2) usual number of awakenings during the night,
(3) number of days in a week where a too-early arousal had occurred, and
(4) subjective usual sleep quality on a scale of 1 (*poor*) to 5 (*excellent*).

Results

Demographic data

The participants' mean age was 37.89, (*SD*= 13.5, range = 20–70). Of the participants, 122 were male (44%); 60% of all participants were married and 20% of the remainder reported having a partner, and 81% reported working. The average educational level was 13.5 years. As regards education, 51% had acquired education up to high school and 49% reported acquiring college or other post-high-school education.

Correlations between the predicting variables

In light of the planned regression analyses, we first tested the intercorrelations between the predicting variables to avoid the possibility of multicollinearity. Pearson correlations between the predictors (sleep latency, nocturnal awakenings, early morning arousals, sleep quality, depression and somatization) were computed (see Table 1). The significant correlations ranged between .2 and .4 (.4 was found in only one case). This range is considered free of multicollinearity, according to Tabachnick and Fidell's (1996) criteria.

Table 1. Pearson correlations among the predicting variables: depression, somatization, sleep latency, nocturnal awakenings, early morning arousals and sleep quality

	1 Depression	2 Somatization	3 Latency	4 Nocturnal awakenings	5 Early arousals	6 Sleep quality
1	—	0.38**	0.25**	0.11	0.20*	0.11
2		—	0.21*	0.22**	0.10	0.07
3			—	0.24**	0.22*	0.11
4				—	0.34**	0.10
5					—	0.08
6						—

*$p < 0.05$; **$p < .01$.

Notes: Depression—depression score from the mental health inventory (Florian & Drory, 1990); somatization—number of somatic symptoms from the Bradford Somatic inventory (Mumford *et al.*, 1991); latency—sleep latency in minutes taken from the sleep questionnaire (Fichten *et al.*, 1995); nocturnal awakening—number of nocturnal awakenings taken from the sleep questionnaire; early arousals—frequency of too-early arousals taken from the sleep questionnaire; sleep quality—subjective assessment of sleep quality.

Predictions of fatigue from somatization, depression and sleep

We performed linear regression analysis to explore the relation between somatization, depression and sleep as predictors of fatigue. The seven fatigue measures (tiredness

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[Montgomery, 1983]; mental fatigue, physical fatigue [Masuda *et al.*, 1994]; severity, situation specific, psychological consequences and fatigue that responds to rest/sleep [Schwartz *et al.*, 1993]) were entered as the dependent variables in seven multiple hierarchical regression analyses, with exclusion criteria for the predictors of significance level $>.05$. Because somatization and depression themselves were found to be associated with sleep, they entered the hierarchical regression at the first step as predictors (background variables). The other predictors, the four sleep variables, were entered at the second step. The results of the analyses are summarized in Table 2. Of all the fatigue measures, the only unpredicted one was 'fatigue that responds to rest/sleep'. Fatigue severity and tiredness were the two measures most strongly predicted by the regression models. Depression predicted significantly five out of the seven fatigue measures, and had the largest unique contribution (beta score) for all the fatigue measures except physical fatigue, where somatization was a better predictor than the depression score. Somatization significantly predicted tiredness, mental fatigue, physical fatigue, and fatigue severity. Early morning arousals had no effect on reported fatigue. Sleep quality significantly predicted tiredness scores according to the Montgomery questionnaire, fatigue severity and the 'situation specific' fatigue measure. Nocturnal awakenings predicted the psychological consequences of fatigue, while sleep latency predicted physical fatigue.

Table 2. Results of seven multiple hierarchical regression analyses with the seven fatigue measures predicted by depression, somatization, sleep latency, nocturnal awakenings, early morning arousals and sleep quality

Fatigue measure	R^2	β Dep.	β Somati.	β Latency	β Nocturn.	β Early	β Sleep quality
Tiredness	.29**	.36**	.13*	—	—	—	.13*
Severity	.37**	.49**	.20*	—	—	—	.16*
Situation specific	.20**	.35**	—	—	—	—	.27**
Psychological consequences	.20**	.40**	—	—	.18*	—	—
Rest/sleep	.02	—	—	—	—	—	
Mental fatigue	.22**	.38**	.15*	—	—	—	—
Physical fatigue	.22**	—	.30**	.27**	—	—	—

*$p < .05$; **$p < .01$.

Notes: Tiredness from the tiredness questionnaire (Montgomery, 1983); severity, situation specific, psychological consequences and fatigue that responds to rest/sleep from the fatigue assessment questionnaire (Schwartz *et al.*, 1993); mental and physical fatigue from the fatigue questionnaire (Masuda *et al.*, 1994). The predictors: Dep. = depression score from the mental health inventory (Florian & Drory, 1990); Somati. = number of somatic symptoms from the Bradford Somatic inventory (Mumford *et al.*, 1991); Latency = sleep latency in minutes taken from the sleep questionnaire (Fichten *et al.*, 1995); Nocturn. = number of nocturnal awakenings taken from the sleep questionnaire; Early = frequency of too-early arousals taken from the sleep questionnaire; Sleep quality = subjective assessment of sleep quality.

Discussion

We looked at the impact of sleep patterns, depression and somatization on the different aspects of fatigue. Overall, the mixed pattern of predictions supported the view that

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fatigue is a multifaceted concept, as the different fatigue measures had varied associations with the predicting factors. In general, the results suggested that psychological measures such as depression, somatization and subjective sleep quality can account for fatigue more than quantitative sleep measures, such as sleep latency, nocturnal awakenings and early morning arousals. Sleep quality was not directly related to the quantitative sleep measures, as indicated by the nonsignificant correlations between sleep quality and the other sleep measures.

The pattern of findings suggests that self-perception of mood, somatization and sleep quality can explain fatigue levels better than the (subjective) quantitative aspects of the night's sleep. We are not arguing that sleep is not related to fatigue. However, the perception of sleep quality is a better indicator of an individual's fatigue than more quantitative sleep measures. A similar conclusion was derived by Pilcher *et al.* (1997). There could be links between sleep patterns and fatigue; however, they are not direct and appear to be mediated by subjective perceptions of sleep quality, mood and health.

The significant associations between sleep quality and several aspects of fatigue are in accordance with previous studies, where sleep quality emerged as a powerful predictor of well-being and perceived health (for elderly people, Ancoli-Israel, 2000; for healthy young adults, Briones *et al.*, 1996; for fibromyalgia patients, Harding, 1998). It is important to note that sleep quality was not correlated with objective polysomnographic sleep measures, while quantitative subjective sleep measures were (though typically overestimated [Baker *et al.*, 1999]). However, subjective sleep quality is a better predictor of perceived health than quantitative sleep characteristics.

The significant correlations between depression and fatigue in a healthy population are in agreement with previous studies (e.g. Walker *et al.*, 1993). Depression was associated with all aspects of fatigue, but not the perceived effect of rest and sleep on fatigue. It may be that the relatively depressed participant does not perceive sleep as an option to relieve tiredness.

As with all cross-section studies, the findings from the current study cannot reveal causal relationships between sleep characteristics and fatigue. Another limitation is the inability to assess the effects of long-term poor sleep quality on fatigue. The solution would be a longitudinal study that would document sleep quality and fatigue correlations over several months, or even years. Such a study would provide the opportunity to estimate the risk of fatigue-related illnesses resulting from poor sleep quality, an assessment that would hopefully lead to efficient preventive procedures.

Another weakness of the current study is that due to the relatively low rate of participation in the survey (42%), and lack of demographic data about the people who refused to take part in the survey, we can only conclude that the findings are relevant to adult, healthy, non-hospitalized populations who are willing to participate in surveys. Despite this restriction, the large and significant correlations between somatization, depression, sleep quality and fatigue highlight the importance of the issue. Medical professionals should be aware of both depression and somatization when dealing with fatigue complaints, as well as with the subjective perception of sleep quality. It may be that people who are relatively depressed, perceive their sleep quality as poor, and are characterized by higher somatization, suffer most from fatigue. Whether they are at risk of developing chronic fatigue should be studied using a longitudinal design.

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