

WORK-RELATED PSYCHOSOCIAL STRESS AS A RISK FACTOR FOR ASTHMA, ALLERGY, AND RESPIRATORY INFECTIONS IN THE SWEDISH WORKFORCE^{1, 2}

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Summary.—This study examined the association between work-related psychosocial stress and asthma, atopy, and respiratory infections. 532 randomly selected occupationally active people (272 men, 260 women; *M* age = 41 yr., *SD* = 13) in Sweden participated. Information on history of asthma, atopy, and respiratory infections was collected by a postal self-report questionnaire. Work stress was assessed based on the demands-control-support model. Current asthma and respiratory infections were associated with work-related psychosocial stress. When stratified for sex, these associations were only found in men. Associations between low control, low support, and current asthma were found among young participants (<40 years), whereas among older participants (>40 years) low supervisor support was associated with frequent respiratory infections.

Asthma and atopy are common diseases. Although asthma is a global problem, it is still predominantly a Western disease (Anandan, Nurmatov, van Schayck, & Sheikh, 2010). Asthma is a severe disease characterized by chronic inflammation in the lower airways (bronchioles and smooth muscles), with sudden occurrences of airway obstruction. Atopy is characterized by an increased production of IgE antibodies to common allergens, e.g., pollen, house dust mites, and furry pet allergens, and the allergic reaction can cause various symptoms such as asthma. Respiratory infections may worsen the symptoms of asthma (Guilbert & Denlinger, 2010). In children, respiratory syncytial virus (RSV) infections may cause atopy and asthma later in childhood (Peebles, 2004).

The role of stress in the development and exacerbation of asthma is not well understood, although stress is a related factor in many explanations of the origins of asthma. Maternal stress during pregnancy may modulate the offspring's immune function towards asthma and atopy, starting *in utero* (Wright, 2011). Stress and severe life events in adults occur in many forms and have a negative effect on the immune system, which may trigger asthma attacks (Loerbroks, Gadinger, Bosch, Sturmer, & Amelang, 2010; Douwes, Brooks, & Pearce, 2011; Jackson, Sykes, Mallia, & Johnston, 2011; Lietzen, Virtanen, Kivimäki, Silanmäki, Vahtera, & Ko-

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skenvuo, 2011). Forms of stress associated with asthma include caregiver stress and maternal depression (Lange, Bunyavanich, Silberg, Canino, Rosener, & Celedon, 2010), adult depression, anxiety, and cognitive dysfunction (Thoren & Petermann, 2000; Lavoie, Joseph, & Bacon, 2009), affective disorders, somatoform disorders, (Goodwin, Jacobi, & Thefeld, 2003), impulsivity (Axelsson, Emilsson, Brik, Lundgren, Toren, & Lötvall, 2009; Runeson, Wahlstedt, & Norbäck, 2011), and personality types characterized by extreme inhibition, covert aggression, marked dependency needs and high need for affection (Sharma & Nandkumar, 1980).

A modern approach to understanding the relationship between stress and respiratory diseases is to consider a range of psychosocial, personality, demographic, and behavioural factors that may contribute to the susceptibility and severity of respiratory tract infections (Aich, Potter, & Griebel, 2009). One proposal is that stress-related triggers may activate mast cells, which would explain the effect of stress in exacerbating asthma (Theoharides, Enakua, Sismanopoulos, Asadi, Papadimas, Angelidou, *et al.*, 2012). Therefore, psychological stressors could increase the incidence and severity of respiratory infections (Cohen, Doyle, & Skoner, 1999), and susceptibility to upper respiratory tract illness (Turner Cobb & Steptoe, 1996; Falagas, Karamanidou, Kastoris, Karlis, & Rafailidis, 2010).

Work can be a source of psychosocial stress. Indeed, studies have demonstrated the effects of work-related stress on many aspects of health, including cardiovascular diseases (Karasek & Theorell, 1990), musculoskeletal problems (Linton, 1990; Bigos, Battié, Spengler, Fisher, Fordyce, Hansson, *et al.*, 1991; Bongers, de Winter, Kompier, & Hildebrandt, 1993; Theorell, 2000; Bongers, Ijmker, van den Heuvel, & Blatter, 2006), inability to relax after work (Loerbroks, *et al.*, 2010), sleep problems (Theorell, Perski, Åkerstedt, Sigala, Ahlberg-Hulten, Svensson, *et al.*, 1988; Runeson, Lindgren, & Wahlstedt, 2011), and the common cold (Takkouche, Regueira, & Gestal-Otero, 2001; Park, Kim, Min, Hwang, Park, & Min, 2011). The commonly used measurement of work stress is the demands-control-support model (DCS), in which the combination of high demands, low control, and low support constitute the psychosocial stress (Johnson, 1986; Karasek, & Theorell, 1990; Theorell, Nordemar, Michaelsen, & Stockholm Music I Study Group, 1993). Cortisol is a commonly used biomarker of stress, and it has been demonstrated that the demand control model (Aldering, Theorell, de la Torre, & Lundberg, 2006) and job strain (Steptoe, Cropley, Griffith, & Kirschbaum, 2000) are associated with saliva cortisol levels.

Given the lack of research on the relationships between psychosocial work-related stress and asthma, allergy, and respiratory infections, this study used the DCS model to explore associations between psychosocial stress at work and asthma, atopy, and respiratory infections.

Hypothesis 1. Participants with asthma, atopy, and respiratory infections will present higher stress in the demand-control-support model.

Hypothesis 2. The associations between asthma, atopy, and respiratory infections and work stress (as measured in the demand-control-support model) are different for men and women.

Hypothesis 3. The associations between asthma, atopy, and respiratory infections and work stress (as measured in the demand-control-support model) are different for people in different age groups.

METHOD

Participants

A random sample of 1,000 participants (women and men ages 20–65 yr.) was drawn from the civil registration register in Sweden. Age, sex, and postal address were completely random. The participants were grouped randomly into four subgroups (250 individuals in each group) which, in different seasons, received by mail a self-administered questionnaire.

Measures

The questionnaire included some personal details such as age, sex, occupation, tobacco smoking, and body mass index (BMI; calculated by dividing weight in kilograms by height in meters squared). Other questions covered the cumulative incidence of asthma (asthma ever), current asthma (during last 12 mo.), atopy (pollen or pet allergy), and frequent respiratory infections (often getting a cold or having respiratory infections). Current asthma was defined as having a wheeze, daytime attacks of breathlessness, or nighttime attacks of breathlessness (three questions).

For the assessment of work demands, control, and support (DCS; Johnson, 1986; Karasek & Theorell, 1990) the questionnaire included 5 items for the demands scale, 6 items for the control scale, and 16 items for the work social support scale. High work demands meant having too much to do in a short time, over a prolonged period. Low work control meant not having enough influence over the way the work is performed on a day-to-day basis. Low work support meant not having sufficient support from co-workers and superiors. Example questions were "Does your job make you work very hard?", "Can you decide how your work will be done?", and "My supervisor treats me in a condescending manner." Responses were: 4: Yes, often; 3: Yes, sometimes; 2: No, seldom; 1: No, almost never. Sum scores of the DCS ratings were calculated with appropriate recoding, such that high scores reflected high demands, low control, and low support. The possible

range of scores in the demands scale was 5–20, with high scores representing high demands. The scale for control ranged from 6–24, the scale for skill discretion ranged from 4–16, and the authority over decisions ranged from 2–8, a high value indicating low control. The scale for social support ranged from 16–64, the supervisors' support scale (5 items) ranged from 5–20, and the scale for co-workers' support (4 items) ranged from 4–16, high values indicating low support.

The validity of the demands and control part of the questionnaire had been previously tested (Theorell, *et al.*, 1993). For the demands index, the validity and internal homogeneity were high: the reliability of the demands index had a Cronbach's α of .84, the control index .83 (Wahlstedt and Edling, 1994), and the social support index .79 (Wahlstedt and Edling, 1997).

Procedure

The study was approved by the ethical committee of Uppsala University, and the participants gave informed consent. They were not financially compensated in any way. The questionnaires had an ID number (no name written), but names and addresses and personal ID codes were known (everybody has such an ID in Sweden) since the participants were drawn from a population register.

Analyses

To enable regression coefficients to correspond to an interquartile range (IQR) increase in each scale, i.e., an increase from the 25th to the 75th percentile, the DCS scales scores were transformed. The scores were not dichotomised, but the interquartile range (IQR) transformed scores were used in the multiple-logistic regression analysis. The transformation into IQR scores is done by dividing the scales' total scores by a constant, which is the difference between the 25th and the 75th percentile scores for each scale. The transformed scores were used in multiple-logistic regression analysis to study gender differences on demands, control, and support scales among participants with asthma, atopy, and frequent respiratory infections. In all models, adjustments were made for sex, age, smoking status, and BMI, as these factors could be related to DCS traits and the diseases studied. BMI was used as a continuous variable in the logistic analysis. In all analyses, two-tailed tests and a 5% level of significance were applied. The odds ratio (OR) with 95% confidence interval (95% CI) was expressed per change of one unit on the IQR score scale. A χ^2 test (2×2 contingency tables) was applied to examine group differences. Differences in prevalence of asthma, atopy, and frequent respiratory infections between the four seasons were examined by the Kruskal-Wallis Test.

RESULTS

The response rate was 70% ($n=695$), of whom 532 were occupationally active (77% of the responders; 81% men and 73% women). Responders ($n=695$) were compared with non-responders ($n=305$), with respect to demographic data. The response rate was 68% for men and 71% for women, a non-significant difference. The mean age was 41 yr. ($SD=13$) for responders and 39 yr. ($SD=13$) for non-responders, a non-significant difference. There were no significant seasonal differences in current asthma, atopy, and respiratory infections or demand, control, and social support. The occupations were: 21.4% production work, 19.2% professional, technical and related work, 16.4% health care work, 14.7% administrative/managerial work, 9.6% sales work, 7.5 service work, 6.0% transport and communication work, 2.8% agricultural and forestry work, 0% mining work, and 2.4 % missing information. Participants with a history of having asthma were slightly more common among females ($n=24$) than among males ($n=14$) (Table 1).

TABLE 1
ASTHMA, ATOPY, AND FREQUENT RESPIRATORY INFECTIONS AMONG MALE AND FEMALE PARTICIPANTS ($N=532$)

Respiratory Symptom	Men		Women		OR (95%CI)	2-tailed p^a
	n	%	n	%		
Asthma ever	14	5.1	24	9.2	1.88 1.94, 3.69	.07
Current asthma	17	6.3	17	6.5	1.06 0.53, 2.13	.86
Atopy (allergy to pollen or pet)	44	16.2	49	18.8	1.20 0.77, 1.88	.43
Frequent respiratory infections	37	13.6	33	12.7	0.94 0.57, 1.55	.80

^aDifferences between males and females, calculated by χ^2 (2×2 contingency tables).

In the study population the minimum and maximum mean scores were: for the demand scale 6–20, the control scale 9–24, the social support scale 16–58, the supervisors' support scale 5–19, and the co-workers' support scale 4–15. The scales' reliability was tested, and the demands index had a Cronbach's α of .76, the control index .76, the skill discretions index .69, the authority over decisions index .77, the social support index .80, the supervisors' support index .70, and the co-workers' support index .73.

Hypothesis 1 was supported; there were associations between low social support and current asthma. Frequent respiratory infections were associated with low control and low support, especially low skill discretion, low authority over decisions, and low supervisor support (Table 2).

TABLE 2
ASSOCIATIONS BETWEEN ASTHMA, ALLERGY, AND FREQUENT RESPIRATORY INFECTIONS AND THE DEMANDS, CONTROL, AND SUPPORT (DCS) SCALES IN A SAMPLE OF OCCUPATIONALLY ACTIVE SWEDISH

DCS Scale	IQR Range, 25 th –75 th Percentile	Asthma Ever OR (95% CI)	Current Asthma OR (95% CI)	Atopy OR (95% CI)	Frequent Respiratory Infections OR (95% CI)
High demands	10–15	1.16 0.65; 2.08	1.34 0.72; 2.48	0.93 0.62; 1.40	1.07 0.73; 1.56
Low control	9–13	1.25 0.85; 1.84	1.32 0.89; 1.94	0.99 0.75; 1.31	1.50† 1.12; 2.00
Low skill discretion	6–9	1.36 0.88; 2.10	1.39 0.89; 2.17	0.93 0.68; 1.29	1.49* 1.07; 2.09
Low authority over decisions	2–5	1.17 0.63; 2.15	1.33 0.72; 2.44	1.10 0.72; 1.69	1.72* 1.11; 2.69
Low support	39–47	1.38 0.89; 2.13	1.65* 1.06; 2.58	1.09 0.79; 1.51	1.45* 1.04; 2.03
Low supervisor support	10–13	0.99 0.63; 1.54	1.48 0.97; 2.25	1.04 0.76; 1.42	1.49* 1.09; 2.03
Low co-workers support	7–10	1.29 0.74; 2.25	1.37 0.78; 2.39	1.01 0.67; 1.53	1.42 0.94; 2.13

Note.—Logistic regression analysis, adjusted odds ratios (OR) are for IQR increase in each scale with 95% confidence interval adjusted for sex, age, current smoking, and BMI in the model. * $p < .05$. † $p < .01$.

Sex Differences, Psychosocial Factors, and Respiratory Illnesses

Hypothesis 2 was supported; associations between the demands, control, and support scales and current asthma and respiratory infections were only found for men: the odds ratios for males having current asthma were higher for those with low social support (OR 2.55) and low managerial support (OR 1.86). In addition, men had higher odds ratios for having frequent respiratory infections when they had low work control, low work skill discretion, low authority over decisions, low support, and low supervisor support. For women, there was a tendency for higher odds ratios for frequent respiratory infections when co-worker support was low (Table 3).

Age Differences, Psychosocial Factors, and Respiratory Illnesses

Hypothesis 3 was supported; association between current asthma and low social support were only found among younger (19–39) participants: frequent respiratory infections were associated with low control, low skill discretion, low authority over decisions, and low social support among younger participants. In contrast, low supervisor support was associated with frequent respiratory infections among older (40–65) participants (Table 4).

TABLE 3
GENDER-STRATIFIED ASSOCIATIONS BETWEEN CURRENT ASTHMA AND FREQUENT RESPIRATORY
INFECTIONS AND THE DEMANDS, CONTROL, AND SUPPORT (DCS) SCALES
IN A SAMPLE OF OCCUPATIONALLY ACTIVE SWEDISH

DCS Scale	IQR 25 th –75 th Percentile	Current Asthma		Frequent Respiratory Infections	
		Men (<i>n</i> = 272)	Women (<i>n</i> = 260)	Men (<i>n</i> = 272)	Women (<i>n</i> = 260)
		OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
High demands	High, 10–15	1.77	1.24	1.66	2.22
		0.63; 4.98	0.56; 2.75	0.83; 3.30	0.66; 2.30
Low control	Low, 9–13	1.44	1.45	1.77†	1.30
		0.81; 2.56	0.82; 2.56	1.16; 2.68	0.84; 2.01
Low skill discretion	Low, 6–9	1.43	1.64	1.71*	1.30
		0.74; 2.79	0.85; 3.16	1.07; 2.73	0.78; 2.15
Low authority over decisions	Low, 2–5	1.66	1.33	2.21*	1.41
		0.70; 3.95	0.72; 1.07	1.15; 4.19	0.73; 2.34
Low support	Low, 39–47	2.55†	1.19	1.57	1.42
		1.28; 5.05	0.63; 2.22	0.96; 2.57	0.89; 2.25
Low supervisor social support	Low, 10–13	1.86*	1.19	1.66*	1.05
		1.05; 3.27	0.73; 1.08	1.09; 2.54	0.93; 1.18
Low co-worker social support	Low, 7–10	1.91	0.96	1.27	1.77
		0.91; 4.05	0.39; 2.35	0.72; 2.22	0.95; 3.31

Note.—Logistic regression analysis, adjusted odds ratios (OR) are for IQR increase in each scale with 95% confidence interval adjusted for age, current smoking, and BMI in the model.

**p* < .05. †*p* < .01.

DISCUSSION

In a sample of the occupationally active general population of Sweden, poor perceived psychosocial work environment, as measured by the demands-control-support model, was associated with both asthma and respiratory infections, but mainly among men and younger participants.

Low social support at work and low supervisor support were the strongest psychosocial factors for an increased risk of current asthma. This is important, as currently there is a lack of information on the associations between psychosocial work stress, measured by the demands-control-support model, and asthma. In Germany, for instance, 80% of general practitioners consider stress has an important role in the etiology of asthma, but only 11% refer their patients for psychological help (Reed, Adolf, Werwick, & Herrmann, 2010).

Frequent respiratory infections were more common among participants who perceived themselves to have poor psychosocial work situa-

TABLE 4
AGE-STRATIFIED ASSOCIATIONS BETWEEN CURRENT ASTHMA, AND FREQUENT RESPIRATORY
INFECTIONS AND THE DEMANDS, CONTROL, AND SUPPORT SCALES IN A SAMPLE OF OCCUPATIONALLY
ACTIVE SWEDISH

DCS Scale	IQR 25 th –75 th Percentile	Current Asthma		Frequent Respiratory Infections	
		Low Age (19–39)	High Age (40–65)	Low Age (19–39)	High Age (40–65)
		OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
High demands	High 10–15	1.62	1.05	1.30	1.36
		0.71, 3.68	0.40; 2.72	0.74; 2.30	0.66; 2.81
Low control	Low 9–13	1.32	1.47	1.61*	1.39
		0.79, 2.22	0.80; 2.70	1.12; 2.31	0.85; 2.27
Low skill discretion	Low 6–9	1.41	1.57	1.61*	1.34
		0.77, 2.56	0.78; 3.15	1.06; 2.44	0.76; 2.36
Low authority over decisions	Low 2–5	1.32	1.45	1.96*	1.59
		0.58, 3.04	0.59; 3.56	1.12; 3.44	0.78; 3.23
Low support	Low 39–47	1.88*	1.41	1.58*	1.33
		1.03, 3.45	0.72; 2.79	1.03; 2.43	0.78; 2.29
Low supervisor social support	Low 10–13	1.68	1.27	1.40	1.81*
		0.98, 2.89	0.62; 2.60	0.96; 2.05	1.05; 3.10
Low co-worker social support	Low 7–10	1.53	1.24	1.36	1.52
		0.72, 3.26	0.53; 2.89	0.81; 2.30	0.80; 2.89

Note.—Logistic regression analysis, adjusted odds ratios (OR) are for IQR increase in each scale with 95% confidence interval adjusted for gender, current smoking, and BMI in the model. **p* < .05.

tions characterized by low control and low supervisor support. This finding is in accordance with previous findings of higher psychological stress being related to more respiratory illness (Cohen, Tyrrell, & Smith, 1991; Cohen, *et al.*, 1999). In another study, high social support was associated with a reduced incidence of infections, but only under low stress and not under high stress (Turner Cobb & Steptoe, 1996). Respiratory infections are considered the most common triggers of exacerbating acute asthma; however, as these exacerbations have a poor response to current asthma therapies, new approaches to therapy are needed (Emuzyte, Firantiene, Petraityte, & Sasnauskas, 2009). Therefore, factors that strengthen the immune system, such as a positive psychosocial work environment, should play an important preventive and protective role for individuals with asthma.

The observed gender difference, with higher prevalence of asthma in women, was in accordance with another study with higher prevalence of

asthma among women (9.2%) than among men (5.2%) (Chittleborough, Taylor, Dal Grande, Gill, Grant, Adams, *et al.*, 2010). The prevalence of current asthma and upper air respiratory infections was the same for both sexes. However, only men showed associations between psychosocial work stress and current asthma and upper respiratory tract infections; in particular, perceived low social support affected men more than women. A longitudinal study from Korea (Park, *et al.*, 2011) found similar results: men experiencing insufficient work control and inadequate social support were more likely to report common colds. This raises the possibility of differences in the response to psychosocial stress particularly in men, which may affect respiratory illness. Among primates, social stress is not associated with respiratory infections, but those with low social status are more susceptible to upper respiratory infections (Cohen, Line, Manuck, Rabin, Heise, & Kaplan, 1997).

There were age differences associated with the demands-control-support model, especially between low support and current asthma, and between low control and low support and respiratory infection in younger participants (<40 years). In contrast, low supervisor support was associated with more frequent respiratory infections among older participants (>40 years). There are only a few studies investigating age differences in association with respiratory infections and the demands-control model. However, one study found no association between demand/control and flu-like symptoms in either younger or older participants (Moen, Wieselander, Bakke, & Norbäck, 2012), although this study was limited to university staff. Even though the current results may be more general, as a sample of the general population of Sweden was studied, the reason for the age differences is unclear. Younger participants may suffer more if they have low control, as they are going through a development period at work and need more freedom to act and more margin for creativity. On the contrary, older participants may suffer from low supervisor support, as they have a greater need to be recognized by their superiors.

The strength of this study was the population-based design that included randomly chosen participants from the general Swedish population. The response rate was high and there were no differences in age and sex between participants and non-participants. It is one of a few on this topic and to our knowledge is the only one using the demand-control-support model to investigate associations between psychosocial work-related stress and asthma, atopy, and respiratory infections.

Limitations and Conclusions

The study has limitations. The cross-sectional design meant no conclusions about causal relationships could be made. Moreover, when collection

of data on both dependent and independent variables uses the same questionnaire, there is a potential risk for response bias. A general response bias would be expected to affect all types of associations in the same way. However, there were significant associations only for specific psychosocial factors and specific health variables. Additionally, there was no clinical testing of asthma, atopy, or respiratory infections, only self-report. One Swedish study in adult males showed that questionnaire data on pollen allergy had 52% sensitivity and 90% specificity when using a positive allergy skin-prick test to birch, timothy, or mugwort as a gold standard (Wieslander, Norbäck, Janson, & Edling, 1997). A Dutch study in females showed that questionnaire data on atopy had 55% sensitivity and 89% specificity when using at least one positive specific IgE to common allergens as the gold standard (Lakwijk, Van Strien, Doekes, Brunekreef, & Gerritsen, 1998). A Danish validation study in the general adult population showed that questionnaire data on pollen allergy had 28% sensitivity and 98% specificity when using specific IgE to birch, grass, or mugwort as the gold standard. Questionnaire data on furry pet allergy had 32% sensitivity and 97% specificity when using specific IgE to cat or dog as the gold standard (Linneberg, Nielsen, Madsen, Frølund, Dirksen, & Jorgensen, 2001). Self-reported asthma has high specificity when validating against either clinical diagnosis of asthma or bronchial challenge tests: Toren, Brisman, and Järholm (1993) reported that specificity was 94% (range 78–100%). Thus, a majority of those reporting atopy or asthma in this study probably have these diseases (high specificity), but some underreporting of symptoms could be expected (lower sensitivity). There are a few recent validation studies available about self-reported respiratory infections (Barrett, Brown, Mundt, Thomas, Barlow, Highstrom, *et al.*, 2009; Aabenhus, Thorsen, Siersma, & Brodersen, 2013). However, the questions on respiratory infections were created before these validation studies and are not comparable.

The instrument for assessing psychosocial work condition, the demands-control-support model, is reliable and useful in assessing psychosocial factors at work (Johnson, 1986; Theorell, *et al.*, 1988; Wahlstedt, *et al.*, 1994), which supported the use of the model in the present study. The reliability of the questionnaire covering psychosocial factors has previously been tested (Theorell, *et al.*, 1993; Wahlstedt & Edling, 1997), and has high internal consistency reliability, also found in the current sample. The effect size was expressed as an odd ratio (OR) with 95%CI. Since the OR depends on the scaling of the psychosocial variables, it is not possible to compare the effect size in this study with other studies.

In conclusion, poor psychosocial work situations, especially low social support, appear associated with current asthma and respiratory infections, with certain groups, such as young participants and men, being more vulner-

able. A good psychosocial work environment is important for quality of life and protection against asthmatic symptoms and respiratory illness. This new knowledge on the associations of work-related psychosocial stress and respiratory illnesses should motivate further investigations of the associations and study if the reduction of psychosocial stress at work would serve as a possible new therapeutic approach for improving respiratory health.

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