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Psychosocial working conditions as determinants of asthma self-management at work: A systematic review

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ABSTRACT

Objective: Asthma exerts a considerable impact on patients and their employers. While adequate self-management is able to improve patients' prognosis, its actual implementation in everyday life may depend on contextual factors. We aimed to review the literature on the potential determinants of asthma self-management at the workplace.

Data Sources: We systematically searched Medline and PsycINFO using terms related to the key concepts of interest (i.e., adult asthma, working conditions, and self-management).

Study Selection: We included original studies published in peer-reviewed journals in English or German since 1992 addressing any type of asthma self-management behavior as the outcome and any type of working condition as the determinant.

Results: Upon implementation of a multi-stage selection process, seven articles were included. As those studies showed considerable methodological heterogeneity, a qualitative analysis was applied. A first study identified three different adaptation profiles among employees with asthma with implications for self-management behavior. Another study suggested that concerns about taking time off from work may be associated with the utilization of emergency ambulance services for asthma. Five studies among workers with various chronic illnesses addressed determinants of self-disclosure, coping with acute symptoms (e.g., medication use at work), and the potential effect of practical and emotional support from line managers or colleagues on self-management.

Conclusion: Our review indicates that the evidence for a potential link of occupational factors with asthma self-management at work is relatively sparse. Future research should take a more comprehensive approach by considering multiple types of working conditions and asthma self-management behaviors simultaneously.

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Chronic illness; occupational factors; respiratory disease; self-care; workplace

Introduction

Asthma can be associated with impairment in various domains of patients' everyday life, including their working life, which is reflected by potentially reduced work ability and employability (1,2). High direct and indirect cost for patients, employers, and social security carriers demonstrate the considerable public health relevance of asthma (3,4). It has been suggested that most of the indirect cost among adults with asthma may be due to absenteeism, occupational disability, and premature retirement (5,6).

Asthma self-management behavior (SMB) has been found to be effective in improving patients' health and prognosis (7), for instance, in terms of a reduced need for unscheduled care and better asthma control (8). Asthma SMB aims at adequate individual symptom control and risk reduction (9) and comprises tasks and skills such as avoidance of exposure to allergens and other irritant

agents (e.g., wood dusts, grains, and cold), symptom monitoring, intake of control and reliever medication, as well as breathing techniques (e.g., pursed lip breathing) (10). The extent to which asthma patients are able to implement the acquired self-management skills and strategies seems to largely depend on contextual factors (11). This may particularly hold true for asthma SMB among adults in occupational contexts. Initial evidence indeed suggests that psychosocial exposures at work (i.e., work stress) may relate to increased asthma morbidity (12). One possible explanation for this finding may be insufficient opportunities for patients with asthma to engage into adequate SMB at their workplace.

The notion of a link between psychosocial working conditions and asthma self-management strategies receives further support from studies addressing other chronic conditions than asthma. Workers with diabetes,

for instance, reported to deliberately maintain higher blood glucose levels than recommended in case they feel unable or are unwilling to run blood tests at work (e.g., due to fear of stigmatization, to prevent hypoglycemia, or when access to suitable food is limited) (13, 14). Furthermore, time pressure and lacking routines on the job (e.g., irregular breaks) might contribute to this unfavorable self-management practice (14) and may also reduce diabetes patients' abilities to pursue physical exercise and a healthy diet (15). Patients with chronic kidney disease describe similar behavioral challenges such as skipping a healthy lunch or physical exercise sessions because of time pressure at work or having difficulties in taking their medication as prescribed because of lacking working routines (16). Then again, flexibility on the job may constitute a factor contributing to effective SMB, e.g., regarding the attendance of important physician appointments or the ability to adapt one's work schedule to one's needs regarding effective SMB (e.g., fatigue) (14–16).

In summary, evidence has suggested that the opportunities for SMB among workers with chronic disease may be determined by a range of psychosocial working conditions. While several SMBs may be disease-specific, yet some of the above-mentioned observations may generalize to asthma self-management at work. For instance, asthma SMB at work may be impaired by fear of stigmatization, e.g., in case of public inhaler use (17). Furthermore, individuals with chronic diseases, including asthma, are to attend regular checkups (9) and this SMB could be influenced by patients' working conditions, e.g., the flexibility of their working schedules or their colleagues' as well as line managers' understanding. We therefore aimed to systematically review the present literature addressing the potential link between psychosocial working conditions and SMB at the workplace among employed individuals with asthma. This evidence may inform further research with the potential ultimate goal to contribute to the design of workplace interventions in order to improve asthma SMB at work. This may not only contribute to employee wellbeing and workability, but also to reduced absenteeism, occupational disability, and risk of premature retirement.

Methods

Based on our research aim, the key concepts to be captured by our literature search relate to the condition (i.e., asthma in adults), the setting (i.e., the workplace), and the outcome (i.e., SMB). We compiled a list of synonyms for those concepts, including expressions covered by Medical Subject Heading terms. Publications were included when all of the following criteria were met: (a) publication of

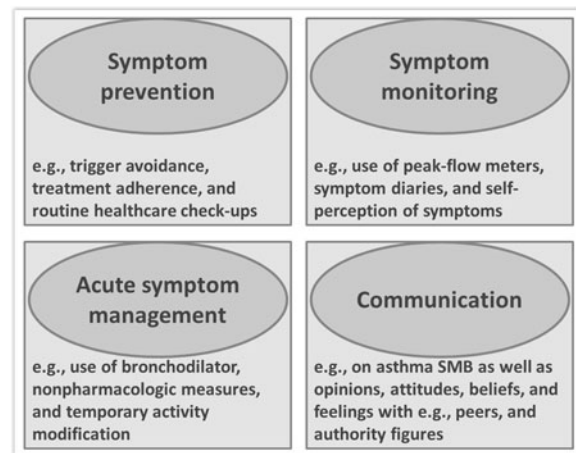


Figure 1. Four domains of asthma self-management behavior (SMB) according to Mammen & Rhee (11).

original data, (b) in a peer-reviewed journal, (c) published in English or German, (d) addressing any type of asthma SMB as the outcome (for definition see below and (11)), and (e) considering any type of working condition (for definition see below) as a determinant of asthma SMB. Furthermore, to identify up-to-date evidence, we restricted our literature search to papers published within the last 25 years (since 1992).

A consensus definition of the key elements of asthma SMB seems to be lacking. We therefore employed an operational definition proposed by Mammen & Rhee (11), which conceptualizes asthma SMB into four domains, as depicted in Figure 1. These domains are symptom prevention (e.g., trigger avoidance), symptom monitoring (e.g., peak flow meter use), acute symptom management (e.g., bronchodilator use), and communication. Although this model was specifically derived for SMB among adolescents, those domains also seem to constitute a useful operational definition to examine asthma SMB among working adults.

Work was defined as paid work in contrast to domestic work or volunteering. Working conditions were viewed as any psychosocial influence on the employees while performing their jobs, which can undoubtedly interact with exposure to allergens and irritant agents (e.g., discussing with colleagues whether or not to open office windows during pollen season). We specifically focused on the employees' subjective perception of their working conditions and the associated self-reported strain, which is in keeping with the major theoretical work stress models (18–20).

We searched three databases applying the above-stated criteria: a medical database (Medline), a database with a mainly psychological emphasis (PsycINFO), and a citation database (Scopus, which claims to provide full coverage of Embase (21)). The search strategies are listed in

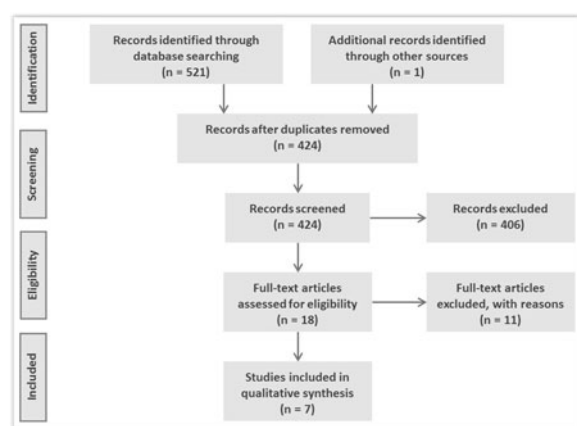


Figure 2. Flow diagram of selection process.

the supplementary material. **Figure 2** depicts the selection process. The identified articles were transferred to bibliographic management software (i.e., Endnote) and checked for duplicates using information on authors, title, journal, volume, issue, and page numbers. After removal of duplicates, a total of 423 documents entered the screening of titles and abstracts, which was performed independently by two raters using Rayyan, a web application to conduct collaborative reviews. Upon title and abstract screening, 398 publications were excluded because they did not meet the inclusion criteria, 13 were included and 12 received conflicting judgments from both reviewers ($\kappa = 0.67$). Upon repeated consensus meetings, four of the publications with initially conflicting assessments were retained thereby yielding a total of 17 publications for full-text reviews. Upon the assessments of full texts a total of 11 of those 17 publications were excluded as they did not focus on the work context ($n = 5$), did not provide original data on the topic of interest ($n = 1$) or as they addressed unsuitable outcomes (no asthma SMB as the outcome; $n = 2$) or unsuitable determinants (no working condition as a determinant for asthma SMB; $n = 3$). A table depicting the characteristics of the excluded articles is included in the supplementary material (Table A). Reference tracking and cross-checking of citing literature of the selected articles yielded one further publication. Thus, seven items entered our pool of papers after rigorous and systematic application of pre-specified selection criteria.

Results

The seven studies we included displayed considerable heterogeneity regarding both their methods (e.g., study design, samples, and variable definitions) and their thematic focus, as detailed in **Table 1**. Operationalizations of the domains of asthma SMB (11) as addressed in the respective papers are shown in **Table 2**.

Qualitative study

One qualitative study was identified, which was a Q-methodological study by Boot et al. (22) among employees with asthma and chronic obstructive pulmonary disease (COPD). Three different adaptation profiles seemed to specifically apply to asthma. Those profiles were denoted as “adjusted,” “cautious,” and “eager.” “Adjusted workers” seemed to accept their limitations and modified their professional goals according to their condition. As Boot et al. (22) stated, those workers avoided dyspnea-inducing activities in everyday life and took regular breaks at work. Although they informed their employer about their disease and were not ashamed of it, they preferred not to talk about it and to take their medication in secrecy. “Cautious workers,” in contrast, appeared to have not fully accepted their illness and were more deficiency-oriented compared to the other adaptation profiles (22). Due to their caution, they avoided dyspnea, did not adjust their medication themselves, and favored to take formal sick leave rather than a day off. According to Boot et al. (22), those workers tended to take their medication openly and communicated with colleagues about their disease and the triggers to be avoided. However, those cautious workers were characterized as not feeling completely understood by their colleagues, especially concerning their reduced work performance. “Eager workers” were described as mostly feeling as capable as others of the same age, they adjusted their medication by themselves, and were reluctant to take sick leave because this might increase their colleagues’ work load. While they experienced only mild limitations due to minor disease severity, they were thought to possibly progress to the other adaptation profiles once their condition worsens. The authors specifically proposed a preventive emphasis on the latter group with regard to asthma (22).

Quantitative studies

In an epidemiological study, Kolbe et al. (23) investigated the correlates for poor SMB among patients admitted to hospital for acute severe asthma. A wide range of medical, socio-economic, and psychological factors were assessed by questionnaires and analyzed as possible determinants of delayed or non-use of oral corticosteroids or of emergency ambulance services in case of asthma exacerbations. The only work-related determinant considered was “concerns about taking time off work,” which showed associations of borderline significance with delayed or non-use of emergency ambulance services ($p = 0.07$). The authors hypothesized that this link may be explained by fear of stigmatization or socioeconomic concerns, e.g., fear of job loss or reduced opportunities to advance one’s career (23).

Table 1. Characteristics and findings of the selected articles.

Authors; year; country	Focus	Design; methods	Sample (mean age; % female)	Recruitment	Analysis	Variables		
						Predictor	Outcome	Main findings relevant to our review
Boot, et al.; 2009; Netherlands (22)	Different ways of adapting to functional limitations among workers with asthma / chronic obstructive pulmonary disease (COPD)	Cross sectional study; Q-methodology: ranking a set of statements according to agreement and providing rationales	34 workers with asthma or COPD (49.6; 58.8)	Through general practitioners and occupational physicians	Factor analysis	No associations, but exploration of adaptation profiles. Statements covered acceptance of disease, insight into disease / own role, ways of coping with boundaries, views about revealing limitations to others, views about openness with regard to disease, attitudes towards functioning at work, emotions related to disease, views about sick leave from work	3 adaptation profiles could be distinguished for asthma: "adjusted" (e.g., dyspnea avoidance, secret medication intake, little communication), "cautious" (e.g., no self-adjusting of medication, open communication) and "eager" (e.g., adjusting medication when necessary, little communication) workers	3 adaptation profiles could be distinguished for asthma: "adjusted" (e.g., dyspnea avoidance, secret medication intake, little communication), "cautious" (e.g., no self-adjusting of medication, open communication) and "eager" (e.g., adjusting medication when necessary, little communication) workers
Kolbe, et al.; 1998; New Zealand (23)	Determinants of major management errors in acute severe asthma	Cross sectional study; questionnaire-based	138 patients admitted to hospital due to acute asthma (30.3; 75)	4 hospitals (general ward or intensive care unit)	Forward stepwise regression (general linear models)	Medical, socioeconomic and psychological variables with limited work context (e.g., financial difficulties in the last year)	Non / delayed use of oral corticosteroids or of emergency ambulance services	Concern about taking time off work correlated with use of emergency ambulance services but not with use of corticosteroids
Munir, et al.; 2005; United Kingdom (24)	Association between self-management of chronic illness and self-disclosure at work	Cross sectional study; questionnaire-based	610 employees with any of eight chronic illnesses; n with asthma = 96 (overall sample: 42.4; 35.3) (sic!)	Single University	Stepwise logistic regression	Perceived practical or social support to manage chronic illness from colleagues or line managers and its subjective importance	Self-disclosure (partial or full ^a) of illness to line managers	Importance of social support to manage chronic illness at work correlated with full disclosure, but not with partial ^a disclosure
Munir, et al.; 2006; United Kingdom (25)	Gender differences in self-management of chronic illness as predictors for self-disclosure to line managers	Cross sectional study; questionnaire-based	610 employees with any of eight chronic illnesses; n with asthma not given (overall sample (n = 734): women: 40.8; men: 45.5; 62.8)	Single University	Multivariate logistic regression	Perceived practical or social support to manage chronic illness from colleagues or line managers and its subjective importance	Self-disclosure (yes or no) of illness to line managers	Importance of social support to manage chronic illness at work is the strongest predictor of self-disclosure of illness to line managers for both genders

Munir, et al.; 2007a; United Kingdom (26)	Psychosocial factors associated with psychological and health-related distress among employees with chronic illnesses	Cross-sectional study; questionnaire- based	1029 employees with any of six chronic diseases, n with asthma = 174 (asthma only: 43.7; 72.1)	4 organizations across 3 sectors: local government, transport and manufactur- ing	Correlation analysis	Instrumental workplace support incl. practical (i.e., provision of information, help and advice) and emotional support (i.e., demonstration of sympathy or understanding) from line managers, colleagues, or occupational health	Illness management (e.g., medication use at work, taking time off for treatment, responding to symptoms at work, following a treatment plan) and extent of self-disclosure to line managers, colleagues, or occupational health	Instrumental workplace support correlated positively with illness management and disclosure
Munir, et al.; 2007b; United Kingdom (27)	Determinants of medication use at work among employees with chronic illness	Cross sectional study; questionnaire- based	1474 employees with chronic disease, n with asthma = 174 (overall sample: 46.2; 57)	4 organizations across 3 sectors: local government, transport and manufactur- ing	Logistic regression	Among others: workplace support, perceptions of medication use at work, work performance	Medication use at work	Medication use at work was correlated with both the ease of taking medication at work and at home
Munir, et al.; 2009; United Kingdom (28)	Relationship between employer support, self-efficacy and self- management of chronic illness at work	Cross sectional study; questionnaire- based	772 employees with any of six chronic diseases, n with asthma = 129 (asthma only: 43.5; 51.9)	4 organizations across 3 sectors: local government, transport and manufactur- ing	Structural equation modeling	Social support (i.e., combined measured of practical and emotional support) from line managers and occupational health staff managers	Performance of SMB at work (i.e., use of medication and self- management of symptoms)	Line manager support was related to employees' symptom management and medication use at work, partially mediated by self-efficacy. Occupational health support was related to both SMB outcomes, fully mediated by self-efficacy.

^aPartial disclosure: "informing line manager about the presence of a chronic illness," full disclosure: "informing line manager how that chronic illness affected [patients] at work" (24).

Table 2. Domains of asthma self-management behaviors addressed in the selected articles.

Authors; year; country	Asthma self-management behaviors (11) ^a			
	Symptom prevention	Symptom monitoring	Acute symptom management	Communication
Boot, et al.; 2009; Netherlands (22)	Adjusting physical tasks to expected dyspnea, adjusting medication dose	—	Secret vs. open medication intake	Revealing disease and functional limitations to others
Kolbe, et al.; 1998; New Zealand (23)	—	—	Use of oral corticosteroids; use of emergency ambulance services	—
Munir, et al.; 2005; United Kingdom (24)	—	—	—	Self-disclosure (partial or full ^b) of illness to line managers and colleagues
Munir, et al.; 2006; United Kingdom (25)	—	—	—	Self-disclosure (yes or no) of illness to line managers
Munir, et al.; 2007a; United Kingdom (26)	Medication use at work, taking time off for treatment	—	Medication use at work, responding to symptoms at work, following treatment plan	Self-disclosure to line managers, colleagues, or occupational health
Munir, et al.; 2007b; United Kingdom (27)	Medication use at work	—	Medication use at work	—
Munir, et al.; 2009; United Kingdom (28)	Medication use at work	—	Medication use at work, self-management of symptoms at work	—

Note. ^aExamples for the four domains of asthma self-management behaviors (11): symptom prevention: trigger avoidance, treatment adherence, and routine health-care check-ups; symptom monitoring: use of peak-flow meters, symptom diaries, and self-perception of symptoms; acute symptom management: use of bronchodilator, following a written treatment plan, nonpharmacologic measures, urgent healthcare use, and temporary activity modification; communication: on prevention, monitoring, and management of symptoms as well as opinions, attitudes, beliefs, and feelings with peers, caregivers, healthcare providers, and authority figures.

^bPartial disclosure: “informing line manager about the presence of a chronic illness,” full disclosure: “informing line manager how that chronic illness affected [patients] at work” (24).

Munir et al. (24,25) carried out a questionnaire-based cross-sectional study among workers with asthma or other chronic diseases. In the two resulting publications based on this dataset, emphasis was put on the role of perceived practical and social support as a determinant of disclosing one's condition at work to line managers. In terms of SMBs, such self-disclosure may be located in the communication domain of asthma self-management (11). One of these papers suggested that for both genders, the relationship between support and self-disclosure is equally strong (25). In this case, self-disclosure was assessed as a dichotomous variable (i.e., yes or no) (25), whereas in the other article, the authors differentiated between partial disclosure (i.e., “informing line manager about the presence of a chronic illness”) and full disclosure (i.e., “informing line manager how that chronic illness affected them at work”) (24). Partial self-disclosure was found to be reported more often by non-academics, workers with diabetes, and employees with pronounced chronic illness experiences (including moderate to severe chronic illness or using medication or special equipment at work). Partial or full self-disclosure to colleagues as well as the subjective importance of receiving practical and

social support predicted full self-disclosure to line managers (24).

Another study among employees with asthma or other self-reported chronic disease conducted by Munir et al. resulted in three publications (i.e., stemming from the same dataset) (26–28). In the first article, the authors focused primarily on another topic, but also provided estimates of the relationships between different psychosocial and work-related variables, amongst others, instrumental (i.e., provision of information, help, or advice) as well as emotional workplace support (i.e., demonstration of sympathy or understanding) and different types of SMB (e.g., medication use at work, taking time off for treatment, responding to symptoms at work, following a treatment plan, and the extent of self-disclosure to line managers, colleagues, or occupational health). Unadjusted correlations showed meaningful relationships between instrumental workplace support and better SMB at work, as measured by a summary variable (illness management). The single behaviors comprised in that variable were not studied separately though. Disease-specific analyses in that study were limited and were not applied to the above-mentioned correlations (26).

The role of support was more specifically explored in the second publication from that study (27). With regard to the special focus of this review, the important observation was made based on unadjusted correlations or unadjusted logistic regression models that practical line manager support was positively associated with medication use at work. In multivariate logistic regression, however, medication use at home and ease of using medication at work emerged as the only remaining determinants of medication use at work. Besides the observation that asthma patients used their medication at home more often than at work, no further asthma-specific analyses were reported in the article (27).

In the third publication from the same dataset, Munir et al. (28) examined whether a direct relationship existed between line manager or occupational health support and SMB and whether the relationship between employer support and SMB was mediated by self-efficacy (i.e., the “belief in one’s capabilities to organize and execute the courses of action required to produce given attainments”) (29). SMB was operationalized in terms of use of medication at work and self-management of symptoms at work. Self-efficacy was measured by the beliefs about being able to make adjustments, take medication and manage symptoms at work. Line manager support directly related to SMB and this relationship was mediated by self-efficacy beliefs. The authors therefore assumed that line manager support had a positive impact not only on SMB but also on self-efficacy which in turn promoted effective SMB. Occupational health support seemed to influence SMB only indirectly, that is, mediated by self-efficacy related to making work adjustments (28). Again, analyses were conducted in a sample of workers with various types of chronic conditions and asthma-specific analyses were thus lacking.

Discussion

Our systematic review suggests that the current evidence on psychosocial working conditions as determinants of asthma SMB at work remains sparse, i.e., being limited to seven cross-sectional studies. Nevertheless, the tentative evidence that is available yielded important and promising observations. Yet, the existing studies on potential relationships between working conditions and asthma SMB at work seem to have taken piecemeal approaches (e.g., addressing single specific types of SMB such as use of oral corticosteroids) (23) or too general approaches (e.g., no asthma-specific analyses, but only among employees with various types of chronic conditions one of which being asthma) (22,24–28). Furthermore, five of the seven studies stem from the same research team and are based on only two different datasets, and therefore share certain

design and analytical properties that may be conceived as limitations given the focus of our review (e.g., lacking disease specificity).

Boot et al. (22) focused on different ways of adapting to respiratory disease at work. The results provide important insights into the problems chronically ill employees may face at work, and the extracted adaptation profiles highlight the complexity of strategies to cope with asthma at work. However, as acknowledged by the authors, their study specifically aimed at characterizing the distinct adaptation profiles, but information on those styles’ prevalence cannot be deduced. Furthermore, it may be of interest to examine potential determinants of the adaptation profiles, e.g., personality traits or illness severity. Concerning eager workers, Boot et al. hypothesized that patients might progress to other adaptation profiles once their illness becomes more severe (22).

With regard to the influence of working conditions on SMB, concrete examples were scarcely quoted from the participants’ statements in the Q-methodology process (22). Additionally, the potential interaction between working conditions, SMB and the adaptation profiles remained unexplored. In our view, it might be of special interest to examine the potential implications of poor matches between one’s working conditions and one’s needs implicated in the adaptation profile, e.g., adjusted workers who are unable to take breaks or to avoid dyspnea-inducing activities at work. Boot et al. (22) reported that eager workers may be sufficiently assertive to advocate their needs at work. This could imply that some employees may be able to actively shape their working conditions to make those match their adaptation style. Another possibility is that employees quit their jobs in case their working conditions are in conflict with their adaptation profiles.

The study by Kolbe et al. (23) explored risk factors associated with severe asthma attacks. A wide range of factors was considered as potential determinants of SMB errors, but only one work-related factor was included (i.e., concerns about taking time off work). Since the focus of the study did not primarily lie on working conditions, this variable and its impact on SMB were not explored in depth. Furthermore, no prior qualitative work or a theoretical model was applied to ensure valid measurement of psychosocial working conditions. Hence, it seems rather unlikely that all the potentially relevant occupational determinants were addressed. Additionally, generalizability of the findings may be limited to employees with exceptionally poor asthma control, as hospital admissions for asthma are rare and are considered largely avoidable (30).

The findings from the five studies by Munir et al. (24–28) substantially contributed to a deeper understanding

of how working conditions may influence SMB at work among chronically ill workers. Those studies' focus varied across different types of SMB (e.g., self-management of symptoms at work or self-disclosure to line managers and colleagues as a form of communication) and the authors specifically demonstrated the influence of social support at work on SMB. As mentioned above, the main problem for clinicians, occupational health specialists, and researchers specifically concerned with asthma is that many different diseases were analyzed inseparably and, as a result, condition-specific conclusions could not be drawn. Providing an illustration of the interpretative challenges associated with the combination of various chronic diseases, Munir et al. reported illness-specific differences between medication use at work and at home and offered the explanation that this might be due to different intake behavior of controlling and of acutely needed medication (27). Furthermore, medication intake as an SMB needs to be defined carefully, also in asthma-specific studies. For example, "use of medication at work" (26–28) could refer to control or reliever medication in asthma and thus to either the domain of symptom prevention or acute symptom management. Additionally, as also stated by Munir et al., illness-specific support may have a stronger effect on SMB than more general forms of support (31). The authors tried to account for the meaningfulness of disease-specific analyses by including the different conditions as covariates in their calculations. It is questionable whether this strategy sufficed, because the SMBs were not assessed in an illness-specific manner. Furthermore, the included studies (22–28) did not consider variables that are highly relevant to asthma and that might influence the relationship between working conditions and asthma SMB. Examples of such variables are asthma severity, the level of asthma control, treatment adherence, and physical job demands. The unavailability of evidence from asthma-specific studies, with a single exception (23), restricts the conclusiveness of our review. It further needs to be noted that all the analyzed studies were performed in high-income countries with likely good access to high-quality health care. The quality of health care and its accessibility, financial affordability, and acceptability may be more restricted in middle- and low-income countries (32), which could not only further impair asthma SMB and functioning at work, but also patients' opportunities to enter employment and remain employed.

Some working conditions with a possible impact on asthma SMB could be identified by this review. Future research should further investigate the relationship between working conditions and asthma SMB and also address the working conditions with impact on illness SMB found in earlier studies on other chronic conditions, e.g., diabetes (13–15). We agree with the call

by Munir et al. (28) and Boot et al. (22) to expand research to a broader set of psychosocial working conditions thereby expanding efforts beyond the mere investigation of support and to carefully differentiate types of (illness-specific) SMBs.

The current evidence could be affected by bias to some extent. In particular, the employed recruitment strategies could have induced selection bias. Boot et al. (22) acknowledged the potential for selection bias related to their recruitment strategy, which aimed at attaining high heterogeneity of patients' viewpoints and opinions which is needed for the Q-methodology process. Munir et al. reported a low response rate (28%) in the two articles from the same dataset (27,28) and speculated that this may reflect selection bias: The topic might have been perceived as irrelevant by a lot of (healthy) employees, but also by those employees with chronic diseases who considered their condition not to interact with their work (28). Other employees with a chronic condition might have felt discomfort concerning a questionnaire on illness at work or might have not reported their disease due to lack of time while filling in the questionnaire. Munir et al. put their discussion of limitations into perspective though by affirming that comparisons of demographic characteristics between responders and non-responders yielded no significant differences (28). Furthermore, the currently available studies were limited to individuals in employment, and thus healthy worker effects cannot be ruled out (33). In this regard, it seems of special interest to examine individuals who are not in employment anymore (i.e., unemployed or in early retirement) or are in the process of returning to work where the ability to balance job demands and disease self-management need is particularly salient. Such research may improve our understanding of the major occupational barriers to successful implementation of SMBs in the workplace.

Some limitations of our systematic reviews need to be mentioned. First, the systematic literature search was limited to three databases. This was partly due to our inclusion criteria concerning original articles published in peer-reviewed journals only, which excluded book chapters as well as the gray literature (e.g., reports, conference abstracts, and poster presentations). Notably though, to compensate for the limited number of search engines, we carried out cross-reference checking to increase the number of relevant articles. A second potential limitation is that articles were only included if written in English or German due to restricted resources. This might have reduced the number of included papers. Third, our search strategy and inclusion criteria narrowed down the result list to very few articles. This was partly due to the specific focus of our research topic (i.e., self-management only among working adults with asthma),

which required higher specificity than sensitivity considering the amount of literature separately dealing with these concepts. Fourth, the seven articles included in our review showed some differences regarding the conceptualization of SMBs and operationalizations of working conditions. Due to this heterogeneity, it was not possible to conduct quantitative analyses (i.e., effect estimation). Finally, we evaluated the variables of the found studies according to the SMB definition by Mammen & Rhee (11). This might have led to the exclusion of certain behaviors that might be considered as SMB by other definitions. For instance, we decided to exclude studies emphasizing sick leave because we considered this a means of medical treatment rather than a SMB.

Conclusion

The evidence related to the link between psychosocial work conditions and asthma SMB at work was relatively sparse, and the included studies have taken a piecemeal approach. Our review nevertheless identified first insights into a potential link of working conditions with asthma SMB at work (i.e., the relevance of support). Future research should specifically focus on workers with asthma, preferably those who do not have a concomitant COPD diagnosis. Additionally, future research efforts should take a more comprehensive approach by considering both multiple types of working conditions and asthma-self management behaviors simultaneously. Therefore, and in keeping with research on other chronic conditions (11,12,14–16,22,34), qualitative approaches among workers with asthma may represent an useful first step to gain a deeper understanding of the relevant types of working conditions and types of SMB as well as to understand the underlying mechanisms. Furthermore, to reduce potential healthy worker effects (33), the study samples may not only include well-adapted employees with asthma, but also those who are at risk of dropping out of work life or have (temporarily) dropped out, e.g., patients in medical or occupational rehabilitation. A systematic conceptualization and operationalization of asthma SMB at work is required as a basis for quantitative analyses in this research field. Systematic investigation of the determinants of all asthma SMB domains at work is needed to propose health promoting workplace interventions and thus, to potentially reduce absenteeism, occupational disability, and premature retirement among employees with asthma.

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Declaration of interest

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

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Supplementary Material

Search strategy for Medline (conducted via Ovid on December 1st 2016)

(ASTHMA/ or asthma.ab,ti.) and (exp WORK/ or exp WORKPLACE/ or workplace.ti,ab. or exp employment/ or employ*.ti,ab. or exp VOCATIONAL REHABILITATION/ or (vocational adj3 rehabilitation).ti,ab. or exp Occupations/ or job.ti,ab. or occup*.ti,ab.) and (exp Self-Management/ or "self management".ti,ab. or exp self care/ or "self care".ti,ab. or "self monitoring".ti,ab. or "self help".ti,ab. or exp Adaptation, Psychological/ or coping.ti,ab.)

Search strategy for PsycINFO (conducted via Ovid on December 1st 2016)

(ASTHMA/ or asthma.ab,ti.) and (work*.ti,ab. or employ*.ti,ab. or exp VOCATIONAL REHABILITATION/ or (vocational adj3 rehabilitation).ti,ab. or exp Occupations/ or job.ti,ab. or occup*.ti,ab.) and (exp Self-Management/ or "self management".ti,ab. or exp Self-Care Skills/ or "self care".ti,ab. or exp Self-Monitoring/ or "self monitoring".ti,ab. or exp Self-Help Techniques/ or "self help".ti,ab. or exp ADAPTATION/ or coping.ti,ab.)

Search strategy for Scopus (including references from Embase, conducted on August 2nd 2017)

(SUBJAREA (medi) AND TITLE-ABS-KEY ("ASTHMA") AND (TITLE-ABS-KEY (work*) OR TITLE-ABS-KEY (employ*) OR TITLE-ABS-KEY (vocational AND rehabilitation) OR TITLE-ABS-KEY (occupations)) AND (TITLE-ABS-KEY ("self management") OR TITLE-ABS-KEY ("self care"))) OR ((TITLE-ABS (asthma)) AND (TITLE-ABS (work OR employ* OR "vocational rehabilitation" OR occup* OR job)) AND (TITLE-ABS ("self-management" OR "self-care" OR "self-monitoring" OR "self-help" OR adapt*))))

[Please insert Table 3A near here]

Determinants of asthma self-management at work

Supplementary Material

Table A: Characteristics of the excluded articles

Authors; year; country	Title	Design; methods	Sample	Reason for exclusion
Adams R, et al.; 2004; Australia [35]	Impact of coping and socioeconomic factors on quality of life in adults with asthma	Prospective cohort study; questionnaire (baseline and 12-months follow-up)	232 adult asthma patients	No work context
Beharry S, et al.; 2015; Trinidad [36]	Reality and understanding of asthma control	Observational cross-sectional study	329 adult asthma patients	Wrong determinants: no working conditions as determinants
Douglass J, et al.; 2002; Australia [37]	A qualitative study of action plans for asthma	Qualitative study	62 adult asthma patients	No work context
Grieshaber R, et al.; 1998; Germany [38]	[Effectiveness of secondary preventive programs for patients with asthma and rhinitis in the baking industry]	Intervention study	55 employees in the baking industry with asthma	Wrong determinants: no working conditions as determinants
Hanania N, et al.; 1997; Canada [39]	Factors associated with emergency department dependence of patients with asthma	Prospective cohort study; structured interviews, assessment of lung function (spirometry) and inhaler device skills	80 asthma patients in emergency departments and 40 asthma patients in ambulatory care	Wrong outcome: SMB as predictor for ED-/AC-visits, not as outcome
Jones I, et al.; 2008; United Kingdom [40]	With an attack I associate it more with going into hospital: Understandings of asthma and psychosocial stressors; are they related to use of services?	Qualitative study	75 adult asthma patients and 19 general practitioners	No work context
Makinen S, et al. (2000); Finland [41]	Self-care in adults with asthma: how they cope	Cross-sectional study; questionnaire-based	150 adult asthma patients	No work context
Moffat M, et al.; 2006; United Kingdom [42]	Poor communication may impair optimal asthma care: a qualitative study	Qualitative study	54 health care professionals (general practitioners and practice nurses)	No work context
Munir F, et al.; 2005; United Kingdom [43]	Work limitations and employer adjustments for employees with chronic illness	Cross-sectional study; questionnaire-based	610 employees with any of eight chronic diseases, n with asthma = 96	Wrong outcome: SMB not as outcome
Munir F, et al.; 2009; United Kingdom [44]	Self-management of health-behaviors among older and younger workers with chronic illness	Cross-sectional study; questionnaire-based	759 employees with any of six chronic diseases, n with asthma = 126	Wrong determinants: age as predictor for SMB, not working conditions
van Weel C, et al.; 2006; Netherlands [45]	Occupational health and general practice: from opportunities lost to opportunities capitalised?	Review of registry data, guidelines, and original studies	Not applicable	Wrong study design: no original data on research topic