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Effort-reward imbalance, overcommitment and sleep in a working population

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The relationship between workplace characteristics and nocturnal sleep in a working population was investigated. Data from 709 employees (mean age = 39 years; 87% men) from two German companies were analysed at the entry of the longitudinal cohort study (overall accrual 73%). We investigated the association between the effort-reward imbalance model at work (Siegrist, 1996) and self-reported sleep quality and sleep disturbances, as assessed by the Jenkins Sleep Quality Index. Effort and overcommitment were found to be higher, and reward was lower in participants with lower ($N = 328$) vs. higher sleep quality ($N = 381$), as well as in participants with ($N = 217$) vs. without ($N = 492$) disturbed sleep (all $ps < .001$). In regression analyses, lower sleep quality ($R^2 = .33$) and sleep disturbances ($R^2_{\text{Nagelkerke}} = .33$) were predicted by older age, female gender (only significant for sleep disturbances), shift-work, lower physical and mental health functioning, and higher overcommitment. Individuals were 1.7 times more likely to report disturbed sleep per standard deviation increase in overcommitment. Gender-stratified analyses revealed that higher overcommitment was associated with unfavourable sleep in men, while in women poor sleep was related to lower reward. The findings suggest that overcommitment at work interferes with restful sleep in men, while in women disturbed sleep may be associated with the amount of overcommitment and perceived job reward and sleep quality associated with the perceived reward.

1. Introduction

Sleep problems (sleep disturbances, insomnia, poor sleep quality) are amongst the most common subjective complaints by patients as observed in general medical practice (Cirignotta, Mondini, Zucconi, Lenzi, & Lugaresi, 1985; Hammond, 1964). They represent a considerable public health problem by increasing use of health care services, drug consumption, and insomnia-related injuries and related costs (Institute of Medicine, 1979; Jacquinet-Salord, Lang, Fouriand, Nicoulet, & Bingham, 1993). An investigation by the National Sleep Foundation reported that 25% of Americans have occasional insomnia and 9% experience regular sleep difficulties (Ancoli-Israel & Roth, 1999). Reported rates of sleep complaints differ slightly in other countries (Angst, Vollrath, Koch, & Dobler-Mikola, 1989; Gislason & Almqvist, 1987; Institute of Medicine, 1979; Janson *et al*., 1995; Quera-

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Salva, Orluc, Goldenberg, & Guilleminault, 1991). Similar rates to the American data have been observed amongst German adults: insomnia has beeen reported to affect 28.5% of the population, with 13.5% of the adults enduring moderate to severe insomnia (Weyerer & Dilling, 1991).

The prevalence of sleep disturbances increases with age and is higher amongst women (Lugaresi, Zucconi, & Bixter, 1987; Reyner, Horne, & Reyner, 1995; Ribet & Derriennic, 1999). Other identified risk factors for sleep problems comprise adverse health behaviour (smoking, caffeine consumption, physical exercise), high body mass index (BMI), and low socio-economic status (SES) (Bixler, Kales, Soldatos, Kales, & Healey, 1979; Cirignotta *et al*., 1985; Habte-Gabr *et al*., 1991; Janson *et al*., 1995; Karacan *et al*., 1976; Shirlow & Mathers, 1985). Beyond these traditional risk factors, more recent research has focused on occupational characteristics, work conditions and aspects of the work environment (Ancoli-Israel & Roth, 1999; Urponen, Vuori, Hasan, & Partinen, 1988). In a prospective study on more than 21,000 participants, Ribet and Derriennic (1999) found that both changes in objective working conditions (shift work, exposure to vibrations, work week > 48 h) and psychosocial aspects were associated with incidence and disappearance of sleep complaints at the 5-year follow-up. Other investigators showed that poor work conditions such as high physical demands, shift-work (Akerstedt, Fredlund, Gillberg, & Jannson, 2002a; Estryn-Behar *et al*., 1990; Marquie & Foret, 1999), high psychological demands, and low social support from co-workers and supervisors (Akerstedt *et al*., 2002b; Jacquinet-Salord *et al*., 1993; Kageyama *et al*., 1998) were associated with sleep disturbances and fatigue at work. Recent data suggest that a person's perception of his or her job conditions exerts an important impact on self-reported sleep complaints (Kageyama *et al*., 1998; Marquie & Foret, 1999; Marquie, Foret, & Queinnec *et al*., 1999).

Siegrist and co-workers have introduced an index of chronic occupational stress in terms of perceived effort in relation to reward received at work (Siegrist, 1996; Siegrist *et al*., 2004). The model assumes that a lack of reciprocity between costs and gains elicits sustained strain reactions (i.e. high cost/low gain conditions). Reward can be distributed by the three transmitter systems, which are monetary remuneration, social approval, and career opportunities including job security. As an additional component of the model, overcommitment (i.e. intrinsic effort) is characterized by a specific pattern of personal coping. Components of the model of effort-reward imbalance are risk factors for coronary artery disease as shown in several prospective studies (Bosma, Peter, Siegrist, & Marmot, 1998; Kivimäki *et al*., 2002; Kuper, Singh-Manoux, Siegrist, & Marmot, 2002). To date, the relationship between the components of the model and sleep in a working population has not been investigated. The aim of our study was to resolve the question as to whether work-related stress in terms of effort, reward and overcommitment at work affects sleep, independently of traditional sleep correlates.

2. Methods

2.1. *Participants*

The present analysis is based on data that was obtained at entry into a longitudinally designed research project termed 'Health and Work'. Study participants were recruited from two differently sized German companies, which were (a) an aeroplane manufacturing plant, and (b) a commercial medical laboratory. For the aeroplane plant, the recruitment procedure followed a stratified random sampling strategy inviting 1126 of the 1958 employees. In terms of the medical laboratory, study participation was offered to all 113 employees. We recruited 894 individuals (aeroplane plant: $n = 822$, accrual rate 73%; medical laboratory:

$n = 72$, accrual rate 64%; overall accrual 72%). Participants with incomplete data on any of the considered dependent or independent variables were excluded from the analysis to allow a full linear and logistic regression approach. This procedure yielded a final study sample of 709 participants. Participants with complete versus incomplete data sets did not differ in respect to age and years of employment, although a higher proportion of women did not provide a complete data set. This is probably due to a small number of women overall. Foremen and qualified skilled workers provided the highest proportions of complete data sets. Beyond paid working time spent participating in the study, and the possibility to request personal health counselling by two study physicians, no other incentives were offered. The local institutional review board approved the study protocol.

2.2. *Data collection*

Participants completed a questionnaire providing medical and psychosocial data and underwent a brief medical examination (BMI, blood pressure). Questionnaires were completed in groups of 10 to 25 individuals in a quiet room, some distance from participants' work stations, following a standardized oral introduction by one of the investigators.

2.2.1. *Sleep:* Sleep quality was assessed by the Jenkins Sleep Quality Index (Jenkins, Stanton, Niemcryk, & Rose, 1988). This scale comprises four items focusing on the most common sleep problems ('difficulties falling asleep', 'waking up during the night', 'waking up having difficulties falling asleep again', 'waking up tired'). Items are rated on a 6-point scale, indicating how often the stated condition occurred during an average month ('not at all', 'up to 3 days a month', '4–7 days a month', '8–14 days a month', '15–21 days a month', '22–31 days a month'). High sleep quality is indicated by a low score on the Jenkins scale. The internal consistency coefficient for this 4-item scale is .79, as reported by the authors of the index. A reliability analysis based on our data revealed that Cronbach's α (alpha) = .77. Additionally, participants were asked to provide an overall assessment of the severity of sleep disturbances (one-item summary measure) on a 4-point Likert scale ('not at all' = 0, 'not much' = 1, 'moderate' = 2, 'severe' = 3).

2.2.2. *Model of effort-reward imbalance:* Effort and reward were assessed following Siegrist's model of effort-reward imbalance (Siegrist, 1996), using the 6-item effort and 11-item reward scale, respectively. For example, items of the effort scale are 'I have a lot of responsibilities in my job' or 'I am often pressured to work overtime'; examples of reward items are 'I receive the respect I deserve from my supervisors (colleagues)', 'Considering all my efforts and achievements, my salary/income is adequate', or 'My job security is poor' (all items are provided in Siegrist *et al*., 2004). The higher the perceived distress due to high effort at work, the higher the resulting effort score. The lower the score for reward, the lesser participants perceived reward at work. The ratio of effort to reward expresses the amount of perceived effort-reward imbalance at work (ERI). Overcommitment (OC) was assessed by the 6-item short form of the Intrinsic Effort Scale. Items assessing over-commitment focus on the 'inability to withdraw from work' (5 items) and 'disproportionate irritability' (1 item) (e.g. 'People close to me say I sacrifice too much for my job' or 'Work rarely lets me go, it is still on my mind when I go to bed'). The validated German version was provided by the authors of the scale. Internal consistency (Cronbach's α) was tested in up to ten different studies by the original authors. For the scale effort, α varied from .61 to .88, for the scale reward from .70 to .91 and for the scale overcommitment from .64 to .81.

2.2.3. *Demographics, socio-economic status and life-style factors:* The questionnaire included items assessing demographic factors (age, gender), SES (education, job position, marital status), shift work (no shift work, 2 and 3/4-shift system), health behaviours and life-style factors (smoking: yes/no; physical activity: computed as calories burnt exerting light and heavy exercise per day; alcohol consumption: number of days per week participants drank alcohol in the previous year; coffee consumption: number of cups ranging from maximal six per day to none in a month). Items related to health behaviours were derived from the Nurses' Health Study (Michael, Colditz, Coakley, & Kawachi, 1999) and from the MONICA study (Jönsson, Rosengren, Dotevall, Lappas, & Wilhelmsen, 1999). The functional health status was assessed employing the German version of the SF (Short Form)-12 Health Survey (Bullinger & Kirchberger, 1998). The 12-item SF12 is a self-report measure of subjective health that assesses the eight dimensions: physical functioning, role limitations due to physical/emotional health problems, freedom from bodily pain, general health perception, vitality, social functioning, and mental health. From these dimensions a physical and a mental summary health score can be calculated following the scoring algorithm outlined in the manual, rendering scores with a mean of 50 ± 10 (SD). The lower the resulting summary scores, the lower the self-reported subjective health functioning.

3. Statistical analyses

Descriptive data are presented as means $\pm$ SD (standard deviation) or median and interquartile range (IQR). To approximate a normal distribution, effort-reward imbalance scores (skewness 1.6, kurtosis 5.0) and activity calories (skewness 3.8, kurtosis 22.1) were logarithmically transformed. To enhance readability all transformed measures are presented in their original units. Correlation analyses were performed following Spearman's rho procedure. For group comparisons, a median split was conducted to split the study sample into a group with high vs. low sleep quality based on the continuous Jenkins sum score. For sleep disturbance, a dichotomized variable was computed (no = 'not at all' and 'not much', yes = 'moderate' and 'severe'). Mann-Whitney U tests were applied to test for differences between groups.

Linear and logistic regression models were performed for the two dependent variables sleep quality (continuous score) and sleep disturbances (dummy variable no/yes), respectively. In three blocks we entered (1) demographic factors (age, gender), SES (education, job position, marital status), shift work, BMI, and health behaviour (alcohol and coffee consumption, smoking, activity calories), (2) the SF-12 physical and mental summary health score, and (3) effort, reward and overcommitment. The same analyses were performed substituting the single variables effort and reward by the combined ERI score. In a subsequent step, regression analyses stratified by gender were conducted with a reduced set of control variables because of the reduced sample sizes, especially for women (entered blocks: 1 = age, 2 = physical and mental functional health, 3 = effort, reward, and overcommitment). All calculations were performed using SPSS statistical software package (version 11.0; SPSS Inc., Chicago, IL). Results were considered statistically significant at the $p \leq .05$ level; all tests were two-tailed.

4. Results

The study population consisted of 616 men and 93 women with a mean age of 40.0 (SD = 10.6 years; age range 15–60 years). The majority of participants were male, married

and qualified skilled workers, whose level of education was primary school (up to 9 years of school attendance) and who did not work in shifts. Further details of the population are provided in Table 1.

Table 1. Detailed characteristics of the study sample ($N = 709$).

Variable		Percentage of sample (%)
Age ± mean (SD)	Mean (SD) = 40.0 (10.6)	
Gender		
Male	616	87
Female	93	13
Level of education		
Did not finish regular school	7	1
Primary school	428	60
Secondary school	165	23
High school	109	15
Job position		
Supervisor/manager	35	5
Foremen	109	15
Qualified skilled worker	496	70
Unskilled worker	33	5
Trainee	36	5
Marital status		
Unmarried	213	30
Married	455	64
Divorced	38	5
Widowed	3	0
Shift work		
No shift work	510	72
2-shift system	142	20
3/4-shift system	57	8
BMI	Mean (SD) = 26.6 (4.2) range 17.7–53.0	
Smoking		
Yes	261	37
No	448	63
Alcohol consumption (days/week)	Mean (SD) = 2.7 (2.1)	
Coffee consumption (number of cups)		
4–6/day	93	13
2–3/day	274	39
1/day	155	22
2–6/week	64	9
≤1/week	123	17
Exercise (kcal/day)	Mean (SD) = 322.8 (399.5) Median 206.2 IQR 97.6–382.0	
SF-12 Health Survey		
Physical summary score	Mean (SD) = 49.2 (8.1)	
Mental summary score	Mean (SD) = 48.2 (9.7)	
Sleep quality (Jenkins)	Mean (SD) = 5.0 (4.2) Median 4.0 IQR 2.0–7.0	
Model of effort-reward imbalance		
Effort	Mean (SD) = 15.0 (4.0)	
Reward	Mean (SD) = 44.8 (7.9)	
Effort/reward (ERI)	Mean (SD) = 0.65 (0.28)	
Overcommitment	Mean (SD) = 14.2 (3.0)	

4.1. *Sleep complaints*

A total of 62 participants (9%) reported severe sleep problems, 155 (22%) individuals reported moderate sleep problems, while 225 (32%) stated that they had minor sleep disturbance and 267 (38%) did not report any sleep problem. Jenkins Sleep Quality Index ranged from 0 to 20 with a mean value of 5.0 ± 4.2 and a median of 4.0 (IQR: 2.0–7.0). Neither the Jenkins Sleep Quality Index nor the general sleep disturbance score differed significantly between men and women (both $p > .45$). Older age was associated with poorer sleep quality ($r = .17$, $p < .001$) and with more severe sleep disturbances ($r = .25$, $p < .001$). The two sleep measures were intercorrelated ($r = .67$, $p < .001$).

4.2. *Group comparisons*

Participants with high sleep quality (Jenkins score: 2.0 ± 1.4) reported significantly lower effort, higher reward, lower effort-reward imbalance (ERI) and showed less overcommitment at work compared to participants with low sleep quality (Jenkins score: 8.6 ± 3.4; median split). Likewise, participants reporting 'no' or 'not much' sleep disturbances had significantly lower effort, higher reward, lower effort-reward imbalance (ERI) scores, and they showed less overcommitment (OC) at work compared to participants reporting 'moderate' or 'severe' sleep disturbances (Table 2). These group differences held for men and women (all ps $< .001$).

4.3. *Regression analyses*

In the total study sample, the above outlined linear regression procedure with the dependent continuous variable sleep quality resulted in 33% of explained variance. Significant explanatory variables were age, shift work, physical and mental functional health, and overcommitment (detailed results are shown in Table 3). Female gender and marital status (unmarried vs. married) tended to be related to lower sleep quality (both ps $< .10$). Entering the combined ERI_{log} score in the regression model instead of the single variables effort and reward did not result in a significant contribution of effort-reward imbalance ($p = .46$). The logistic regression analyses with the dependent binary variable sleep disturbance no/yes resulted in $R^2_{Nagelkerke} = .33$ and revealed the following significant predictors: higher age, female gender, shift-work, lower physical and mental health functioning, and higher overcommitment (detailed results are shown in Table 3).

Table 2. Group differences in effort, reward, effort-reward imbalance (ERI), and overcommitment between (a) participants with high vs. low quality of sleep (median split), and (b) participants with disturbed sleep ('moderate' and 'severe') vs. without sleep ('not at all' and 'not much').

	Mean (SD)			
	Effort	Reward	ERI	OC
(a) High sleep quality ($N = 381$)	14.1 (4.0)	46.5 (7.3)	0.59 (2.6)	12.5 (3.6)
Low sleep quality ($N = 328$)	16.0 (3.7)	43.0 (8.2)	0.73 (0.27)	15.5 (3.8)
p-level (Mann–Whitney U)	$< .001$	$< .001$	$< .001$	$< .001$
(b) Sleep disturbances ('not at all' and 'not much'): 'No' ($N = 492$)	14.4 (3.9)	46.2 (7.1)	0.60 (0.24)	13.0 (3.6)
Sleep disturbances ('moderate' and 'severe'): 'Yes' ($N = 217$)	16.3 (3.8)	41.6 (8.8)	0.78 (0.32)	15.9 (3.9)
p-level (Mann–Whitney U)	$< .001$	$< .001$	$< .001$	$< .001$

Table 3. Regression analyses in the total study sample (men and women, $N = 709$) with the dependent variables (a) sleep quality (continuous variable; linear regression model), and (b) sleep disturbances (dummy coded yes/no; logistic regression model); predictors: (1) demographic factors (age, gender), SES (education, job position, marital status), shift-work, BMI, health behaviours (alcohol and coffee consumption, smoking, activity calories), (2) SF-12 physical and mental health functioning, and (3) effort, reward and overcommitment.

	Linear regression model (a)			Logistic regression model (b)		
Dependent variable	Sleep quality			Sleep disturbances		
Variables entered	Standard β	t	p-level	Odds Ratio*	95% CI	p-level
Age	.16	3.39	$<.001$	1.50	1.13–1.93	.004
Gender	–	–	n.s.	1.79	0.99–3.2	.05
Education	–	–	n.s.	–	–	n.s.
Marital status	–	–	n.s.	–	–	n.s.
Job position	–	–	n.s.	–	–	n.s.
2-shift vs no shift work	.08	2.40	$<.02$	8.3	4–16.6	$<.001$
3/4-shift vs no shift work	.14	4.2	$<.001$	5.0	2.2–10.0	$<.001$
BMI	–	–	n.s.	–	–	n.s.
Alcohol consumption	–	–	n.s.	–	–	n.s.
Coffee consumption	–	–	n.s.	–	–	n.s.
Smoking	–	–	n.s.	–	–	n.s.
Activity calories	–	–	n.s.	–	–	n.s.
SF-12 physical sum score	−.24	−6.81	$<.001$	0.66	0.55–0.80	$<.001$
SF-12 mental sum score	−.26	−6.76	$<.001$	0.67	0.55–0.85	$<.001$
Effort	–	–	n.s.	–	–	n.s.
Reward	–	–	n.s.	–	–	n.s.
Overcommitment	.26	5.96	$<.001$	1.7	1.42–2.10	$<.001$
	$R^2 = .33$			$R^2_{\text{Nagelkerke}} = .33$		

*Odds Ratio per Standard Deviation (SD).
n.s. = non-significant.

Substituting the single factors effort and reward with the effort-reward ratio score did not result in a significant contribution of effort-reward imbalance ($p = .50$).

Separate regression analyses for men and women revealed that in men, higher sleep quality was significantly predicted by higher physical and mental functional health, and lower overcommitment ($r^2 = .30$). Likewise, sleep disturbances were significantly predicted by lower physical and mental functional health, and higher overcommitment. Reward approached significance ($p < .10$). In women, lower sleep quality was significantly predicted by poor physical health functioning and marginally by lower reward ($p = .06$) ($r^2 = .34$). Sleep disturbances were significantly predicted by lower job reward and higher overcommitment. Forcing the combined ERI_{log} score into the regression model instead of the single variables effort and reward did not result in a significant contribution of effort-reward imbalance either in men or in women (Table 4).

5. Discussion

We investigated the relationship between the components of the model of effort-reward imbalance and self-reported sleep quality and disturbances at entry into a longitudinal designed cohort study on 709 men and women, controlling for traditional factors affecting sleep. We applied two measures of subjective sleep complaints to avoid spurious findings related to measurement errors. First of all, we found that a considerable percentage of our sample (31%) complained about moderate to severe sleep disturbances, which is line

Table 4. Regression analyses in (a) men, and (b) women with the dependent variables (i) sleep quality (continuous variable; linear regression model) and (ii) sleep disturbances (dummy coded yes/no; logistic regression model) predictors: (1) age, (2) SF-12 physical and mental health functioning, and (3) effort, reward and overcommitment.

	Linear regression model			Logistic regression model		
Dependent variable	(i) Sleep quality			(ii) Sleep disturbances		
Variables entered	Standard β	t	p-level	Odds Ratio*	95% CI	p-level
(a) Men ($N=616$)						
Age						
SF-12 physical sum score	−.25	−6.94	<.001	0.62	0.51–0.75	<.001
SF-12 mental sum score	−.29	−7.06	<.001	0.62	0.50–0.77	<.001
Effort	–	–	n.s.	–	–	n.s.
Reward	–	–	n.s.	–	–	n.s.
Overcommitment	.22	5.01	<.001	1.4	1.2–1.7	<.001
	$R^2=.30$			$R^2_{\text{Nagelkerke}}=.26$		
(b) Women ($N=93$)						
Age						
SF-12 physical sum score	−.32	−3.24	.002	–	–	n.s.
SF-12 mental sum score	–	–	n.s.	–	–	n.s.
Effort	–	–	n.s.	–	–	n.s.
Reward	−.22	−1.90	.06	0.51	0.27–0.97	.04
Overcommitment	–	–	n.s.	1.9	1.1–3.40	.03
	$R^2=.34$			$R^2_{\text{Nagelkerke}}=.36$		

*Odds Ratio per Standard Deviation (SD).
n.s. = non-significant.

with earlier reports from different countries (Ancoli-Israel & Roth, 1999; Cirignotta *et al*., 1985; Janson *et al*., 1995; Quera-Salva, Orluc, Goldenberg, & Guilleminault, 1991; Weyerer & Dilling, 1991). Second, individuals with poorer sleep quality and those with more sleep disturbances had significantly higher effort, lower reward, therefore higher effort-reward imbalance, and higher overcommitment scores compared to individuals with high sleep quality or only slight sleep disturbances. For sleep quality, the beta weight for overcommitment was as high as the beta weights estimated for physical and emotional health functioning. Furthermore, individuals were 1.7 times more likely to report disturbed sleep per standard deviation increase in overcommitment at work.

Interestingly, neither the combined effort-reward imbalance score nor the effort score alone showed a significant association with sleep quality or sleep disturbances, controlling for established risk factors for sleep problems (regression models with multivariate adjustment). This was true for the total study samples as well as the male and female sub-samples. These results might suggest that neither high effort nor the imbalance between effort and reward, but an excessive commitment towards work intrudes on an individual's sleep, particularly in men. However, significant associations between effort, reward, effort-reward imbalance, and overcommitment with sleep were found in the bivariate analyses (Table 2). Taken together, this raises the idea that mental/psychological regulatory processes (as captured by the SF-12 mental summary score) might be important mediators of the observed relationship between the effort component as well as the effort-reward imbalance index and sleep. Indeed, an exclusion of the SF-12 mental summary health score from the list of control variables yielded significant contributions of effort-reward imbalance or the reward component (but not the effort component) for sleep quality as well as sleep disturbances in the total study sample. This effect was not observed when excluding other

control variables such as the SF-12 physical summary score, SES, or shift work. In the male and female sub-samples, comparable results were only observed after exclusion of the SF-12 mental as well as physical summary health score.

The observed associations between overcommitment and sleep underline the importance of being able to unwind during leisure time to achieve adequate and restful sleep. As pointed out by Kalia (2002) sleep disturbances (among other indicators) can be bodily symptoms of considerable job stress and therefore be interpreted as early warning signs of stress at work. Alternatively, the present results are also compatible with the hypothesis that high intrinsic effort (i.e. overcommitment) may bias or affect a person's ability to accurately assess cost-gain relations of the work situation due to, for example, extremely high work motivation or identification with a particular job/company. Such a specific pattern of personal coping carries the danger of preventing an individual from timely adaptation to job changes arising from increased effort-reward imbalance.

In contrast to men, lower sleep quality was significantly predicted by lower physical health functioning and lower reward in women, while disturbed sleep was significantly predicted by lower reward and higher overcommitment. This finding suggests a differential pattern in women, to the extent of positive and negative feedback about their work in terms of social approval, career opportunities, and monetary remuneration (i.e. reward). Alternatively, one could hypothesize that this observation might reflect, at least in part, inequalities in reward processes between men and women at the workplace. Based on five independent study samples, Siegrist *et al*. (2004) reported that scores of perceived reward did not differ according to gender in a consistent way, but there was a tendency towards higher reward scores among older employees and especially in men. Finally, although the implicit causal direction of the raised hypotheses seems quite plausible, we cannot totally exclude reverse relationships with, for example, poor sleep increasing a person's perceived need for commitment or reward at work.

Corroborating an earlier report by Bixler *et al*. (1979), the general health status was highly related to sleep quality and both the prevalence and severity of sleep disturbances (but see also Edell-Gustafsson, Kritz, & Bogren, 2002). It has been suggested that problems with sleep reflect a negative physical and/or psychological condition or may be a marker for chronic stress (Jacquinet-Salord *et al*., 1993; Mellinger, Balter, & Uhlenhuth, 1985; Schwartz *et al*., 1999; Tachibana *et al*., 1996). Sleep problems have consistently been observed in association with a variety of somatic and psychiatric conditions (Bixler *et al*., 1979; Klink, Quan, Kaltenborn, & Lebowitz, 1992; Quera-Salva *et al*., 1991; Weyerer & Dilling, 1991). Epidemiologic and clinical evidence suggest that disturbed or inadequate sleep is a risk factor for cardiovascular diseases, gastrointestinal disorders as well as increased morbidity and even mortality (Kripke, Garfinkel, Wingard, Klauber, & Marler, 2002; Partinen, Kaprio, Koskenvuo, & Langinvainio, 1983; Schwartz *et al*., 1999). As potential underlying physiological mechanisms, Edell-Gustafsson and co-workers (2002) argued that reduced sleep quality causes lighter sleep and increased arousal which may directly interfere with the functioning of the autonomic nervous system, the hypothalamic-pituitary-adrenal (HPA) axis, and the immune system.

Several limitations of the present data have to be addressed. First, the selected nature of the study cohort raises the issue of generalizability, especially because of the small proportion of female participants. Second, the cross-sectional nature of the present report does not allow definite inferences on causation. Third, this report is based on self-reports in form of questionnaires, raising the issue of common method variance (e.g. response biases or attribution processes). Another disadvantage is that questionnaire data in general depend on the person's subjective assessment of his or her own sleep symptoms. Using objective

methods of measurement such as actimetry or EEG, some investigations were able to demonstrate a discrepancy between subjective and objective assessments of disturbed sleep (Carskadon *et al*., 1976; Reyner *et al*., 1995). Finally, the severity of sleep disturbances was assessed by a single-item summary measure that cannot differentiate between different aspects of disturbed sleep. A more elaborated assessment might be important in diagnostic terms, e.g. for differentiation between sleep apnoea and stress-related sleep disturbances. This should be considered in more detail in future studies.

Bearing these restrictions in mind, our findings in a large sample size point to an intriguing avenue of research that deals with the effects of operationalized job strain on sleep. Such research seems worth pursuing in smaller studies applying more sophisticated methods of sleep assessment (e.g. polysomnography). For example, the ERI questionnaire could easily be included in clinical differential diagnosis of individuals undergoing polysomnography for sleep problems.

In sum, the present data shows that the amount of experienced effort, reward, effort-reward imbalance and overcommitment at work differentiates working individuals in terms of sleep quality and disturbances in bivariate statistical assessments. As shown in regression models with multivariate adjustment, overcommitment at work appears to intrude into sleep in men, while in women disturbed sleep may be associated with the amount of overcommitment and perceived job reward and sleep quality with perceived reward.

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