Can work make you sick? A meta-analysis of the relationships between job stressors and physical symptoms

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A meta-analysis of 79 studies reporting cross-sectional and longitudinal relationships between physical symptoms and various occupational stressors was conducted. Stressors were organizational constraints, interpersonal conflict, role conflict, role ambiguity, workload, work hours, and lack of control. The relationships between stressors and eight physical symptoms were quantitatively summarized and contrasted, for both individual symptoms and composite symptom scales. All of the occupational stressors were significantly related to physical symptoms in cross-sectional analyses, and the effect sizes of these relationships varied both by the stressor and the individual symptom examined. The longitudinal relationships were similar to the cross-sectional results, and provided some evidence of temporal consistency of the occupational stressorphysical symptom relationship. Organizational constraints and interpersonal conflict had the strongest relationships with symptoms in both the cross-sectional and longitudinal analyses. Gastrointestinal problems and sleep disturbances were significantly related to more stressors than other symptoms examined. These findings show that it is important to examine physical symptoms, as they are related to a wide range of job stressors and these relationships prevail over time. Potential underlying mechanisms, including the immediacy of physiological reactions to stressors, participants' attributions concerning stressor–physical symptom relationships, and the possible multidimensional nature of symptoms, are proposed and discussed.

Keywords: stress; physical symptoms; organizational constraints; interpersonal conflict; role stressors; workload; work hours; meta-analysis; work-related stress

Introduction

Employee health and well-being have gained increasing societal attention, driven by both rising worker compensation claims and the considerable personal, organizational, and medical costs associated with stress-related illness (Smith, Karsh, Carayon, & Conway, 2003). For example, the annual costs of employee stress, including costs for missed wages due to absenteeism and reduced productivity and health care costs, have been estimated to be $200–350 billion in the United States, $64.8–66.1 billion in the United Kingdom, and $232 billion in Japan (Miree, 2007).

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Researchers have conducted a great deal of research using a variety of health indicators, but few quantitative reviews are available that integrate this literature. A notable exception is Spector and Jex (1998), who conducted a small-scale (2 to 8 studies across variables) meta-analysis in order to provide validation evidence for their physical symptoms scale by showing positive relationships of symptoms with role ambiguity, role conflict, and weekly working hours, and a negative relationship with job autonomy. However, this meta-analysis had limitations: it was confined to a few stressors, included only studies using the authors' own symptom scale, looked only at an overall symptom score, analysed a small number of studies, and only investigated cross-sectional designs. Although those finding are certainly suggestive, it is important to see whether they hold for specific symptoms, across diverse indictors of physical symptoms, and in longitudinal designs that enable more confident conclusions to be drawn about possible antecedents of symptoms. The present meta-analysis addresses this gap in the literature by presenting a large-scale review of the association between specific health complaints and various indicators of job stress in both cross-sectional and longitudinal designs.

While most studies report results for composite symptom scores, it is important to look at individual symptoms to see if they each relate to stressors in a similar way. For example, does the perception of organizational constraints relate similarly to a variety of symptoms, or does it relate more to headaches than to eye strains or stomach distress? Darr and Johns (2008), looking at individual symptoms, found that absenteeism had a stronger relationship with fatigue ($r = .32$) than a composite of other physical symptoms ($r = .17$). These findings underscore the need to examine the relationships between stressors and individual symptoms in addition to composite scores. We believe that this study makes an important contribution to the literature in that it is probably the first review to address the unique relationships between specific symptoms and various job stressors.

Stress and physical symptoms

There are several theoretical models that attempt to explain the occupational stressor–strain relationship, and many of them contain similar variables and elements (e.g., French & Raven, 1962; Frese & Zapf, 1988; Spector, 1988). The process that underlies such theoretical frameworks posits a stimulus-response process in which job stressors (aspects of the work environment) lead to strains (psychological, physical, and behavioural reactions), mediated by perceptions of the environment. Emotional responses, such as anxiety or frustration, are often the most immediate psychological strain responses that are associated with physiological changes in the body (Spector, 1988).

The neurochemical responses of the body to stress have been examined extensively, and while there remain many interactions between these neurochemicals and the body that need further investigation, the major components of the process are believed to be well identified and understood. Current research suggests that the hypothalamic-pituitary-adrenocortical (HPA) axis and the sympathetic-adrenomedullary (SAM) systems are heavily involved in the relationship between stressors and health (Dienstbier, 1989; Frankenhaeuser, 1991; Taylor, 1999). When an employee encounters an event that is evaluated as harmful or threatening, the hypothalamus is activated and reacts in two ways. First, it activates the HPA system, which is best

understood through the three stages of the general adaptation syndrome: alarm, resistance, and exhaustion (Selye, 1936, 1976). During this process, the hypothalamus releases corticotrophin-releasing factor (CRF) into the nervous system. CRF, in turn, stimulates the pituitary gland, causing it to secrete growth hormone, prolactin, and adrenocorticotropic hormone (ACTH). ACTH affects the adrenal cortex, which releases corticosteroids. Corticosteroids help the body return to a neutral state after reacting to a stressor. Enzymes that act on opioid receptors, such as beta-endorphin and enkephalin, are also released during the HPA system response to a stressor. They are associated with immune system disruption (Cohen, Kessler, & Gordon, 1995).

When the hypothalamus is activated, it in turn activates the SAM system by setting off one of the earliest responses to stress through the sympathetic nervous system, a reaction that is commonly referred to as the fight-or-flight response (Cannon, 1932). The activation of the sympathetic arousal in turn stimulates the adrenal medulla, which secretes catecholamines, specifically epinephrine and norepinephrine. The secretion of these hormones leads to increased pulse rate, increased blood pressure, and sweating, among other physiological reactions. Over time such reactions can result in the experience of physical symptoms, such as stomach distress, headache, backache, and other musculoskeletal pain. We will next discuss specific mechanisms leading to such individual symptoms.

Individual symptoms

Our meta-analysis will summarize the findings regarding eight types of individual symptom: Backache, headache, eyestrain, sleep disturbance, dizziness, fatigue, appetite, and gastrointestinal problems. We chose these symptoms because they have been found to be associated with stress and because for each one there was a sufficient number of cross-sectional studies available for a meta-analysis to be conducted ($k \geq 5$).

Backache. Musculoskeletal pains that originate in the upper back, lower back, shoulders, and neck generally fall into the overarching category of backache. It has been shown that tenderness in muscles and soft tissues such as tendons and ligaments are markedly influenced by the impact of daily stressors (Manne & Zautra, 1989; Zautra et al., 1998). A longitudinal study in individuals with the chronic musculoskeletal pain diseases, specifically Fibromyalgia and arthritis, found that exposure to stressors and negative mood over one week was related to increased reports of pain intensity over the ensuing weeks (Davis, Zautra, & Reich, 2001; Zautra, Johnson, & Davis, 2005). This relationship between stressors and musculoskeletal pain is believed to arise from the low cortisol and elevated prolactin levels present during times of stress, which may increase overall pain sensitivity by down-regulation of the immune system and increased inflammation (Huyser & Parker, 1999; McLean et al., 2005; McLean et al., 2006).

Headache. Headache is pain experienced in the upper half and back of the head, arising from a variety of mechanisms. Tension-type headaches in particular are associated with exposure to stressors. The mechanism underlying such a headache is likely multifactorial and mostly neurological in nature (Spierings, Ranke, &

Honkoop, 2001). It is widely believed that pain-signalling pathways in the brain can become overly sensitive to painful stimuli when stress is experienced (Bendtsen, 2003). Once the brain is overly sensitive to pain, even the slightest twinge may increase nerve excitability and be translated into pain signals, leading to the increased experience of headaches. This heightened nerve sensitivity leads to increased muscle activity, which facilitates muscular tension, thus leading to the co-occurrence of stress-induced back and body aches with headaches.

Eye strain. Eye strain, or asthenopia, refers to itchy, sore, or heavy eyes, as well as blurred or double vision. Eye strains are considered one of several types of musculoskeletal disorder (MSD) originating from muscular tension associated with occupational stressors (Gura, 2002). As with backaches and headaches, an individual's response to occupational stressors produces a biochemical reaction that promotes inflammation and increases sensitivity to pain sensation in and around the eyes. Furthermore, workplace activities such as using a computer or performing visually intense tasks promote the muscles of the inner eye to tighten and fatigue. These effects combine with a heightened sensitivity to pain and are cumulative.

Sleep disturbance. Work-related stress is the most frequently reported cause of sleep-related difficulties (Ertel, Karestan, & Berkman, 2008; Rau, Georgiades, Fredrikson, Lemne, & de Faire, 2001; Roth & Ancoli-Israel, 1999) and 10% to 40% of the working-age population (20–60 years) in Sweden reported that they experienced difficulty sleeping (Linton & Bryngelsson, 2000). Sleep difficulties are negatively related to workplace productivity and positively related to the use of physical and psychological health services and sick leave (Chevalier, Souques, Coing, Dab, & Lambrozo, 1999; Jacquinet-Salord, Lang, Fouriaud, Nicoulet, & Bingham, 1993; Stoller, 1994). In a self-report study, work demands were positively related to the development and chronicity of sleeping problems (Jansson & Linton, 2006). Some theories emphasize that blood ACTH and cortisol concentrations are increased in response to acute stress by the release of corticotropin-releasing hormone (CRH) from the hypothalamic-pituitary-adrenal axis (Aguilera, 1994). These hormones have been shown to consequently reduce surges in night-time melatonin levels, which may provoke insomnia and sleep disturbance.

Dizziness. The stress process can lead to feelings of dizziness or light-headedness for some individuals. The primary mechanisms for this reaction are through changes in metabolic rate, such as blood pressure and heart rate that are associated with stressors (Sparacino, 1982). Dizziness may also be related to hyperventilation. An increase in breathing rate mediated by the sympathetic nervous system during a stressful time, even if it is minute, can alter the chemistry including the acid/base levels in the body. This in turn may disrupt neural responses to balance and coordination through the cerebellum and eighth nerve, which control balance. It has been shown that nonspecific dizziness due to hyperventilation gradually increases over several minutes and eventually resolves once the stressor is removed.

Fatigue. Fatigue, a feeling of lack of energy or tiredness, is one of the most common symptoms reported by individuals who experience stressful situations (Dittner, Wessely, & Brown, 2004; Franssen, Bultmann, Kant, & van Amelsvoort, 2003).

Individuals who report fatigue often report other overlapping symptoms including muscle pains, sore throats, inattentiveness, headaches, and unrefreshing sleep (Fukuda et al., 1994). Stress-mediated fatigue is typically reported in the absence of other illnesses and is directly correlated with a triggering event, even persisting well beyond the period of stress. Several endocrine and metabolic dysfunctions have been postulated to generate fatigue symptoms, yet the physiological mechanisms of fatigue remain unclear. Studies do suggest a relationship with undersecretion of CRH and cortisol (Demitrack et al., 1991), while others alternatively show no alteration in the pituitary-adrenal axis (Young et al., 1998). Interestingly, recent genetic studies have proposed that certain sequences of DNA that control stress through the hypothalamic-pituitary-adrenal axis and the sympathetic nervous system vary among people (Goertzel et al., 2006). On the individual basis, response to the hormones and chemical messengers released by stress are interpreted uniquely (Smith, White, Aslakson, Vollmer-Conna, & Rajeevan, 2006). Thus, people may have a genetic predisposition to develop stress-mediated fatigue. This condition, no matter what the physiological basis, is often chronic and disabling, leading to employees' decreased overall health and well-being as well as a decreased ability to meet the job requirements (Wagner, 1997).

Appetite. Exposure to stressful events has been associated with increased or decreased appetite (Kandiah, Yake, & Willett, 2008). There are several mechanisms through which this reaction can occur. For instance, brain-signalling pathways respond to emotional stressors by rapidly increasing the production of hormones from the melanocortinergic pathways, namely ACTH and melanocyte-stimulating hormone (MSH). These in turn have been shown to mediate stress-induced anorexia, leading to a loss of appetite (Liu et al., 2007). Alternatively, the sympathetic nervous system mediates release of the amino acid ghrelin from the stomach. Ghrelin, in turn, creates a hunger response that stimulates mealtime initiation. The normal ghrelin levels present before a meal are increased by acute stressors, thus creating a need-for-food state in the body and an increase in appetite (Ochi et al., 2008). While these mechanisms may function in the immediate stress response, stress-induced cortisol production tends to exert its effect over longer periods of time. Chronically high levels of cortisol and ghrelin cause increased body fat stores. These newly formed fat deposits in turn release the signalling peptide leptin, which decreases appetite through neurogenic pathways. Leptin is released following the exhaustion phase of the physiological stress process. This process may account for the recent finding that 21% of respondents reported a significantly lower appetite after a stressful event (Kandiah et al., 2008). Research on changes in appetite in the occupational stress and health literature primarily focus on loss of appetite (rather than increase in appetite), which will be examined in this meta-analysis.

Gastrointestinal problems. There are several specific symptoms that fall into the category of gastrointestinal problems, including nausea, acid indigestion or heartburn, abdominal and stomach cramps (excluding those that are due to menstruation), and irritable bowel syndrome. There are several physiological mechanisms through which the stress process can affect gastrointestinal process. For instance, during the acute stress response, the body produces increased amounts of ACTH. This sympathetic nervous system mediator delays the stomach emptying phase of

digestion, potentially leading to cramping and aches. Parodoxically, chronic stress actually leads to increased amounts of the stomach enzyme ghrelin that in turn increases hunger/appetite (Ochi et al., 2008).

The stress process also worsens the symptoms of heartburn by reducing the stomach's threshold level for pain. This in turn increases the perceived severity of symptoms, such as burning ulcers and indigestion (Farré et al., 2007; Fass et al., 2008). In much the same way, stress responses in the nerve fibres in the gastrointestinal track lead to a lower tolerance for the stomach's natural ability to expand. This leads to increased colonic muscle contractions, which may result in irritable bowel symptoms or diarrhoea. These symptoms are thought to be secondary to overactive production and release of corticotropin releasing factor (CRF), a peptide that mediates stress responses (Keck & Holsboer, 2001).

The current study

We decided to conduct a meta-analysis, the goals of which were four-fold. First, we quantitatively summarized findings across studies that showed relationships between people's reports (perceptions) of specific occupational stressors and physical symptoms. This was to provide some evidence concerning the magnitude of effects that speak to the importance of studying stressor–symptom relationships. We report results for variable combinations where there were sufficient numbers of studies available. Second, we contrasted the magnitude of correlations across different stressors to show if the potential effects of some stressors were larger than others. Such findings can potentially help focus intervention attempts toward those stressors that are likely to have the biggest impact on health. Third, we compared the magnitude of correlations across different symptoms within each stressor to show if the potential effects of stressors varied by the particular symptom. Finally, we compared results from studies using cross-sectional designs with results from studies using longitudinal designs to help rule out the possibility that observed relationships might be due to occasion factors (i.e., shared biases produced by transitory conditions such as mood), and to show that the potential effects of stressors might persist over time. Although the nature of all of these studies does not allow for confident causal conclusions to be drawn, demonstrating relationships both contemporaneously and over time is a first step.

The studies we meta-analysed assessed physical symptoms by means of employee self-reports. The nature of these symptoms is such that it would be difficult to use other than self-reports, since do not normally exhibit physical signs that could be subjected to a medical test. However, such symptoms can serve as important indicators of health, as they have been shown to predict a variety of long- and short-term health outcomes (Benyamini & Idler, 1999; Ferraro & Kelley-Moore, 2001; Idler & Benyamini, 1997), including mortality (Idler & Benyamini, 1997).

Method

Literature search

In order to locate relevant studies for this meta-analysis, we conducted an electronic search of bibliographies using the PsycInfo (*Psychological Abstracts*), ABI/Inform,

Medline, and Dissertation Abstract International databases. We searched for published studies up to 2009 that examined the relationship between occupational stressors and physical health outcomes. Occupational stressors examined in this review include (lack of) control or autonomy at work, interpersonal conflict, organizational constraints, role conflict, role ambiguity, workload, and work hours. Stressors were included that were included in at least five studies that we could locate, which was the minimum number for a meta-analysis. The following search terms were utilized: *role conflict, role ambiguity, workload, work hours, constraints, interpersonal conflict, relationship conflict, conflict at work, autonomy, control, well-being, physical symptoms, symptoms, health, ill-health,* and *illness*. Additionally, database searches were conducted for two prominent symptom scales in stress research: the Physical Symptom Index (PSI; Spector & Jex, 1998) and the Occupational Stress Indicator (OSI; Cooper, Sloan, & Williams, 1988).

Manual searches for the most popular outlets for occupational stress research were conducted, and included three conferences for the years 2002 through 2009: these were the *Work, Stress, & Health conferences, American Psychological Association conventions,* and the conferences of the *Society for Industrial/Organizational Psychology*. We manually searched six journals for the years 1996 through 2009: *Work & Stress, Journal of Occupational Health Psychology, Journal of Organizational Behavior, Journal of Occupational and Organizational Psychology, Stress & Health,* and *Anxiety, Stress, & Coping*. Additionally, we emailed relevant electronic mailing lists (listservs) to request unpublished and new work being conducted. Finally, several prominent authors in this area were contacted in order to obtain additional samples of published and unpublished work. Given that multiple search methods were used, we came across similar articles by the same author using the same or overlapping datasets. Overlapping data only occurred when conference presentations, dissertations, or unpublished data sets were used, which were then later published in a peer-reviewed journal. If two versions of the same study reported some variables in one but not the other, both studies were used. In the case of overlapping data sets, only one was included in our analyses and the duplicate was discarded.

Inclusion criteria

Our meta-analysis examined the relationships between a variety of occupational stressors and physical health outcomes. The studies that were considered for the meta-analysis had to meet several criteria: (a) the level of analysis had to be the individual employee as opposed to a group, team, or organization; (b) the study had to use one or more measures of occupational stressor; (c) the study had to use one or more measures of physical symptoms; (d) the study had to report a correlation coefficient, or other statistic that could be converted into a correlation coefficient; (e) the study must have been conducted with working populations reporting about naturally occurring job settings, thus excluding laboratory samples or scenario studies; (f) the data must have been self-report by the employee experiencing the stressor only and not reported from other sources; and (g) longitudinal data must have reported the relationship between occupational stressor variables measured at time one and physical symptoms measured subsequently.

Stressor variables

Interpersonal conflict. Interpersonal conflict refers to negative interactions with others in the workplace, which can range from momentary disagreements to heated arguments and bullying. Interpersonal conflict can develop as a result of a competitive work environment and rude or aggressive behaviour of coworkers, supervisors, and customers. Interpersonal conflict has also been examined by separating conflict with supervisors from conflict with coworkers, although the strength of the associations between interpersonal conflict and employee physical symptoms did not vary significantly across the supervisors and coworkers in the few studies that compared them (Bruk-Lee & Spector, 2006; Frone, 2000; Lubbers, Loughlin, & Zweig, 2005). Therefore, these two sources of conflict were combined by averaging correlations across sources. Interpersonal conflict included measures of direct and indirect conflict at work, verbal and physical abuse, and bullying. In the studies that we surveyed interpersonal conflict was measured with a wide variety of scales, the most commonly used of which was the Interpersonal Conflict at Work Scale (ICAWS; Spector & Jex, 1998).

Lack of control. Job control, or job autonomy, is a manifestation of perceived control in the workplace. High levels of job autonomy indicate that an employee has control over how or when his or her tasks are performed (Jex, 2002). Studies in this meta-analysis used measures of both the presence of and lack of control. However, the relationships examined in this study were based on lack of control, and for any study reporting relationships between control and symptoms we reversed the sign of the correlation. The most common measures for control were the Job Content Questionnaire (JCQ; Karasek, 1985), the Job Diagnostic Survey (JDS; Hackman & Oldham, 1975, 1976; Idaszak & Drasgow, 1987), and the Leiden Quality of Work Questionnaire (LQWQ, van der Doef & Maes, 1999).

Organizational constraints. Organizational constraints are situations or environmental hurdles that impede employees from completing their job duties and hinder job performance. Organizational constraints can refer to elements of the job, such as not having job-related information, having limited time and materials, or not having the necessary job-related authority to be able to complete one's task (Peters & O'Connor, 1988). All organizational constraints studies used in this meta-analysis measured them with either the Organizational Constraints Scale (Spector & Jex, 1998) or the Job Effectiveness Survey (Eulberg, 1984).

Role ambiguity. Role ambiguity occurs when job-related information is not made clear, causing an employee to be unsure of his or her job duties and requirements. Role ambiguity can refer to performance expectations or standards, tasks or duties, scheduling, and other aspects of the work environment. The most common measure that we found for role ambiguity was developed by Rizzo, House, and Lirtzman (1970).

Role conflict. Role conflict occurs when different members of the organization give employees inconsistent or conflicting information concerning their job demands. Conflicting or inconsistent information could come from multiple individuals or a

single person within the organization. The most common measure for role conflict in the studies that we surveyed was that of Rizzo et al. (1970).

Workload. Workload refers to the amount of work an employee is required to complete in a given amount of time, along with the effort it takes to complete it. Workload includes both a quantitative component, such as the amount of work one is expected to complete, and a qualitative component, or the mental effort required to complete the tasks. The most common workload measure used was the Quantitative Workload Inventory (Spector & Jex, 1998).

Work hours. Work hours refer to the amount of time an employee works per unit of time on average. Work hours were measured in either total number of hours worked per week or average number of hours worked per day/week.

Physical symptoms. Physical symptoms were necessarily measured via self-report. In this meta-analysis, analyses were conducted for both total aggregate symptoms and individual symptoms, specifically backache, headache, eye strain, sleep disturbance, dizziness, fatigue, appetite loss, and gastrointestinal problems. The majority of studies only indicated symptoms at the aggregate level, but when individual symptom data were available, the study was utilized in both total and individual symptoms analyses. The most commonly utilized physical health/symptom measure was the PSI (Spector & Jex, 1998).

A complete list of measures for all independent and dependent variables analysed in this meta-analysis can be obtained from the first author.

Statistical methods

For our analyses, we used the Rosenthal (1991) approach to meta-analysis. The Rosenthal approach computes descriptive statistics based on the sample of correlations that are similar to the bare-bones approach outlined by Hunter and Schmidt (1990). The primary differences between these approaches is that the Hunter and Schmidt approach recommends estimating how much observed variance in correlations can be attributed to artefacts such as sampling error or unreliability of measures by applying adjustment formulas. These formulas are also used to estimate the underlying theoretical population parameters by allowing for the adjustment of the observed mean correlations. These adjustments can be problematic and inaccurate (e.g., James, Demaree, & Mulaik, 1986; Rosenthal, 1991; Spector & Levine, 1987), particularly when analysing a relatively small number of studies per variable, as is the case with some of our variable combinations in this meta-analysis. Additionally, the most frequent correction applied in the Hunter and Schmidt approach is unreliability in the criterion. Our studies did not routinely report internal consistencies for total symptom scores, and no measures of reliability were reported for single-item measures of individual symptoms. Data from longitudinal studies were dealt with separately from cross-sectional studies.

The coding process included identifying the relevant correlations and sample sizes for studies that met our inclusion criteria. When the sample size was reported as a range, a conservative approach was employed by taking the minimum of the range.

Coding of relevant information from manuscripts was conducted by the authors, with each article being coding by two coders. Any discrepancies found were clarified by an additional coder to ensure accurate information was recorded. For the 95% confidence intervals used to draw conclusions about the significance of the mean correlations, we multiplied the standard deviation of the mean by 1.96 and then added and subtracted the result from the mean correlation as recommended by Lee (1989).

Results

Our literature search returned a total of 510 published journal articles, dissertations, and unpublished papers/data that concerned occupational stressors and health outcomes. Studies were screened according to the inclusion criteria described below. We found 79 studies that fitted the inclusion criteria; 64 were journal articles, 7 were theses or dissertations, 4 were conference presentations, and 4 were unpublished data sources. For cross-sectional relationships between occupational stressors and composite physical symptoms, the literature search yielded 313 correlations. The number of samples per variable for the cross-sectional analyses ranged from 25 to 92 for composite symptoms analyses and 3 to 40 for the analysis conducted at the individual symptom level. The number of samples per variable for longitudinal analyses ranged from 2 to 7.

A list of references for articles included in the meta-analysis is available upon request from the first author.

Composite physical symptoms and occupational stressors

The relationships between the overall physical symptoms scale scores and each of the occupational stressors are presented in Table 1. More complete meta-analytical results for all analyses are available upon request from the first author. All of the occupational stressors examined in this study were positively related to composite symptom scores. The confidence intervals for each of the occupational stressors

Table 1. Meta-analysis of the relationships between composite physical symptoms and occupational stressors.

Occupational stressor	Cross-sectional analyses				Longitudinal analyses			
	k	N	wr	SD	k	N	wr	SD
Interpersonal conflict	25	10,215	.22*	.11	3	1,483	.13*	.17
Lack of control	58	32,645	.07*	.15	4	2,455	.14*	.15
Organizational constraints	34	8,212	.33*	.09	1	110	.18	–
Role ambiguity	33	13,556	.15*	.11	4	726	.17*	.11
Role conflict	26	4,880	.27*	.13	4	499	.10*	.13
Work hours	39	11,354	.09*	.11	2	496	.06	.04
Workload	92	36,610	.22*	.14	7	3,057	.16*	.13

Note: k = number of correlation; N = combined sample size; wr = weighted effect size; SD = standard deviation.
*95% confidence interval excludes 0.

excluded zero, indicating that the relationships with composite scores from physical symptom inventories are significantly different from zero.

The meta-analytical results indicated that we can classify the stressors into three groups based on strength of relationship with physical symptoms, using z-tests for independent correlations to determine significant differences in effect sizes. Organizational constraints had the strongest mean weighted correlation *(wr)* with overall physical symptoms; $wr = .33$. This relationship was significantly stronger than all of the other relationships between occupational stressors and physical symptoms. The next largest mean correlation was for role conflict ($wr = .27$), which was significantly larger than for the remaining variables. Next was interpersonal conflict ($wr = .22$), and workload ($wr = .22$), both of which were significantly larger than for the remaining variables. Next was role ambiguity ($wr = .15$), which was significantly different from that of the other variables. Finally, work hours ($wr = .09$) and lack of control ($wr = .07$) had significant relationships with the composite physical symptoms. These last relationships did not differ from one another, although they were significantly smaller than other occupational stressors relationships with physical symptoms, as demonstrated by the exclusive confidence intervals.

Longitudinal relationships between composite physical symptoms and occupational stressors

All of the occupational stressors had been examined in relation to composite physical symptoms in a longitudinal context (see Table 1). Time frames across studies varied considerably from one month to more than a year, and given the limited numbers of studies, time frames were not the same across stressors. As can be seen in Table 1, six of eight mean correlations were significantly different from zero (all but interpersonal conflict, which had a small sample size [$N = 110$], and working hours). The magnitudes of the relationships between three of the longitudinal mean correlations (organizational constraints, role conflict, and work hours) were not significantly different from the cross-sectional results based on z-tests. Three of the longitudinal relationships (interpersonal conflict, role conflict, and workload) were significantly smaller, and one longitudinal relationship (lack of control) was significantly larger in magnitude when compared to cross-sectional relationships. Additionally, the relationship between work hours and physical symptoms was found to be non-significant in the longitudinal context and significant in the cross-sectional context.

Individual physical symptoms and occupational stressors

The individual symptom analysis revealed that the occupational stressors did differentially relate to individual strains (see Table 2a–c). Interpersonal conflict, organizational constraints, and workload were significantly related to every physical symptom, although there was a different pattern in relative strength of relationship across these stressors. Interpersonal conflict had a significantly larger mean correlation with sleep disturbances than with dizziness, headaches, or fatigue. Organizational constraints had significantly larger mean correlations with fatigue and gastrointestinal problems than the other symptoms. Workload had a larger mean correlation with fatigue, followed by its relationship with eye strain, which were both significantly larger than the relationship with the other symptoms. Workload had

Table 2a. Meta-analysis of the relationships between occupational stressors and individual physiological symptoms: Backache, headache and eye strain.

	Physiological symptoms											
	Backache				Headache				Eye strain			
Occupational stressor	k	N	wr	SD	k	N	wr	SD	k	N	wr	SD
Interpersonal conflict	6	2,853	.19*	.04	5	844	.12*	.16	5	845	.19*	.10
Lack of control	13	5,556	.13*	.08	12	3,522	.07*	.10	6	867	−.01	.11
Organizational constraints	29	7,226	.16*	.10	29	7,326	.18*	.10	29	7,327	.19*	.08
Role ambiguity	5	971	.05	.16	4	644	.02	.13	4	644	.00	.09
Role conflict	4	487	.16*	.10	4	487	.04	.10	4	487	.13*	.05
Work hours	30	7,894	−.01	.08	29	7,567	.03	.10	29	7,568	.08*	.07
Workload	40	11,086	.12*	.08	39	10,643	.14*	.11	33	7,989	.20*	.09

Table 2b. Meta-analysis of the relationships between occupational stressors and individual physiological symptoms: Sleep disturbances, dizziness and fatigue.

	Physiological symptoms											
	Sleep disturbances				Dizziness				Fatigue			
Occupational stressor	k	N	wr	SD	k	N	wr	SD	k	N	wr	SD
Interpersonal conflict	5	845	.22*	.06	4	710	.11*	.12	3	351	.09*	.02
Lack of control	12	3,522	.13*	.12	6	867	.06	.08	6	1,621	.08	.10
Organizational constraints	29	7,326	.17*	.10	29	7,326	.17*	.11	29	7,327	.25*	.08
Role ambiguity	4	644	.04	.20	4	644	.02	.07	3	508	.13*	.11
Role conflict	4	487	.13*	.15	4	487	.10*	.07	3	351	.09	.02
Work hours	29	7,568	.05*	.09	29	7,567	.02	.11	30	8,458	.09*	.09
Workload	39	10,644	.14*	.09	33	7,988	.10*	.10	33	8,744	.31*	.09

Table 2c. Meta-analysis of the relationships between occupational stressors and individual physiological symptoms: Appetite and gastrointestinal problems.

	Physiological symptoms							
	Appetite				Gastrointestinal problems			
Occupational stressor	k	N	wr	SD	k	N	wr	SD
Interpersonal conflict	5	845	.16*	.07	6	2,852	.19*	.06
Lack of control	6	867	.03	.10	12	3,522	.09*	.08
Organizational constraints	29	7,327	.18*	.09	29	7,325	.26*	.09
Role ambiguity	4	644	-.04	.11	4	644	.06	.13
Role conflict	4	487	.10	.15	4	487	.17*	.03
Work hours	29	7,568	.04*	.10	29	7,565	.05*	.09
Workload	33	7,989	.11*	.10	39	10,642	.13*	.09

Note: k = number of correlations; N = combined sample size; wr = weighted effect size; SD = standard deviation.
*95% confidence interval excludes 0.

significantly larger mean correlations with appetite loss and dizziness than headaches and sleep disturbances, based on results from *z*-tests.

Role conflict and work hours were each significantly related to five of the eight physical symptoms examined. Role conflict had positive relationships with backaches, dizziness, eye strain, gastrointestinal problems, and sleep disturbances. Role conflict had a significantly larger mean correlation with gastrointestinal problems than with headaches, based on results from *z*-tests. Work hours had positive relationships with appetite, eye strain, fatigue, gastrointestinal problems, and sleep disturbances. Work hours had a larger mean correlation with fatigue than all other symptoms except eyestrain. Work hours had a larger mean correlation with eyestrain than backaches, headaches, dizziness, and appetite loss. Additionally, work hours had a significantly smaller relationship with backaches than all other symptoms with the exception dizziness. Lack of control had positive relationships with four of the physical symptom variables, including backaches, gastrointestinal problems, headaches, and sleep disturbances. Backaches and sleep disturbance had larger mean correlations with lack of control than headaches and appetite loss. Additionally, lack of control had a smaller mean correlation with eye strain than backaches, headaches, sleep disturbances, fatigue, and gastrointestinal problems. Finally, role ambiguity was only significantly related to fatigue; this relationship was significantly larger than the relationships between role ambiguity and eyestrain or appetite, based on *z*-tests.

None of the physical symptoms related to all of the occupational stressors. However, gastrointestinal problems and sleep disturbances were significantly related to more occupational stressors than any of the other physical symptoms, each having significant relationships with six of the seven occupational stressors examined. Backaches, eye strains, and fatigue were each related to five occupational stressors. Changes in appetite, dizziness, and headaches showed the fewest significant relationships with occupational stressors, each relating to four occupational stressors.

Discussion

Physical symptoms as defined in our study are manifestations of physical strain that are likely to be responses to environmental stressors at work. Such strains are particularly important given that they are predictive of future morbidity and mortality as well as absenteeism (Benyamini & Idler, 1999; Darr & Johns, 2008; Ferraro & Kelley-Moore, 2001; Idler & Benyamini, 1997). The goal of this meta-analysis was to quantitatively summarize the cross-sectional and longitudinal relationships between occupational stressors and both composite and individual self-reported physical symptoms. These relationships had not been as thoroughly examined previously in a meta-analysis. Results demonstrate that occupational stressors were related to physical symptoms both cross-sectionally and over time. Additionally, certain physical symptoms, including gastrointestinal problems and sleep disturbances, were related to more occupational stressors than other symptoms, such as dizziness or headaches. In the following section, we will discuss the relationship patterns identified in these analyses – mechanisms that may help explain these relationship patterns, as well as relevant research and practical implications and opportunities.

Composite symptoms and occupational stressors

All of the occupational stressors included in this meta-analysis were significantly and positively related to composite physical symptoms in the analysis of cross-sectional studies, although relationships with physical symptoms were stronger for organizational constraints, role conflict, interpersonal conflict, and workload than for role ambiguity, work hours, and lack of control. Longitudinal analyses, while hindered by the limited number of available studies ($k = 2$ to 7), provide some evidence for temporal consistency of the stressor–physical symptom relationships. Importantly, the effect sizes of the longitudinal relationships between some of the occupational stressors were not significantly different from the cross-sectional results. Specifically, longitudinal relationships between interpersonal conflict, workload, and working hours were positive and not significantly different from the corresponding cross-sectional relationships. It should be kept in mind that the sample sizes for some stressors in the longitudinal studies was rather limited, thus not providing adequate statistical power. For example, the largest correlation with the longitudinal studies was for organizational constraints ($r = .18$), which was non-significant, although only based on a sample size of 110.

Our results show that three of the four stressors (organizational constraints, interpersonal conflict, and workload) relating most strongly to overall symptoms are the same that have consistently emerged as most salient in qualitative studies of stressful work incidents (e.g., Keenan & Newton, 1985; Liu, Spector, & Shi, 2007; Narayanan, Menon, & Spector, 1999). Perhaps these stressors are reported more frequently in qualitative research because they have a stronger impact on strains, including physical symptoms, and thus the stressors are more salient to employees. Thus, employees might judge the severity and impact of a stressor by the physiological reaction that follows the stressor. On a different note, this pattern of meta-analytic findings has implications for the ways in which occupational stressors are conceptualized. Specifically, our results show that both chronic stressors (i.e., organizational constraints, role conflict) and acute stressors (i.e., interpersonal conflict) can have significant relationships with employees' health; therefore further examination into both types of stressor is essential. Additionally, research addressing the underlying mechanisms for acute and chronic stressors is warranted, as these chronic and acute stressors may impact on physical symptoms through unique underlying mechanisms. Finally, this pattern of results can help guide intervention and restructuring efforts by organizational leaders concerned with the physical health of their employees. Reducing organizational constraints and role conflict may be effective and accessible ways to reduce employees' physical symptoms that might play a role in more serious health problems.

Immediacy of physiological reactions and specific symptoms

The individual symptom analyses revealed differences and patterns across relationships between occupational stressors and physical symptoms. We propose that the immediacy of physiological reactions represents an underlying mechanism that is useful in understanding many of these diverse relationships. Taking all of the occupational stressor–individual symptom relationships into account, gastrointestinal problems and sleep disturbances were significantly related to more occupational

stressors than the other physical symptoms. One reason that individuals may frequently report these physical symptoms is that they are the by-product of immediate physiological reactions. Experiences of increased levels of physical and mental stressors initiate an immediate physiological reaction involving elevated ACTH and sympathetic nervous system agonists, which create the rapid response of slowing digestion and causing an upset stomach. The time period for this reaction to occur is minimal, leading to the almost instantaneous perception of the physical symptom, and an awareness that a stress reaction has taken place. The fact that many people report gastrointestinal reactions is probably secondary to this strain being one of the first noticed and easily relatable symptoms to stressors.

In much the same way, sleep patterns may vary in the immediate setting as well. As the body enters a stressful situation, its sympathetic nervous system activity is elevated. The hormones generated by the "fight or flight" response may cause lasting tension and eventually disrupt sleep. In fact, the very mechanisms needed to gain sleep are the opposing mechanisms driven by the "fight or flight" response; they specifically include blood pressure, heart rate, and respiratory rate. A disruption of these mechanisms may lead to ineffective sleep, which is often an immediate outcome and one that is, like gastrointestinal problems, easily attributable to stressors. A promising area for future research could be examining the role that mental rumination, or replaying and dwelling on a stressful event, may play in sleep disruption by increasing anxiety and stress reactions (Cropley, Dijk, & Stanley, 2006).

Many of the other symptoms, including backaches, headaches, eye strain, and loss of appetite, represent physical reactions that generally develop over time. Stressful events are often related to increased complaints of pains and strains weeks after the initial incident (Davis et al., 2001; Manne & Zautra, 1989; Zautra et al., 1998; Zautra et al., 2005). When individuals experience stressors, the body's pain threshold is decreased while the pain signalling pathways become increasingly sensitive (Huyser & Parker, 1999; McLean et al., 2005; McLean et al., 2006). Thus, the nervous system becomes overly sensitive to pain signals, such that even the slightest insult to the system may cause symptoms such as headaches, back pains, or eye strains.

Elusively, transient and subtle symptoms may not be as easily explained by the immediacy of physiological responses. These symptoms, such as dizziness, are easier to miss or otherwise explain away. Dizziness passes quickly, thus individuals may take little note of this reaction, while backache remains more pervasive over long periods of time, making it more likely that individuals will be concerned about back pain and recall it when completing a symptom checklist. This alternative hypothesis should be evaluated through future research.

The immediacy of physiological responses in reaction to stressors reinforces the need for longitudinal research examining physical reactions to occupational stressors. Currently, to our knowledge individual symptoms related to occupational stressors have not been examined in a longitudinal research setting. This is an important next step for this area of research, as the relationships between these variables may vary over time. In particular, time series designs would be useful in examining the development of chronic physical symptoms, as well as changes such as habituation or further progression to chronic illnesses.

Fatigue

Fatigue is somewhat unique among the individual symptoms that were examined in this study. Unlike the other seven symptoms, fatigue is a condition that can be associated with other symptoms, including muscle pains, headaches, and unrefreshing sleep. Consequently, the relationships between fatigue and occupational stressors may be explained through additional means than the other physical symptoms. One potential reason that fatigue is a very frequently reported strain is that it is the most easily recognizable and often disabling consequence of chronic stress (Dittner et al., 2004; Franssen et al., 2003). Alternatively, the multidimensional nature of fatigue may itself account for the frequency with which it is reported. If individuals report fatigue when any combination of symptoms is present, it might receive more frequent endorsements than a uni-dimensional symptom, such as back pain. In the future, researchers should consider studying reports of fatigue in more depth, to gain a better understanding of how occupational stressors impact on this constellation of symptoms.

Limitations

Despite an extensive search of both published and unpublished literature in an attempt to include as many effect sizes as possible given our inclusion criteria, a few of the findings reported here are based on a small number of studies and, therefore, require more careful consideration. This is particularly relevant when interpreting the longitudinal results and the findings associated with several occupational stressors and individual physical symptoms. Given the inability to draw causal conclusions from cross-sectional data, it is important that researchers conduct more longitudinal research in this area. As more longitudinal research is conducted, the nature of longitudinal relationships should be examined in comparison to the cross-sectional relationships to search for emerging differences.

    Another limitation particular to the individual symptom analyses is that many had low incidence rates, thereby attenuating the magnitude of possible correlations. One reason that individual symptoms are often combined into composite indices is to increase the range and variance of the measure, thus increasing the likelihood of finding significant relationships. Our results suggest that relationships of individual symptoms can vary across stressors, which argues against combining symptoms into composites. At the very least one needs to be cautious not to interpret composite scores to mean that all components of the composite are necessarily related to stressors (or other variables) or that the magnitude of relationships are equivalent across components.

    There are also sources of potential bias that plague meta-analytic work, and this project is no exception. First, there is always the danger than these results suffer from publication bias that produces the "file drawer" problem in which only significant results are published. It is possible that our results over-estimate the size of stressor–symptom relationships due to this limitation. However, it should be noted that many of the studies in our meta-analysis included measures of psychological strains that generally show stronger stressor–strain relationships. It seems unlikely that an author would fail to publish a study just because there were small or nonsignificant relationships with physical symptoms, as psychological strains would likely show

significant results. Furthermore, in an attempt to address these sources of bias, we included conference presentations, dissertations, and unpublished studies that would not be subject to the same publication biases, unless it is the case that authors are reluctant to share null results. Nevertheless, as with any meta-analysis, we cannot be certain that we did not have a biased sample of studies.

Furthermore, the studies included in our meta-analysis were entirely self-report with all measures coming from a survey of employees. Thus we can say that perceptions of stressors relates to reported symptoms. What cannot be determined from such designs is the extent to which these relationships generalize to actual environmental exposure. In other words, is it the amount of the stressor (e.g., number of constraints) or merely the perception? This is important as it determines whether interventions should focus on the environment or the individual. If the former, then a focus on changing the environment would likely be most important, for example, by shifting workloads to relieve overwork, or hiring more staff to reduce overtime hours. On the other hand if the environment itself is unimportant, a focus on the individual, perhaps through stress management training focused on cognitive restructuring should be the target of intervention.

Another limitation to single-source designs is whether observed correlations are distorted by shared biases among variables. For example, are people who are high on neuroticism predisposed to be negative and complain, thus giving high ratings on stressor and symptom scales? One possible mechanism by which biases could arise is attributions: that is, the way in which an individual attributes a cause to an effect. Individuals' schemata of strains may consist of more immediate reactions, such as abdominal and stomach cramps and fatigue, as opposed to long-term reactions, such as eye strain. It may be that while responding to a survey about stressors, this strain schema is activated, leading individuals to report more immediate physical strains. This mechanism could also potentially explain why dizziness is less often reported as a physical symptom associated with occupational stressors. While dizziness is an immediate reaction to stress, in our findings it did not demonstrate a similar pattern of relationships with occupational stressors as did the other immediate physical symptoms, perhaps because dizziness is not primarily attributed to the physiological stress process (Kasper et al., 2005).

The attributional process could potentially inflate relationships between stressors and strain. For instance, individuals who have reported many symptoms that they believe relate to stressors might then inflate reports of stressors, or individuals who report frequent and intense experience of occupational stressors might then inflate symptom reports. In the future it would be interesting to investigate how schemata about the impact of occupational stressors on physical health might impact on self-reported physical symptom data. The lack of research concerning the role of attributional processes in which individuals engage when responding to stressor and strain surveys is a substantial hindrance in the development and advancement of this field, and one that critically needs to be addressed in future research.

Conclusions

We believe that this study advances knowledge and provides a platform for researchers to better understand the relationships between occupational stressors

and employees' physical health, as well as provide pointers to essential next steps in this research area. All of the occupational stressors examined were significantly related to composite ratings of physical symptoms, with organizational constraints, role conflict, interpersonal conflict, and workload having the strongest relationships with physical symptoms. Studies that examined longitudinal relationships between these occupational stressors and physical symptoms provide some evidence for the temporal consistency of symptoms, and help control for transient occasion factors that could distort observed relationships.

Based on our findings, we conclude that physical symptoms are a vitally important strain to continue studying in occupational health research, not just because of the possible severity of outcomes, which can be highly related to morbidly and mortality, but also because physical symptoms are affected by a wide range of occupational stressors and these relationships can prevail over time.

By examining the relationships between occupational stressors and specific physical symptoms (rather than composite symptoms), we identified that there were differences across these relationships. Furthermore, a novel feature of this study is the distinction that was drawn between immediate and delayed physiological responses to stressors. This immediacy of physiological responses was proposed as a mechanism to explain differences in relationships between stressors and specific physical symptoms. We have also drawn attention to the importance of understanding how individuals' attributions about the nature of physical responses to stressors may relate to stressor–physical symptom research. Future research examining the diverse relationships between occupational stressors and physical symptoms, as well as potential underlying mechanisms, may lead to changes in the research methodology currently used to study physical symptoms, such that they may be better examined by multidimensional scales, rather than the uni-dimensional scales currently employed.

Acknowledgements

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Note: A complete list of references for articles included in the meta-analysis is available upon request from the first author.

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