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QUALITY OF LIFE

Work stress, asthma control and asthma-specific quality of life: Initial evidence from a cross-sectional study

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ABSTRACT

Objective: Research has suggested that psychological stress is positively associated with asthma morbidity. One major source of stress in adulthood is one's occupation. However, to date, potential links of work stress with asthma control or asthma-specific quality of life have not been examined. We aimed to address this knowledge gap. **Methods:** In 2014/2015, we conducted a cross-sectional study among adults with asthma in Germany ($n = 362$). For the current analyses that sample was restricted to participants in employment and reporting to have never been diagnosed with chronic obstructive pulmonary disease ($n = 94$). Work stress was operationalized by the 16-item effort-reward-imbalance (ERI) questionnaire, which measures the subcomponents "effort", "reward" and "overcommitment." Participants further completed the Asthma Control Test and the Asthma Quality of Life Questionnaire-Sydney. Multivariable associations were quantified by linear regression and logistic regression. **Results:** Effort, reward and their ratio (i.e. ERI ratio) did not show meaningful associations with asthma morbidity. By contrast, increasing levels of overcommitment were associated with poorer asthma control and worse quality of life in both linear regression ($\beta = -0.26$, $p = 0.01$ and $\beta = 0.44$, $p < 0.01$, respectively) and logistic regression (odds ratio [OR] = 1.87, 95% confidence interval [CI] = 1.14–3.07 and OR = 2.34, 95% CI = 1.32–4.15, respectively). **Conclusions:** The present study provides initial evidence of a positive relationship of work-related overcommitment with asthma control and asthma-specific quality of life. Longitudinal studies with larger samples are needed to confirm our findings and to disentangle the potential causality of associations.

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Asthma morbidity; effort reward imbalance; epidemiology; job stress; Germany

Introduction

Research has suggested that psychological stress is associated with an increased occurrence of adult asthma [1]. One prominent and prevalent source of stress in adult life is one's occupation [2]. Work stress has been found to predict various chronic conditions such as depression [3], diabetes [4], and coronary heart disease [5]. Likewise, epidemiological studies have suggested positive associations between work stress and the prevalence [6–8] or incidence [9–11] of asthma. Notably, psychological stress is not only linked to the occurrence of asthma, but may also be associated with a poorer prognosis and with elevated morbidity in asthma patients: A recent study found that many patients perceive psychological stress as an important determinant of their level of asthma control [12]. Furthermore, two epidemiological studies found evidence that high levels of overall stress are associated with poor asthma control [13] and a decreased quality of life [13, 14].

Although prior studies have thus suggested links a) between work stress and the occurrence of asthma (i.e.,

its presence versus absence) and b) between overall stress levels and asthma morbidity, studies that specifically consider work stress (rather than overall stress) in relation to asthma morbidity (rather than its prevalence or incidence) remain markedly sparse. In fact, the current evidence is limited to one single report [15]: in that study, data from several cohort studies were pooled to examine the link between work stress and severe asthma exacerbations, which were operationalized as asthma hospital admissions or asthma death. Overall, a weak positive relationship was documented, which did not reach conventional levels of statistical significance, however [15].

Although that earlier study provided important initial insights, its scope and potential implications remain limited: hospital admission for asthma and fatal exacerbations are considered very rare and largely avoidable events [16] and likely reflect levels of exceptionally poor asthma control. It is thus of interest to examine potential links between work stress and more fine-grained asthma morbidity markers, such as asthma control or asthma-specific quality of life. Asthma control refers to the degree

to which manifestations of asthma are present in a given patient [17].

Asthma control comprises two domains, these are, symptom control and the future risk of adverse outcomes. These domains are operationalized, amongst others, by questions inquiring after daytime and nocturnal experience of respiratory symptoms and after the frequency of reliever medication use. Asthma-specific quality of life refers to the perceived impact that asthma has on the patient's quality of life [18]. Importantly, quality of life is distinct from symptoms and considers the degree to which experienced impairment matters to the patient. Any relationship between work stress and asthma control or asthma-specific quality of life would be consistent with findings from the above-mentioned prior studies addressing overall stress and asthma [13,14] and with compelling evidence suggesting biological plausibility of such associations [19]. We set out to address this knowledge gap by providing initial epidemiological data on the potential relationship of work stress with asthma control and asthma-specific quality of life.

Methods

Study population

In 2014/2015, we conducted a cross-sectional study among patients with asthma in Germany. Details have been reported elsewhere [20]. Briefly, individuals were eligible if they a) were aged 18 years or above and b) reported that they had been diagnosed with asthma by a physician. Participants were recruited through various pathways, including physicians they were regularly in contact with, pharmacies and patient organizations. Participants could complete the questionnaire either online or as pencil-on-paper. In total, 362 individuals had participated [20]. For the current analyses, that sample was limited to those who were in employment and reported to have never been diagnosed with COPD (chronic obstructive pulmonary disease) ($n = 94$). The latter selection criterion was applied to reduce the likelihood of confounding by COPD [21]. Our study was approved by the ethics committee of the Medical Faculty at the University of Düsseldorf. Participants provided written informed consent prior to their inclusion in our study.

Work stress

Work stress was quantified by the 16-item version of the effort-reward-imbalance questionnaire (ERI) [22], which has been extensively psychometrically validated in different occupational samples [23]. The key theoretical assumption of this established model [24,25] is that work stress is present if work-related efforts exceed the received

rewards (the latter being for instance an adequate salary, recognition, job security and promotion prospects). Work stress according to the ERI model has been identified as a robust predictor of numerous health outcomes in prospective studies, including depression [26], cardiovascular disease [27] and sickness absence [28].

Our ERI questionnaire measures effort by 3 items and reward by 7 items, respectively. Examples of effort items are "I have constant time pressure due to a heavy workload" or "I have many interruptions and disturbances while performing my job." Illustrative reward items are "I receive the respect I deserve from my superior or a respective relevant person" or "My employment security is poor" [23]. Responses to items are provided on a 4-point Likert scale to indicate the level of agreement (1 = *strongly disagree*; 2 = *disagree*; 3 = *agree*; 4 = *strongly agree*). We collapsed responses across items to create continuous effort and reward variables. The resulting effort and reward subscale scores potentially range from 3 to 12 and from 7 to 28, respectively. Further, in line with recommendations [24,25], we calculated the ratio of effort and reward weighted by the respective number of items.

Except for effort and reward, the ERI model contains a third component, that is, overcommitment. Being overcommitted to work implies that one feels overly obligated and dedicated to her/his work. Overcommitment was measured by six items. Illustrative items are "As soon as I get up in the morning I start thinking about work problems" or "If I postpone something that I was supposed to do today I'll have trouble sleeping at night" [23]. Again, responses were 4-point Likert scaled and were collapsed to operationalize overcommitment as a continuous variable which had a potential score range from 6 to 24. All three ERI subscales showed good internal consistency as indicated by Cronbach's alphas of 0.75 for effort and 0.79 for reward and overcommitment, respectively.

Asthma morbidity

Levels of asthma control were assessed by the Asthma Control Test (ACT) [29], which consists of five questions inquiring after the frequency of nocturnal asthma symptoms, shortness of breath, limitations in everyday life and the utilization of reliever medication. In addition, respondents are asked to provide an overall estimate of their perceived level of asthma control. Each question has five response options, which are scored as 1 to 5 points, respectively. We summed up the scores across all items yielding a total score with a potential range of 5 to 25 points with higher scores indicating a better level of control.

Participants also completed the German version of Asthma Quality of Life Questionnaire Sydney (AQLQ-S)

[30,31] which may be the most suitable tool for measuring disease-specific quality of life among German-speaking asthma patients [32]. The AQLQ-S comprises 20 items which are 5-point Likert-scaled. Responses on each item are scored as 0 to 4 points. As recommended [31], the derived total scores was multiplied by 2.5 to transform scores to a range from 0 to 10, which improves interpretability. Lower AQLQ-S scores reflect better quality of life.

Statistical analyses

We conducted analyses using different regression models. We used linear regression models to examine the links of each continuous independent variable (i.e., effort, reward, the ERI ratio and overcommitment) with each dependent continuous variable (i.e., ACT and AQLQ-S). Associations were quantified by standardized (β) and unstandardized regression coefficients (b). Furthermore, we ran logistic regression analyses with z-transformed continuous independent variables and with dichotomized dependent variables. To dichotomize the ACT, its well-established cut-off (i.e. ≤ 19 points) [33] was applied. In contrast to the ACT, the AQLQ-S lacks an established cut-off. We therefore dichotomized the AQLQ-S based on the distribution of its scores. This approach to the dichotomization of quality of life measures is consistent with earlier research [20,34,35]. Specifically, we used two alternative cut-offs in two separate sets of analyses to examine the robustness of findings. One cut-off was set at the bottom tertile and another at the median of the score distributions. Logistic regression estimates were expressed as odds ratio (OR) with corresponding 95% confidence intervals (CI).

Confounders were identified based on the literature [11,14,36–39]. All models were initially adjusted for age and sex. Next, we additionally corrected for educational levels, body mass index (BMI) and smoking status. Educational levels were measured by reports of the highest school degree that had been attained in the German schooling system and were categorized into high (= general qualification for university entrance [‘Abitur’] or entrance qualification limited to universities of applied sciences [‘Fachhochschulreife’]), intermediate (= secondary school certificate [‘Mittlere Reife’]), low (= secondary modern school qualification [‘Haupt-/Volksschulabschluss’] or no formal school degree). BMI was calculated based on reported height and weight (kg/m^2) and employed in the analyses as a continuous variable. To characterize the study sample more appropriately, we also categorized BMI into lean, i.e., $\text{BMI} < 25 \text{ kg/m}^2$, overweight, i.e. BMI of 25 to $< 30 \text{ kg/m}^2$ and obese, i.e., $\text{BMI} \geq 30 \text{ kg/m}^2$.

Smoking status was measured by three categories (i.e., current, former, and never), which were collapsed into two categories (e.g., ever vs never) due to low numbers. In addition, participants reported whether they suffered from a wide range of allergies. We did not control for reported allergies as this atopic outcome may lie on a potential causal pathway and may thus operate as mediating factors [36,40] and adjustment for such factors is not recommended [41]. We will however add those data to the description of our study sample. In addition, we will present data on the duration of disease (i.e., year of study participation – reported year of diagnosis), the age at diagnosis (i.e., year of diagnosis – reported year of birth) and the mode of employment (full-time versus part-time).

Results

Our study included 94 participants (Table 1). Participants were mainly middle-aged (mean = 44.8, standard deviation = 10.7), female (78.5%), held intermediate or high school degrees (82.8%), were overweight or obese (60.2%) and have never smoked (58.5%). In total, 90% of the participants reported to have at least one allergy. Slightly more than half of the sample reported to be in full-time employment. As much as 70% of the respondents were exposed to work stress according to the ERI-model (i.e.

Table 1. Characteristics of the study population.

Characteristic		
Age (years), mean (SD)		44.8 (10.7)
Female gender, n (%)		73 (78.5)
Years since asthma diagnosis, mean (SD)		12.1 (11.5)
Age at diagnosis (years), mean (SD)		32.4 (14.4)
Education, n (%)	Low	16 (17.2)
	Intermediate	37 (39.8)
	High	40 (43.0)
Body mass index (kg/m^2), n (%)	Lean	37 (39.8)
	Overweight	29 (31.2)
	Obese	27 (29.0)
Body mass index (kg/m^2), mean (SD)		27.7 (5.8)
Smoking status, n (%)	Never	55 (58.5)
	Ever	39 (41.5)
Any allergy ¹ , n (%)	No	10 (10.6)
	Yes	84 (89.4)
Mode of employment, n (%)	Full-time	52 (55.3)
	Part-time	42 (44.7)
Effort score, mean (SD)		8.4 (2.2)
Reward score, mean (SD)		15.6 (3.6)
High effort reward imbalance at work ² , n (%)	No	27 (29.6)
	Yes	64 (70.3)
Effort reward imbalance at work, mean (SD)		1.4 (0.6)
Overcommitment score, mean (SD)		12.0 (3.2)
Poor asthma control ³ , n (%)	No	52 (55.3)
	Yes	42 (44.7)
ACT score, mean, (SD)		19.2 (4.6)
AQLQ-S score, mean (SD)		3.3 (1.8)

¹Any report of allergy to either foods, pollen, dust mites, fur, venom, drugs or allergic contact eczema in response to detergent, cosmetics, nickel and alike.

²Work stress operationalized by the theory-based effort-reward-imbalance ratio cut-off at 1.0.

³Defined as a score of 19 or lower on the Asthma Control Test.

Table 2. Associations of work stress with asthma control and asthma-specific quality of life (linear regression).

	Asthma control						Asthma-specific quality of life					
	Model 1 ^a			Model 2 ^b			Model 1 ^a			Model 2 ^b		
	b	β	p	b	β	p	b	β	p	b	β	p
Work stress												
Effort	−0.05	−0.02	0.83	−0.03	−0.01	0.91	0.14	0.16	0.13	0.12	0.16	0.13
Reward	0.09	0.07	0.52	0.01	0.01	0.92	−0.09	−0.17	0.13	−0.06	−0.13	0.24
ERI ratio	−0.40	−0.05	0.64	0.01	0.00	0.99	0.59	0.19	0.08	0.45	0.15	0.17
Overcommitment	−0.35	−0.28	0.01	−0.34	−0.26	0.01	0.21	0.41	<0.01	0.22	0.44	<0.01

Note. Significant findings are shown in bold.

^aAdjusted for age and sex.

^bAdjusted for age, sex, education, body mass index and smoking status.

Abbreviations: b = unstandardized regression coefficient; β = standardized regression coefficient; ERI = effort-reward imbalance; p = p value.

ERI-ratio > 1.0). We observed a broad score range for each ERI construct, that is, 3 to 12 points for the effort subscale, 7 to 24 points for reward, and 6 to 23 points on the overcommitment subscale. Almost half of the participants (45%) had poorly controlled asthma according to the ACT cut-off. The asthma-specific quality of life, as measured by the AQLQ-S, was rather good as reflected by a mean score of 3.3 points.

As shown in Table 2, effort, reward and the ERI-ratio did not show meaningful associations with asthma morbidity in linear regression analyses. By contrast, irrespective of the level of statistical adjustment, we observed that increasing levels of overcommitment were associated with poorer asthma control ($\beta = -0.26$, $p = 0.01$) and worse quality of life ($\beta = 0.44$, $p < 0.01$). The logistic regression models (Table 3) generally confirmed the observations from linear regression analyses, in particular overcommitment's association with poor asthma control (OR = 1.87, 95% CI = 1.14–3.07) and its poor asthma quality of life (OR for the cut-off at the median = 2.80, 95% CI = 1.51–5.19, and OR for the cut off at the bottom tertile = 2.34, 95% CI = 1.32–4.15).

Discussion

This cross-sectional study investigated potential links of work stress, measured by the ERI model, and asthma morbidity as quantified by the ACT and AQLQ-S. We observed consistent relationships between overcommitment and asthma morbidity while there was no

evidence of important associations with the other ERI constructs.

Previous longitudinal studies have suggested that work stress is associated with an increased risk of asthma [9–11]. Interestingly, in support of our current findings, we observed in an earlier study that one specific work stress factor, which was conceptually related to overcommitment (e.g., including items on the inability to relax after work) predicted the onset of asthma [11]. With regard to work stress according to the ERI model, there is evidence from prior cross-sectional studies, which suggested rather modest associations between the individual ERI constructs and asthma prevalence [6,8].

To date, evidence on the links between stress and asthma morbidity from adult samples remains sparse and prior studies [13,14,42] have only drawn on a summary measure of psychological stress (i.e., the Perceived Stress Scale [43]). Overall, those studies found stress to be positively associated with asthma morbidity [13], asthma-related quality of life [14] and flares among patients with allergy [42]. Building on that that prior evidence we sought to examine potential links between stress specifically due to one's work and asthma morbidity. Effort, reward and the ERI ratio were unrelated to asthma control or asthma-specific quality of life and thus in this respect our findings are not in agreement with those previous observations.

Our study did, however, reveal close associations between overcommitment and asthma morbidity. This

Table 3. Associations of work stress with asthma control and asthma-specific quality of life (logistic regression).

	ACT				AQLQ-S (cut-off at median)				AQLQ-S (cut-off at tertile)			
	Model 1 ^a		Model 2 ^b		Model 1 ^a		Model 2 ^b		Model 1 ^a		Model 2 ^b	
	OR ^d	95% CI ^e	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Work stress (z-scores)												
Effort ^f	1.08	0.70–1.66	1.09	0.69–1.71	1.32	0.85–2.05	1.34	0.82–2.17	1.44	0.89–2.32	1.49	0.89–2.47
Reward ^f	0.76	0.50–1.17	0.81	0.51–1.29	0.75	0.48–1.15	0.87	0.54–1.41	0.69	0.44–1.09	0.77	0.47–1.26
ERI ^g -ratio ^f	1.32	0.82–2.12	1.25	0.76–2.07	1.34	0.82–2.20	1.15	0.67–1.95	1.55	0.94–2.57	1.41	0.83–2.39
Overcommitment ^f	1.76	1.11–2.77	1.87	1.14–3.07	2.40	1.42–4.06	2.80	1.51–5.19	2.06	1.25–3.39	2.34	1.32–4.15

Note. Significant findings are shown in bold.

^aAdjusted for age and sex.

^bAdjusted for age, sex, education, body mass index and smoking status.

Abbreviations: CI = confidence interval standardized regression coefficient; ERI = effort-reward imbalance; OR = odds ratio.

finding may highlight the potential importance of work-related psychosocial exposures that are traditionally conceptualized as fairly constant personal characteristics: Overcommitment is assumed to be related to personality traits rather than to the actual work conditions. One may therefore hypothesize that employees with asthma who may face reduced workability due to their condition [44] are to some extent able to adapt their work conditions to their disease (e.g., reducing efforts, expecting less reward). As a result, efforts and rewards may lack associations with asthma morbidity. However, such coping may be less feasible when it involves fairly stable personality-related factors such as overcommitment, which could explain why this factor was related to asthma morbidity. Alternatively, overcommitment may have been the only ERI model component linked to asthma morbidity, because overcommitment is most likely to capture actual work-related physiological strain. Although effort and reward items inquire after the exposure to psychosocial work conditions, overcommitment captures the psychophysiological responses to work conditions (e.g. increased arousal, rumination and sleep problems). Thus, high levels of overcommitment may identify workers who are psychophysiological most vulnerable to adverse work conditions, which may generalize to elevated morbidity in workers with asthma.

The biological mechanisms potentially underlying our observed associations likely involve the physiology of stress responses. Acute stress is associated with increased release of corticosteroids. Representing a cornerstone of asthma therapy, corticosteroids down-regulate immune responses and thus result in decreased airway inflammation [17]. However, during chronic stress exposure corticoid sensitivity may be decreased, as suggested by *in vitro* experiments [45]. According to Liu et al. [46] airway inflammation after allergen exposure may be increased by psychological stress. Furthermore neuroendocrine and immunological deregulation due to psychological stress was observed in several studies: for instance, psychological stress was related to increased delayed-type allergic reactions [47] and to higher levels of substance p, a pro inflammatory neuroendocrine messenger [48]. Finally, links between stress and asthma would be consistent with observations related to other inflammatory diseases with similar pathomechanisms and similar therapy (i.e., corticosteroids or immunosuppressants), such as chronic inflammatory bowel diseases [49].

The main limitation of our study is its cross-sectional design. Despite the plausibility that overcommitment contributes to increased asthma morbidity, the opposite direction of effect cannot be ruled out. Further, the sample size of our study was small. As a consequence, estimates derived in particular from multivariable models

may have constrained validity due to a suboptimal ratio of the number of cases to the number of independent variables. Also, owing to the small sample we were unable to conduct analyses stratified by sex or other potentially relevant effect-modifiers.

Our study would have been strengthened by availability of data on asthma severity and objective data such as peak-flow measures or results from spirometric testing. Regrettably though, collection of such information was beyond the scope of our study. Such data had also been useful to improve our asthma case definition, which solely relied on self-reports of having ever received a physician's diagnosis. However self-reports of physician diagnosed asthma are considered valid approaches to assessing asthma in surveys [50], are highly reliable [51], and show good agreement with data from medical records [52,53].

Furthermore, the distribution of some key characteristics of our sample is in line with what would be typically expected in an asthma patient population: For instance, the vast majority of participants reported at least one allergy. Moreover, the mean age at asthma diagnosis was 32.4 years and most have never smoked. These aspects and the restriction of our study to patients who reported to have never been diagnosed with COPD, just like in previous studies [13,14], make the confusion of asthma with COPD unlikely in our study. Further, the proportion of participants with poorly controlled asthma (45%) is closely in line with findings reported elsewhere [54]. Our study population comprised a relatively high percentage of women (79%), which falls, however, in the range reported in prior studies in this field of research, that is, the studies by Wisnivesky et al. (63% women)[13] and Kimura et al. (83% women)[14]. However, we cannot be certain that our sample is representative for all asthma patients in Germany, because patients were recruited by various pathways (partially locally, partially nationwide), and the response rate cannot be determined.

Conclusion

The present study found, for the first time, evidence of a positive relationship of overcommitment at work with asthma control and asthma-specific quality of life. Further studies with a longitudinal design and larger samples are needed to confirm our findings and to provide insights into the potentially causal directions of those associations.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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