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# Chronic strain, daily work stress, and pain among workers with rheumatoid arthritis: Does job stress make a bad day worse?

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## Abstract

The structure of the job and the daily experience of work are challenges for workers with rheumatoid arthritis. Yet little is known about how these two factors interact to put workers with chronic pain at risk for worse pain on a given day. This exploratory 20 workday diary study of 27 workers with rheumatoid arthritis used hierarchical linear modeling to examine how the structure of the job and neuroticism moderate the relationship between daily undesirable work events (daily stressors), and pain reports within a day. On days with more undesirable work events compared to days with fewer events, individuals with jobs associated with job “strain” (high demand/low control) reported greater midday pain, irrespective of neuroticism and negative mood, than workers with other combinations of demand and control. These findings demonstrate the utility of analyzing fluctuating within-person relationships among pain, mood, and daily work stressors within the context of the structure of the job, and helps to explain why daily work stressors result in worse health outcomes for some but not all workers with RA.

**Keywords:** job strain, work stress, pain, rheumatoid arthritis

## 1. Introduction

Remaining active in paid work is important for people with Rheumatoid Arthritis (RA). Workers with RA report lower levels of emotional distress than non-workers (Fifield, Reisine, & Grady, 1991; Fifield, Reisine, Pfeiffer, & Affleck, 1989), and workers who have been out of work and distressed find that their distress declines on return to work (White, Wrigley, LaGory, Fine, Maisiak, & Straaton, 1995). Also, they often use their continued ability to work as a source of comfort (Affleck, Tennen, Pfeiffer, & Fifield, 1987). Although paid work may be beneficial, the workplace can also be a source of unique challenges for many individuals with RA, demonstrated by the high rates of work disability (Albers *et al.*, 1999; Allaire, Anderson, & Meenan, 1996; Reisine, McQuillan, & Fifield, 1995; Yelin, Nevitt, & Epstein, 1980).

This study brings together two contrasting explanations for the unique negative effects of paid work for individuals with RA. The first explanation focuses on situational or acute stress associated with the undesirable events that occur on a daily basis in the changing experience of work. A growing body of evidence indicates that such stressful daily circumstances are associated with daily mood (Affleck, Tennen, Urrows, & Higgins, 1990; Armeli, Tennen, Affleck, & Kranzler, 2000; Bolger, DeLongis, Kessler, & Schilling, 1989), and illness symptoms (DeLongis, Folkman, & Lazarus, 1988; Repetti, 1993; Stone, Reed, & Neale, 1987). Studies show an association between minor stressful events and the course of RA as well, including symptoms such as pain (Affleck *et al.*, 1990, 1994; Crosby, 1988; Parker *et al.*, 1988), emotional well-being (Zautra, Burleson, Matt, Roth, & Burrows, 1994), daily mood (Affleck *et al.*, 1990) and indicators of disease activity (Mason, Anderson, Meenan, Weaver, & Haralson, 1990; Smith & Zautra, 2002). Few studies have examined the role of work events at the daily (cf. Affleck, Tennen, Urrows, & Higgins, 1992) or weekly level (cf. Potter, Smith, Strobel, & Zautra, 2002) in an arthritis population, although there is growing evidence in the general population that changes in daily mood are linked to daily work events (Barling & Kryl, 1990; Bolger *et al.*, 1989; Peeters, Buunk, & Schaufeli, 1995; Reicherts & Pihet, 2000; Repetti, 1993; Stewart & Barling, 1996; van Eck, Nicolson, & Berkhof, 1998).

In contrast, a second model focuses on the strain associated with more stable characteristics of the job such as high psychological demands and low levels of control (Karasek, 1979; Karasek & Theorell, 1990). While the model of daily work stress posits that health outcomes such as pain and mood are linked to the momentary, undesirable events that happen in the course of a day at work, Karasek's job strain model posits that the structure of the job creates chronic conditions within which workers interact. The model has been widely tested, and despite mixed results from the proposed interaction of demands and control, new variations of the model focusing exclusively on control (Bosma *et al.*, 1997) and a new operationalization of control (Wall, Jackson, Mullarkey, & Parker, 1996), the job strain model is considered to be a primary model of chronic work stress with implications for both physical and mental health outcomes (Marmot, Theorell, & Siegrist, 2002; Schnall, Schwarz, Landsbergis, Warren, & Pickering, 1998; Schwartz, Pickering, & Landsbergis, 1996; Soderfeldt *et al.*, 1997) including musculoskeletal pain among workers (Nahit, Pritchaard, Cherry, Silman, & Macfarlane, 2001; Pope, Silman, Cherry, Pritchaard, & Macfarland, 2001).

The present, exploratory study investigates a multilevel (MLM) model of work stress that combines the chronic "strain" (high demand, low control) associated with the structure of work, the acute stress associated with undesirable daily work events, and neuroticism (Costa & McCrae, 1985), a personality characteristic of the individual. This multilevel stress/strain model is based on the notion that the chronic strain associated with jobs that are demanding and lacking in control may make exposed workers more vulnerable to the daily stressors they experience, resulting in higher levels of pain within that day. They may be more vulnerable or reactive to daily work stressors, either because their coping capacity is diminished from the chronic "strain" of their work or because their job lacks access to coping resources such as control in their work (Pearlin & Schooler, 1978). The model also recognizes that individuals vary in their reactivity to undesirable daily events, based on personality characteristics such as neuroticism that may moderate the stressor-health outcome relationship (Affleck *et al.*, 1992, 1994; Bolger & Schilling, 1991; Bolger & Zuckerman, 1995; David *et al.*, 1997; Persson & Sahlberg, 2002). Despite evidence that chronic stress associated with conditions such as neighborhood environment exacerbates the effects of daily stressors (Caspi, Bolger, & Eckenrode, 1987; Lepore, Evans, & Palsane, 1991), multilevel models of work stress are rare (Grebner *et al.*, 2004; Sonnentag, 2000), but may

explain why undesirable work events result in worse health outcomes on a day-to-day basis for some but not all workers with RA.

The current study was undertaken to address this gap by exploring linkages among the relatively stable control and demand characteristics of the job associated with job strain, personality characteristics of the individual (neuroticism), undesirable daily work events, and pain and mood reports recorded on a daily basis in work event diaries. In particular, as Figure 1 shows, we examine the associations among pain, mood and undesirable daily work events in the narrow time frame between waking in the morning and taking a mid-day break at work (Level One).

We predict that on days when workers experience more undesirable events in the morning at work (stressors), they will report higher levels of pain within a short time-frame than on days with fewer undesirable events, controlling for pre-work pain and negative mood. This association is then examined within the context of the characteristics of the job and the person to test whether it is moderated by the chronic strain associated with the structure of the job (high demand/low control) or a personality characteristic of the individual (Level Two).

At Level Two, we predict that workers in “high strain” jobs will have even greater responses (higher levels of pain) to the undesirable events they encounter in the morning than their co-workers who encounter such events but are not in high strain jobs.

## 2. Methods

### 2.1. Sample

Patients with definite or classical RA, without major co-morbidity, were recruited from the practices of two community-based rheumatologists. To be included in the study, patients had to be between the ages of 20 and 65 years to avoid student workers and retirees, and had to be working the day shift for pay, outside the home, for at least 35 hours/week. Letters were sent from the rheumatologists explaining the study. Those interested in hear-

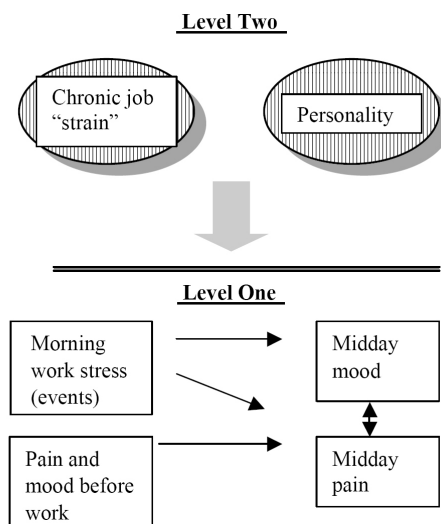


Figure 1. Multilevel work stress/strain model.

ing more about the study ( $N = 46$ ) were scheduled for an in-home interview and training session. As an incentive to encourage adherence to the 20-day daily protocol, participants were paid \$2 for each completed daily report form.

As Table 1 illustrates, the participants were primarily white, middle-aged women with at least a high school education and a moderate family and personal income in 1995. This sample is similar to samples found in other RA studies recruited from rheumatology practices (Reisine, Fifield, & Winkelman, 1998). The high percentage of women in the sample is consistent with the higher prevalence of RA among women.

The majority of workers (not shown) were employed full-time and in occupations that ranged from semi-skilled to major professional, with most being either clerical or sales workers. About one-third of the sample had supervisory responsibilities. Most had benefits with full sick pay and health insurance, with fewer having paid meal breaks and only a minority being involved in profit sharing. The majority of workers had some kind of physical activity on the job: they were either involved in physical work or work that involved a computer, which constitutes physical work for people with RA due to the usual involvement of the hand joints.

## 2.2. Procedures and measurement

Daily measures of pain, mood and work events were obtained for 20 workdays with a daily work diary (DWD) that had been developed and validated with a sample of RA workers in an earlier phase of the study (Fifield, Affleck, & Reisine, 1994; Fifield, Reisine, Affleck, & Pasquale, 1996). Following the recommendation of Stone and Neale (1982) the DWD was in the form of a small booklet including a checklist of 86 work-related events

**Table 1.** Sample characteristics.

	Mean	SD	Reported range	Percentage
<i>Demographic information</i>				
Age				
Education (years)	48	10	28-65	
Family income (\$ US)	15	2	12-17	
< 30,000				4
30,000-49,000				35
>50,000				54
Personal income (\$ US)				
< 20,000				12
20,000-29,000				20
30,000-49,000				40
>50,000				28
% Women				74
% White				93
<i>Daily events and pain measures (average across days)</i>				
				<u>N</u>
Pre-work pain (scored 0-100)	27.71	20.48	0-80.00	463
Midday pain (scored 0-100)	27.76	20.20	0-99.00	463
Prework negative mood (scored 0-3)	0.28	0.43	0-2.56	463
Midday negative mood (scored 0-3)	0.25	0.39	0-2.00	463
Morning undesirable events (scored 0-86)	2.32	2.20	0-20.00	463
<i>Personality</i>				
Neuroticism (scored 0-3)	1.43	0.52	0.58-2.50	27
<i>Structural work characteristics</i>				
Control at work (reversed) (scored 1-4)	1.87	0.49	1.00-2.75	27
Demand at work (reversed) (scored 1-4)	1.91	0.56	1.00-3.00	27

as well as detailed instructions and a description of how to classify experiences using an event appraisal rating. Workers were asked to check off an item in the DWD during their midday break if it occurred that morning, and at the end of the workday if it occurred in the afternoon. Each item could be checked off once in each timeframe (morning and afternoon). They were then asked to rate or classify that experience in terms of its desirability/undesirability on a 6-point bipolar adjective anchored scale with ratings from -3 (extremely undesirable) to +3 (extremely desirable) (Redfield & Stone, 1979). This rating was included to identify the range of work events rated as desirable and undesirable by workers with RA. Participants were asked to record their pain and mood in the morning prior to leaving for work, during their midday break and again at the end of the workday before leaving work. To avoid transition from work to home effects, the "end of workday before leaving work" reports are not used in this analysis. This analysis is focused on the narrow time frame of pain reactivity to work stressors experienced during the morning at work, thus only the undesirable events (work stressors) that were recorded as occurring during the morning are included (Taylor, 1991).

Twenty work days was chosen as the recording period to: (1) provide an ample sampling of days ( $n = 20$ ) for work stressors to occur; (2) offer sufficient within-person observations ( $n = 20$ ) to provide reliable estimates and an adequate number of individuals to evaluate the effect of personal characteristics such as work demand and control; and (3) capture a time period that may parallel certain naturally occurring work stressors such as monthly quotas, Blue Mondays and pay days.

A procedure similar to other studies (Schanberg, Anthony, Gil, & Maurin, 2003) was followed to enhance and track adherence to the daily diary protocol. Workers were visited at home by the research assistant one or two days prior to the first day of recording for an orientation to the daily work diary and a structured interview about their work and their personality. Participants were given 20 diaries and 20 stamped envelopes and were encouraged to follow the same schedule each day and to mail their diaries in the next morning's mail on 20 sequential workdays. The cover of each DWD was stamped with a calendar and participants were asked to circle the date on the calendar corresponding to the recording day. The research assistant visited the post office daily to retrieve the mail. Participants were called on the second day of recording and then on the first day of each of the next three recording weeks to enhance adherence. Additional calls were made when there was an interruption in the return of diaries for any given individual. This reminder and tracking procedure resulted in most workers completing their 20-day diary series in sequence. Only 5 work days (1%) were missed (no diary returned) over the 540 possible person days and, in most cases, workers continued on to complete their 20-day series.

The morning's undesirable work events were obtained from each participant's DWD. The events were grouped into 11 domains concerning: (1) people who supervise, manage or employ you; (2) co-workers or colleagues; (3) people you supervise or who are subordinate to you; (4) others with whom you interact on the job; (5) gatherings with people at work for work-related discussion or process; (6) your personal performance; (7) physical activity that is a part of the workday; (8) the office environment; (9) job/ financial security; (10) work routine/pace/schedule; (11) other work-related events (Fifield *et al.*, 1994, 1996). Examples of work events that were rated as undesirable include: "She/he (supervisor) assigned an unusually disagreeable or difficult task to me"; "I had to interact with a difficult client, e.g. intimidating, unhappy or uncooperative"; "An unexpected meeting was called (or no time to prepare for a meeting)"; "I had an argument with someone"; "I participated in some activity using my hands that was more physically challenging than usual (e.g. typing, filing lifting carrying, etc.)"; "The air temperature became less comfortable than



usual"; and "I parked in a less convenient space." Undesirable events were the number of events rated as slightly (-1), moderately (-2) or extremely (-3) undesirable.

Pre-work and Midday negative mood were measured by three scales (anxious, depressed, and hostile, all rated 0-3) from the Profile of Mood States-B (POMS-B, Lorr & McNair, 1982). Before leaving for work in the morning participants were asked to report how they were feeling at the moment on the 18-item scale. At midday they were asked to report how they had been feeling over the morning. The full POMS-B measures both negative and positive mood and has been used in previous research with RA patients (Affleck *et al.*, 1990, 1992). Evidence for the instrument's concurrent and predictive validity comes from a number of investigations of seriously ill patients and their family members (Affleck, Tennen, Allen, & Gershman, 1986; Affleck, Tennen, & Gershman, 1985; Pfeiffer, Affleck, & Tennen, 1986). The reliability of the midday POMS-B negative affect scale showed high internal consistency on three separate reporting days chosen at the beginning, middle and end of the reporting period ( $\alpha$  reliability = .89, .83, and .93, respectively). The mean of the three negative mood subscales (anxious, depressed, and hostile) for both pre-work and midday was used in this analysis.

Workers were asked to report their joint pain upon awakening and then during their midday break. Upon awakening in the morning they were asked, "thinking about your arthritis pain in general, on a scale of 0 to 100 with 0 being the least pain possible and 100 being the most, how much pain do you feel now?" At midday they were asked to report their joint pain over the morning at work. Such scales have been shown to be sensitive self-reports of pain in RA (Meenan, Yelin, Nevitt, & Epstein, 1981).

Job strain, indicated by low control and high demand, was measured during the in-home interview with items developed by Karasek and Theorell (1990). Control was an equally weighted sum of two subscales: (a) Skill Discretion, and (b) Decision Authority. Skill Discretion was measured by the sum of six questions that asked how much workers agreed with the following statements on a scale from 1 (strongly agree) to 4 (strongly disagree): (1) "My job requires that I keep learning new things." (2) "I get to do a number of different things on my job." (3) "My job requires that I do the same things over and over." (4) "My job requires a high level of skill." (5) "My job lets me use my skills and abilities." (6) "My job requires that I be creative." Question 3 was reverse coded so that a score of 1 equals high decision authority. Using the same response categories of "strongly agree" to "strongly disagree," decision authority was measured by six questions: (1) "It is basically my own responsibility to decide how my job gets done." (2) "I have the freedom to decide what I do on the job." (3) "I determine the speed at which I work." (4) "I decide whom I work with on my job." (5) "I decide when I take breaks." (6) "I decide when to come in to work." All items were scored within the range 1 to 4.

Demand (scored 1-4) was measured by the sum of five questions that asked how often (always, sometimes, rarely, or never) the following five statements were true. (1) "My job requires that I work fast." (2) "My job requires that I work hard." (3) "I am never asked to do excessive amounts of work." (4) "I do not have conflicting demands placed on me." (5) "I have enough time to get the job done." Questions 3, 4, and 5 were reverse coded so that a score of 1 equals high demand. Both the control and demand scales were recoded so that high scores in all of the analyses and tables indicate high demand or control.

Neuroticism was measured by the 48-item Neuroticism scale of the NEO Personality Inventory (Costa & McCrae, 1985). The NEO-PI with five response categories from strongly disagree to strongly agree, measures six dimensions of neuroticism indicating a predisposition to experience depression, chronic anxiety, chronic hostility, self-consciousness, im-



pulsiveness, and vulnerability. In this sample the  $\alpha$  reliability of these sub-scales ranged from .65 to .88.

### 2.3. Multilevel data and models

We collected multiple within-day reports across days and individuals, therefore the data are multi-level (days nested within-persons). We examined within-person day-level associations (level 1) and the moderating effect of between-person characteristics on those associations (level 2). We used HLM5 (Raudenbush, Bryk, Cheong, & Congdon, 2000) to assess: (a) whether undesirable morning work events (UWE) and pre-work pain (PWP), controlling for pre-work negative mood (PWNM), have a partial effect on that day's midday reports of negative mood over the morning at work (MNM) and midday work pain over the morning (MWP); and (b) how these within-person associations varied as a function of chronic strain-producing jobs (demand and control separately and in combination) and neuroticism. This analytic strategy appropriately accommodates the unbalanced, non-independent, nested data structures commonly found in daily studies of stress (Bolger & Zukerman, 1995; Gunthert, Cohen, & Armeli, 1999). It also follows Raudenbush and Bryk's (2002) suggestions to first establish the level 1 model (pain and mood reactivity to daily stressors) before adding level 2 variables (moderators of pain/mood reactivity such as chronic "strain").

In the final full model we simultaneously estimated two sets of regression equations: the within- and between-person models (Bryk & Raudenbush, 1992; Kreft, Leeuw, & Aiken, 1995). The primary focus of this analysis is on the moderating effect of chronic strain and personality on the relationships between daily events and daily pain reports, therefore we followed Hofmann and Gavin (1998) by group-mean-centering all level 1 predictors.

Most (96.4%) of the work events recorded occurred between Monday and Friday and therefore we examined only these days. In all analyses, we controlled for day of the week by including four uncentered dummy variables (with Friday as the reference day) to model day of the week (West & Hepworth, 1991). The day variables (time-varying covariates) were included in all the analyses and modeled as fixed effects (no level 2 variance component) (Bryk & Raudenbush, 1992, p. 151).

## 3. Results

Thirty (out of a possible 46) workers with rheumatoid arthritis were recruited, giving a response rate of 65%. Some 27 (90%) of the workers completed the study for a total of  $N = 540$  potential person days (27 participants and 20 days). One participant missed one day and another missed four days of daily reporting. Participants reported events on 40 weekend workdays, which were excluded from this analysis and 31 days were dropped due to missing values. Thus,  $N = 463$  daily diary days were used in the analysis. For summary purposes, daily pre-work and midday pain reports, pre-work and midday negative mood, and morning work events were averaged across all days and persons ( $N = 463$  person-days) (Table 1). Although pain ratings could range from 0–100, no one in the sample recorded a pre-work pain score over 80, nor a midday pain score over 99. The aggregated means and standard deviations for pre-work pain ( $M = 27.71$ ,  $SD = 20.48$ ) and midday pain ( $M = 27.76$ ,  $SD = 20.20$ ) were very similar. The same was true for pre-work and midday negative mood scores; both indicated low levels of negative mood (mean = .28,  $SD = .43$  for pre-work and mean = 0.25,  $SD = 0.39$  for midday). On most mornings participants experienced an average of 2.36 undesirable work events (with a high of 20).

Neuroticism, control, and demand were all measured at the person level. Average neuroticism scores were at the middle of the actual range from .58 to 2.50 ( $M = 1.43$ ), but below the midpoint of the theoretical range (1 to 5). Control and demand scale scores were summed and averaged to retain the original theoretical range, reverse coded, of 4 (high control, high demand) to 1 (low control, low demand). No actual scores reached the theoretical limits (mean control = 1.87, actual range from 1 to 2.75; mean demand = 1.91, actual range from 1 to 3). In the multi-level analysis control and demand were entered as  $z$ -scores.

### 3.1. Aggregate level correlations

We also aggregated the within-person variables by creating average pre-work pain, midday pain, pre-work negative mood, and midday negative mood scores for each person across their 20 days. Table 2 contains the bivariate correlations from these variables. We examined these correlations primarily to contrast them with the within and between person associations in the HLM analyses. Low statistical power and within-person dependence make interpretations of the significance of the results challenging (Raudenbush & Bryk, 2002). Despite lower power to detect an effect, there was a strong positive association between pre-work pain and midday pain at the aggregate level. All of the other variables were associated with midday pain in the expected directions. Pre-work and midday negative mood had a strong positive association. Neuroticism was associated with higher levels of negative mood. Demand and Control showed a moderate negative association ( $r = -.38$ ), suggesting that individuals with more control at work experienced somewhat less work-related demand. At the aggregate bivariate level, the morning's undesirable work events, chronic strain-producing jobs (control/demand), midday mood, and personality indicators had weak, non-significant associations with aggregate pre-work or midday pain.

### 3.2. Within-person day level associations

The next step in the analysis was taken to identify whether individual workers differed in the way their midday pain reports related to their midday mood, and to their experience of undesirable morning work events within a day, controlling for pre-work negative mood. Table 3 presents the mean within-person intercepts and slopes for the associations among

**Table 2.** Intercorrelations among aggregate pain, daily event, mood, personality, and work structure variables ( $N = 27$ ).

	Midday pain	Morning undesirable events	Pre-work pain	Pre-work negative mood	Midday negative mood	Work control	Work demand
Morning undesirable events	-.117	—					
Pre-work pain	.97***	-.12	—				
Pre-work negative mood	-.13	-.24	-.10	—			
Midday negative mood	-.08	-.27	-.03	.96***	—		
Work control (high/4)	-.16	-.13	-.07	-.05	-.04	—	
Work demand (high/4)	-.05	.12	-.04	-.02	.03	-.38*	—
Neuroticism	.26	-.00	.30	.52**	.54**	-.05	-.13

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

**Table 3.** Pooled ( $n = 27$ ) within-person associations (Level 1  $n = 463$ ) of negative midday mood and midday pain with pre-work pain, pre-work negative mood and undesirable morning events.

Average within-person coefficients	Midday negative mood			Midday pain					
	Model 1†			Model 2			Model 3		
	B	SE	<i>t</i>	B	SE	<i>t</i>	B	SE	<i>t</i>
Intercept	0.24	0.05	4.71***	27.69	3.39	8.16***	27.73	3.41	8.13***
Pre-work pain	-0.00	0.00	-0.11	0.73	0.13	5.82***	0.72	0.13	5.71***
Undesirable work events	0.01	0.01	2.41*	0.67	0.34	1.96	0.60	0.34	1.75
Pre-work negative mood	0.57	0.06	9.43***	1.33	0.95	1.40	-1.38	1.05	-1.31
Midday negative mood	—	—	—	—	—	—	5.11	1.33	3.84***

Note: We controlled for day of the week at level 1 in all of the analyses. The coefficients were estimated from 463 observations across 27 study participants.

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

† In model 1, the intercept has an error term; in models 2 and 3, the intercept, pre-work pain, and morning undesirable events have error terms.

the daily variables. We first regressed midday negative mood on pre-work pain and undesirable morning work events, controlling for pre-work negative mood (Table 3, first column). Negative mood before going to work and undesirable morning events at work each showed independent associations with midday negative mood. The within-person variables were centered around each person's own mean, therefore the intercept is the average of all 27 intercepts when each person's score on the other variables equals 0 (the mean of those variables across each person's daily reporting). Although at just less significant than the conventional .05, undesirable work events in the morning tended also to be positively associated with midday pain reports, even controlling for pre-work negative mood (Table 3, second column). To determine if this association was an artifact of greater pre-work pain leading to the perception of more undesirable events at work, we regressed undesirable work events on pre-work pain, and found no association ( $B = -0.01$ ,  $SD = 1.006$ ,  $df = 26$ ,  $p = .324$ ). The positive association between undesirable work events and midday pain suggests that undesirable work events are associated with an increase in negative mood and pain over the morning. Days starting off with greater pre-work pain and more undesirable work events were associated with greater midday negative mood and more midday pain compared to days without such morning stressors, controlling for each person's mood at the beginning of the day. Midday mood showed a significant positive association with midday pain, and only slightly diminished the effects of pre-work pain and undesirable events on midday pain (Table 3, column 3).

The second step in the analysis tested whether the chronic strain associated with the demands and control of the job, and the predisposition to react to negative events (neuroticism), moderated the within-person daily associations between undesirable events and pain at midday. We regressed the level 1 pain, mood, and event parameters (intercepts and slopes) on neuroticism, demands, control, and the interaction of demands and control (Table 4). All of the between-person variables were standardized, therefore a zero indicates average neuroticism, control, and demands for this sample. Therefore, all of the intercepts for the level 2 models indicate the average pain for people with average neuroticism, control, and demand.

The within-person association between pre-work pain and midday pain varied as a function of the structure of the job, such that individuals reporting low control and low

**Table 4.** Multi-level regression results for cross-level interactions: midday pain with pre-work pain, pre-work negative mood, undesirable morning work events, midday negative mood by chronic strain (control and demand), and personality (neuroticism).

	Midday pain†		
	B	SE	t-value
1st-level intercept (average midday pain), $b_0$			
Intercept, $\gamma_{00}$	26.49	3.890	6.80**
Effect of neuroticism $\gamma_{01}$	5.02	3.73	1.35
Effect of control (high = high) $\gamma_{02}$	-4.45	4.18	-1.06
Effect of demand (high = high) $\gamma_{03}$	-2.11	3.87	-0.54
Effect of control $\times$ demand interaction $\gamma_{04}$	-3.33	4.52	-0.74
1st-level slope (pre-work pain to midday pain, $b_1$ )			
Slope on average $\gamma_{10}$	0.84	0.14	5.90***
Effect of neuroticism $\gamma_{11}$	-0.14	0.13	-1.07
Effect of control (high = high) $\gamma_{12}$	-0.14	0.15	-0.98
Effect of demand (high = high) $\gamma_{13}$	-0.11	0.15	-0.70
Effect of control $\times$ demand $\gamma_{14}$	0.37	0.17	2.13*
1st-level slope (undesirable work events to midday pain, $b_2$ )			
Slope on average $\gamma_{20}$	0.07	0.38	0.120
Effect of neuroticism $\gamma_{21}$	-0.16	0.35	-0.445
Effect of control (high = high) $\gamma_{22}$	-0.74	0.340	-1.87
Effect of demand (high = high) $\gamma_{23}$	-0.08	0.36	-0.21
Effect of control $\times$ demand $\gamma_{24}$	-1.21	0.44	-2.78*
1st-level slope (pre-work negative mood to midday pain, $b_3$ )			
Slope on average $\gamma_{40}$	1.30	2.45	0.53
Effect of neuroticism $\gamma_{41}$	-2.20	2.60	-0.85
Effect of control (high = high) $\gamma_{42}$	3.85	2.36	1.63
Effect of demand (high = high) $\gamma_{43}$	2.76	2.267	1.22
Effect of control $\times$ demand $\gamma_{44}$	5.27	3.456	1.53
1st-level slope (midday negative mood to midday pain, $b_4$ )			
Slope on average $\gamma_{30}$	4.23	2.00	1.93
Effect of neuroticism $\gamma_{31}$	-0.25	2.08	-0.12
Effect of control (high = high) $\gamma_{32}$	-1.70	2.13	-0.80
Effect of demand (high = high) $\gamma_{33}$	-2.72	2.16	-1.26
Effect of control $\times$ demand $\gamma_{34}$	-1.83	3.23	-0.57

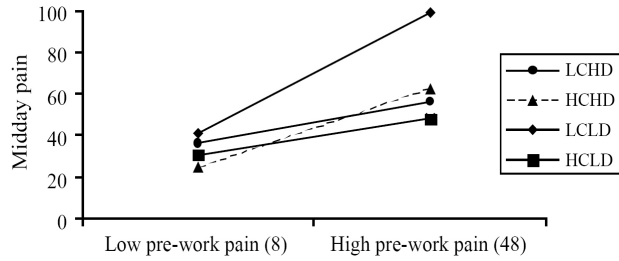
Note. We controlled for day of the week at level 1 in all of the analyses. The coefficients were estimated from 463 observations across 27 study participants.

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

† The intercept, pre-work pain, and undesirable events have error terms.

demand work situations showed the strongest within-person associations. That is, on high pre-work pain days, individuals with low control and low demand work situations were more likely to experience high midday pain compared to their counterparts in other work situations (Figure 2).

The within-person association between undesirable work events in the morning and midday pain reports also varied as a function of the structure of the job. Specifically, individuals with jobs characterized as high demand/low control (thought to produce chronic strain) demonstrated the strongest positive associations between undesirable work events and midday pain. That is, on days with more undesirable work events compared to days with fewer events, individuals with high demand/low control reported greater midday pain, irrespective of neuroticism (Figure 3). Individuals in high demand but high control situations had even lower pain as undesirable events increased. There was very little change in pain among those in low demand work situations (regardless of the level of control in their job situation).

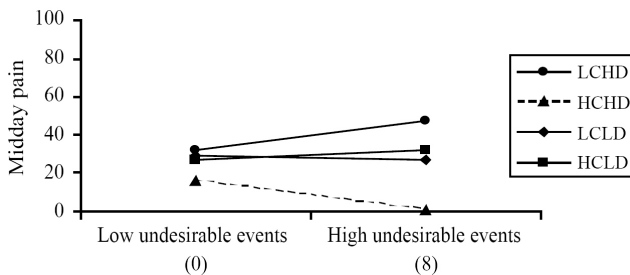


**Figure 2.** Moderating effect of job strain (control/demand) on the within-person pre-work pain-midday pain association. L = low; H = high; C = control; D = demand.

**4. Discussion**

This exploratory study was undertaken to explore the utility of a multilevel model to identify conditions in paid work that may make workers with rheumatoid arthritis more vulnerable to worse health outcomes on a day-to-day basis. In particular we explored whether the chronic “strain” associated with jobs that are high in demands and low in control increases workers’ reports of pain and mood at midday on a day when they experience more undesirable work events after they arrive at work. We also considered whether a personality attribute of the individual (neuroticism) might moderate the association. This was done to bring the individual and the changing daily experience of work into models of chronic job strain that view the structure of work as a chronic stressor. At the same time it was undertaken to bring a relatively stable social context to the daily work event perspective on work stress that usually stays at the level of the individual and the day.

We found support for the multilevel model. First, we found support for the notion that daily undesirable work events are correctly specified as fluctuating from day-to-day within individuals. To assess the amount of within-and between-person stability/instability in undesirable morning work events we used the MLM analysis to estimate a model with undesirable morning work events as the outcome and an error term for the intercept. The intercept for this model indicated that, on average, workers experienced two undesirable morning work events a day ( $B_0 = 2.31, SE = .24, p < .001$ ). The variance component for the intercept ( $U_0 = 1.38, SD = 1.17, \chi^2 = 200.72, df = 27, p < .001$ ) was smaller than the variance component for the within-person error term ( $R = 3.50, SD = 1.87$ ), therefore 82% of the variance in undesirable morning work events was within people, indicating considerable instability day-to-day despite permanent control/demand work structures.



**Figure 3.** Moderating effect of job strain (control/demand) on the within-person undesirable morning work events-midday pain associations. L = low; H = high; C = control; D = demand.

Second, in this sample of workers with RA, undesirable morning work events and midday mood independently predicted changes in pain over the morning, and the associations varied as a function of job characteristics thought to result in chronic strain. Specifically, the effect of undesirable work events emerged only under conditions of job strain as proposed by Karasek (1979). For workers with high demand and low control jobs (high strain), pain at midday was higher on days when they encountered more undesirable work events in the morning, irrespective of any predisposition to be more reactive to events due to neuroticism or to negative mood at midday. The contrast to workers in lower "strain" situations is clearly seen in Figure 3. Some workers even appear to have had a protective effect from their work in that those with high control and high demand jobs (Karasek and Thoerell's (1990) "active" jobs, thought to be "without negative psychological strain") showed a reduction in pain by midday, even on days with more negative events. The lack of pain reactivity for those with high levels of neuroticism is consistent with other RA studies, where neuroticism has not moderated the relationship between disease activity and symptom reports (Smith, Wallston, & Dwyer, 1995), undesirable daily events and daily pain (Affleck *et al.*, 1994) or workplace stressors and weekly arthritis symptoms (Potter *et al.*, 2002). While neuroticism may well moderate the relationship between daily events and mood (Bolger & Zuckerman, 1995), it does not appear to moderate the relationship between undesirable events and pain in RA patients.

In addition, while not predicted, we found that participants in low control and low demand jobs showed the strongest within-person associations between pre-work pain and midday pain. That is, on high pre-work pain days, workers in Karasek and Theorell's (1990) "passive job" category were more likely to have high midday pain compared to people in other work situations (Figure 2). Furthermore, individuals in high control and low demand ("low strain") situations appear to have the weakest association between pre-work pain and midday pain. This suggests that being able to experience greater control and fewer demands than workers in the average situation provides a mechanism through which the perception of pain is reduced. In contrast, workers in low control, low demand work, are not afforded that protection.

This study also demonstrates the utility of multi-level research designs. The within-person association between pain recorded before work and pain recorded at midday is notably different from the between-person aggregate association, which approached a perfect correlation. Specifically, pre-work pain only accounted for 47% of the within-person variance in midday pain compared to the 97% shared variance at the aggregate level. These differences in patterns of association highlight the importance of separating levels of analysis, and not assuming that what holds at the between-person level will be true at the within-person level of analysis. Similarly, very little about work (neither demands, control, nor undesirable daily events) was associated with pain at the aggregate level (between-person), where undesirable work events during the morning were not correlated with either pre-work, nor midday pain reports at midday. However, within-person analyses revealed the association between undesirable morning work events, pain and negative mood during the workday. Thus, this multilevel stress/strain model adds importantly to the work of Grebner *et al.* (2004), who recently showed that chronic conditions set the stage for greater reactivity to stressful encounters on the daily level among young workers without chronic disease. As they point out, the Karasek job strain model may be highly relevant for explaining worse outcomes from situational or daily stressors, whereas it has had mixed success in predicting chronic stress outcomes (Marmot *et al.*, 2002). These analyses also add to the literature on job strain showing that while the characteristics of work may



be rather stable and unchanging, the effect on the health of the individual worker may fluctuate from day-to-day, based on the events of the day.

Although the relatively low statistical power in this study failed to detect additional moderating effects of the within-person associations, our sample size (20 person-days within 27 participants) comes close to Kreft's (1996) recommendation of a sample with at least 30 participants and at least 30 observations per participant. In a simulation study, Maas and Hox (2002) found that within-person estimates (level 1) and fixed between-person estimates (level 2) are unbiased with 30 participants, but that significance tests of un-fixed between-person coefficients (such as demand and control) are biased (9% fall outside the confidence interval of the true coefficient). Further research with a minimum of 30 study participants is necessary to increase confidence that the null findings in this sample are accurate, and this study must therefore be regarded as exploratory.

These findings, and recent modifications to the measurement of job strain, raise questions that must be addressed before new models or interventions can be developed. First, it is not clear just how the control and demand in a job contribute to the response of workers to undesirable events. For instance, having challenging, stimulating work and having control over one's pace, schedule, and activities may give one a feeling of control over the events that occur, as Karasek and Theorell (1990) suggest, or it may offer real options for action that help to neutralize the effect of a negative event. Workers in structural locations that offer such control may also be individuals who happen to possess a personal sense of control irrespective of their social location (see Tennen *et al.*, 1992 for a review of this literature). The effort-reward imbalance model of chronic work stress may provide insights into some of these issues, as it includes both a structural and a personal dimension (Siegrist, 2002). Future studies should consider using both the job strain and the effort-reward imbalance models to increase our understanding of the mechanisms behind the stress/strain model. Finally, the model may be improved by adopting the reconceptualization of the control dimension of job strain as suggested by Wall *et al.* (1996) to remove the confounding concept of job complexity.

This study explored the associations among events, mood, and pain reports within a day without the benefit of electronic prompt technology to promote and verify adherence to the within-day reporting schedule (Tennen & Affleck, 2002). While participants had in-home orientations to the procedures, received periodic telephone calls to enhance adherence, and were provided with well-marked daily diaries, we cannot be sure that morning reports were actually recorded in the morning and midday reports at midday, although we are confident that the daily reports were reliable. However, it is unlikely that workers in chronic strain situations would systematically record undesirable events, pain and mood reports to reveal the moderating effects found in this analysis. This would require that only these workers systematically "misremembered" their pain to be higher at midday, only on the days when they experienced more negative events. While it is unlikely that this occurred, a future test of the multilevel work stress/strain model should be undertaken with more attention to the prompting and verifiable recording of symptom reports and experienced events.

Although we demonstrated a possible moderating effect for control and demands in paid work on the event-mood relationship within a day, we have used a widely-tested model that views undesirable events as stressors that lead to outcomes such as changes in mood and pain (Affleck *et al.*, 1990, 1994; Crosby, 1988; Mason *et al.*, 1990; Parker *et al.*, 1988; Smith & Zautra, 2002; Zautra *et al.*, 1994). However, we cannot rule out the fact that negative mood states at midday might have enhanced the recall of the morning's negative events (Blaney, 1986; Bower, 1981). Finally, we did not examine how chronic strain

and acute, daily stress work together to affect pain and mood across days. As Affleck *et al.* (1990, 1994) have shown, it is a mistake to abstract one day out of the week, month or life of an individual with a disease like RA that changes from day-to-day. Future studies must examine how both paid and unpaid work events pile up over the week, the month, the year and with what effect on health. Such studies might offer new insights into factors that contribute to flaring up of the condition, work loss and ultimately withdrawal from work.

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