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Examining the effects of perceived social support on momentary mood and symptom reports in asthma and arthritis patients

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Objective: Social support has been linked to beneficial effects on health directly (main effect) and as a buffer to stress. Most research, however, has examined these relationships using global and retrospective assessments of health and stress, which may be subject to recall biases. This study used ambulatory ecological momentary assessment (EMA) methods to test the main and stress-buffering effects of social support on the daily health and well-being of asthma and rheumatoid arthritis (RA) patients.

Design: Community volunteers with asthma ($n = 97$) or RA ($n = 31$) responded to EMA prompts five times daily for one week.

Main outcomes: Baseline perceived social support was obtained, and then, participants reported mood, stress and symptoms using EMA. Multilevel mixed-modelling examined whether social support predicted mood and symptoms directly or via stress-reducing effects.

Results: Supporting a main effect, more perceived social support predicted decreased negative mood and stress severity. Supporting a stress-buffering effect, more perceived social support resulted in fewer reported symptoms when stress was present.

Conclusion: Results suggest perceived social support directly relates to better ambulatory status and dynamically buffers individuals against the negative effects of stressors, and highlight the importance of studying social support across different temporal and contextual levels.

Keywords: arthritis; asthma; ecological momentary assessment; social support; stress

Across numerous empirical examinations, social support has been linked to beneficial effects on health (e.g. Gallant, 2003; Hagedoorn et al., 2000; Hale, Hannum, & Espelage, 2005; Levine et al., 1979; Sin, Kang, & Weaver, 2005; Spitzer, Llabre, Ironson, Gellman, & Schneiderman, 1992). Yet, how social support exerts its salutary effect is complex, with behavioural, developmental and coping pathways proposed (Cohen & Wills, 1985; Uchino, 2009). Two major pathways suggest that social support has either a main effect or stress-buffering effect (e.g. Cohen & Wills, 1985). The main effect model suggests that social support has a direct beneficial effect on mood and

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health, in part because social support provides a sense of stability even in the absence of stress, which may promote positive mood and feelings of well-being (Cohen & Wills, 1985). In contrast, the stress-buffering pathway suggests that social support benefits health indirectly via buffering one from the harmful effects of stress. That is, when faced with a stressful experience, those high in social support have more positive appraisals of the situation and perceive greater coping resources; these processes make the experience less stressful (Cohen & Wills, 1985; Lazarus & Folkman, 1984). Social support may also buffer one from a stress response by reducing inappropriate responses or promoting adaptive health behaviours (Martin & Brantley, 2004). Although there are many aspects of social support (instrumental, emotional, tangible, etc.), evidence points to the particularly positive effect of perceived (vs. structural) aspects (especially as they relate to the stress-buffering pathway; e.g. Barrera, 2000; Cohen & Wills, 1985; Gallant, 2003; Uchino, 2004). The purpose of this paper is to simultaneously test both the main and stress-buffering effects of perceived social support on the health and psychological well-being (i.e. more positive mood, less negative mood) of patients with asthma or rheumatoid arthritis (RA) using ambulatory real-time symptom reporting.

To date, much of the social support research has examined global and/or retrospective assessments of health, such as on the severity of disease status (e.g. Martin & Brantley, 2004) or health-related behaviours (e.g. Gallant, 2003). Although these approaches provide the opportunity to test the main effect pathway, which is largely a between-person question (i.e. do those with more vs. less perceived social support report less disease severity), they are unable to provide a careful test of the stress-buffering pathway, which is largely a within-person question (i.e. does social support attenuate the negative effects of stress on health for an individual on a moment by moment basis). Put another way, the stress-buffering pathway is best tested with repeated prospective data, whether over relatively short or long durations. When a cross-sectional measurement is used to test the stress-buffering pathway, what is being tested is whether between-person differences in levels of stress and symptoms vary as a function of social support. Although a potentially useful question, it does not test whether perceived social support disrupts the coupling between stress and symptoms at a given moment, which is what the stress-buffering hypothesis actually proposes (for discussion of the different applications of between- and within-person models see Molenaar & Campbell, 2009). Thus, the present analysis is one of the first to provide a more stringent naturalistic test of the stress-buffering effects of social support on health and psychological well-being using intensive longitudinal data over a short measurement burst.

Finally, to better capture the range of possible effects of social support, daily positive and negative mood is examined as a measure of subjective well-being in addition to real-time physical symptom reporting. Research suggests that daily mood is influenced by perceived stress and related to health complaints, with independent relationships for both positive and negative mood states (Gil et al., 2004; Watson, 1988). Moreover, work suggests the importance of examining mood as an outcome influenced by stress and social resources (DeLongis, Folkman, & Lazarus, 1988), although other work also suggests that mood may be a predictor of health (Salovey, Rothman, Detweiler, & Steward, 2000). Given that this study examines real-time dynamics, we conceive of momentary mood as largely a consequence of stressful experiences.

Why asthma and RA patients?

We focus on patients with RA and asthma as an existing body of literature has demonstrated a relationship between social support and health in these diseases. For arthritis patients, more social support and social networks have been found to be significantly related to a milder disease progression (i.e. less increase in functional disability) and less pain at follow-up three and five years later (Evers, Kraaimaat, Geene, Jacobs, & Bijlsma, 2003). Also, RA patients high in social support were less likely to decline in performance of home and family activities when stressors regarding their disease were present (Goodenow, Reisine, & Grady, 1990). Turning to asthma, greater social support predicts less incidence of asthma (Loerbroks, Apfelbacher, Bosch, & Stürmer, 2010). Moreover, asthma patients in stressful environments report better health when they perceive high (vs. low) levels of social support (de Ridder, Schreurs, & Kuijer, 2005; dos Santos, dos Santos, Rodrigues, & Barreto, 2012; Kang, Coe, Karaszewski, & McCarthy, 1998).

More broadly, we utilised two patient samples – RA and asthma patients – for the following reasons. First, many chronic diseases are positively affected by social support (Uchino, Cacioppo, & Kiecolt-Glaser, 1996) suggesting that a range of patient populations would be appropriate to sample. RA and asthma represent, physiologically, distinct chronic diseases, thus providing a more heterogeneous, and ultimately more generalisable, sample. Second, symptom presence and severity varies significantly within individuals over time for both RA and asthma patients (e.g. pain and/or fatigue for RA patients: Schneider et al., 2012; Stone, Broderick, Porter, & Kaell, 1997; lung function and/or wheezing for asthma patients: Smyth, Soefer, Hurewitz, Kliment, & Stone, 1999). In addition, for both patient and non-patient samples, mood states also vary significantly throughout the day (e.g. Murray, Allen, & Trinder, 2002; Stone, Smyth, Pickering, & Schwartz, 1996), with momentary mood related to health complaints (e.g. Watson, 1988). Thus, RA and asthma patients are optimal samples to test the main and stress-buffering effects of social support on within-person experiences assessed in daily life.

Why global perceived social support?

We focus on the role that global levels of perceived support have on daily health outcomes, as opposed to other aspects of social support. One rationale for focusing on global perceived social support is that we view this as a likely target for intervention. That is, helping a person to be aware of their potential resources when deciding how to cope with stress may be a preferable strategy than, for example, prescribing individuals to seek the (emotional or instrumental) support of others every time they are stressed. Our focus on perceived support is further driven by the expectation that perceptions of social support may be critical to shaping immediate responses to stressors, and thus individuals' momentary mood and symptom variability (e.g. moderating stress responses by increasing perceived coping resources). As such, our research is theoretically informed by, and contributes to current conceptualisations of, Lazarus and Folkman's (1984) seminal work on primary and secondary stress appraisal. Briefly, primary appraisals concern whether an experience or stimulus in the environment is labelled as stressful. Secondary appraisals are concerned with how 'stressful' the stressor is, or rather, whether one has the capacity or perceived resources to respond to the stressor.

In this way, perceived social support is likely to function as a perceived resource available that in turn impacts how stressful a stressor is appraised. In other words, the stress-buffering pathway of social support observed in the moment can be seen as an extension of a secondary appraisal process.

The present study

Research suggests that social support may influence health-related outcomes in asthma and arthritis patients both directly (e.g. overall health) and as a buffer to stress (e.g. less reactivity in response to stressors). Although real-time assessments of symptom reporting have become more common (and some are related to social support; e.g. de Ridder et al., 2005; Spitzer et al., 1992), we are unaware of any research examining whether global perceptions of social support influence *momentary* indices of health. We draw a contrast between ecological momentary assessment (EMA) studies and studies using end-of-day reports or related daily diary methods, of which many have examined the relationship between social support, stress and health (e.g. DeLongis et al., 1988). Such studies, although valuable in their own right, do not readily tap the dynamic within-day processes proposed to be affected by social support. That is, diary studies as less apt to assess whether general beliefs and perceptions about being cared for, valued, included, etc. influence the daily experiences that shape *momentary* well-being (e.g. mood states) and disease states (e.g. symptoms). Furthermore, the buffering role of social support can best be examined when the individual experiences a stressful event. Thus, the examination of these two pathways should be assessed via ecologically valid, momentary methods (i.e. providing within-person moments of both stress and non-stress), as it can be difficult to get accurate retrospections of dynamic momentary processes. When research relies on retrospective reports of health and/or stress, it may be subject to recall biases, such as participants over-estimating the number of symptoms experienced (Houtveen & Oei, 2007). These biases may arise because retrospective reports may tap more into global semantic judgments and beliefs rather than actual dynamic experiences (e.g. Robinson & Clore, 2002a, 2002b; Smyth & Stone, 2003). Thus, a data capture approach that provides more fine-grained information using limited recall intervals may help elucidate the pathways by which perceived social support impacts health and well-being in the dynamic flow of daily life (see Smyth & Heron, 2012; Smyth & Stone, 2003).

One strategy that facilitates this measurement precision is EMA. EMA allows the examination of repeated measures in real-time, measuring psychological and physiological processes as they occur within the natural environment. This allows researchers the opportunity to assess events and/or perceptions closer to their real-life occurrence, thus reducing biases associated with longer-term recall (Smyth & Heron, 2012). EMA has been used to study asthma and arthritis, with a particular focus on stress and mood (e.g. Affleck et al., 1999; Affleck et al., 2000; Smyth et al., 1999; Smyth, Litcher, Hurewitz, & Stone, 2001). To our knowledge, this is the first study to examine the influence of global perceived social support on momentary (real-time) reports of symptoms, mood and functioning in asthma and arthritis patients.

Hypotheses

Support for the main effect pathway would be obtained whether individuals higher in perceived social support demonstrate better health in daily life, regardless of reported stress levels. We predicted that those higher in perceived social support would report more positive mood, less negative mood, less interference and restrictions from their illness in daily life (across all measurements, regardless of stressor presence) and fewer disease symptoms (for both asthma and arthritis). Support for the stress-buffering pathway would be evidenced by the benefit of social support being observed when stressful experiences occur. We predicted that when a stressful experience was reported, those higher in perceived social support would report less negative mood, more positive mood, less interference and restriction in daily routines, and less symptom severity than those lower in social support. In contrast, during non-stressful conditions, those low and high in perceived social support would report similar health and mood states. (It is important to note that the main effect and buffering hypotheses are not opposing views; rather, support for neither, either or both pathways may be observed.)

Method

Participants

The study was approved by all relevant institutional review boards. The sample consisted of 128 community volunteers with a physician verified diagnosis of either asthma ($n = 97$) or RA ($n = 31$). Sample characteristics can be found in Table 1.

Procedure

Individuals diagnosed with asthma or RA were recruited via print media (e.g. flyers), television and radio advertisements for a study examining how daily experiences relate

Table 1. Ethnic and gender composition of the sample and disease groups, with means and standard deviations of affect, physical limitations and disease-specific symptoms.

	Entire sample ($n = 128$)	Asthma ($n = 97$)	RA ($n = 31$)
Ethnicity			
Caucasian	84%	85%	87%
African-American	9%	8%	10%
Other	7%	7%	3%
Gender (Female)	73%	72%	74%
Age, M (SD)	44.16 (14.20)	42.28 (14.09)	50.03 (13.08)
	M (SD)	M (SD)	M (SD)
Stress experiences	0.22 (0.16)	0.22 (0.16)	0.22 (0.14)
Severity of stress	0.72 (0.55)	0.72 (0.58)	0.71 (0.43)
Positive affect	10.94 (3.47)	11.27 (3.69)	9.98 (2.66)
Negative affect	5.23 (3.85)	5.45 (4.14)	4.62 (2.94)
Physical limitations	1.36 (1.24)	1.15 (1.09)	2.16 (1.32)
Coughing/wheezing	—	1.38 (1.03)	—
Peak flow	—	346.07 (102.37)	—
RA severity	—	—	2.34 (1.31)

to the health and well-being of persons diagnosed with chronic illness. Interested individuals were encouraged to call the research office, at which time a trained staff member assessed eligibility. Participants were ineligible if they were not 18 years of age, did not have a clinically verified diagnosis of asthma or RA, reported receiving emergency room treatment (other than minor injury) in the previous 3 months, reported current drug or alcohol abuse problems or received a diagnosis of a mental illness within the prior 3 months. Eligible and interested participants were scheduled for an initial training session at an off-campus community research office and provided informed consent for participation. From baseline assessment to the termination of EMA utilisation, the duration of the study lasted 8 days (the day of baseline measurement and EMA training, followed by one week of EMA). These data were obtained during a baseline assessment period at the start of a larger longitudinal study (not discussed in this report).

Baseline measures

Following informed consent, participants were trained on how to use the palmtop computer. Participants completed several questionnaires that evaluated a variety of psychological, social and disease-related factors (these measures were not utilised for this report; more information is available from the first author). In addition, for patients with asthma, participants were trained on how to use the peak flow metre. A peak flow metre assesses a person's maximum ('peak') expiratory flow rate (the amount and rate of air as it is forcefully expelled from the lungs), which is a measure of lung function and asthma symptom severity as peak flow decreases when airways are obstructed.

A global measure of perceived social support, as assessed by the Social Support Appraisals Scale (SS-A; Vaux et al., 1986), was administered within a larger package of surveys during an initial visit. The scale consists of 23 items assessing the extent to which individuals believe themselves to be loved by, esteemed by and involved with family and friends (focusing on more emotional aspects of support). Participants indicated their level of agreement with various statements on a scale ranging from 1 (*strongly agree*) to 4 (*strongly disagree*). Some examples are 'I feel valued by other people', and 'My family cares for me very much'. A total scale score (SS-A Total) and two subscales (SS-A Family and SS-A Friends) can be computed; due to a high inter-scale correlation ($r = .48$), however, only the total score was used in the present analysis (Cronbach's $\alpha = .93$).

EMA measures

Using provided palmtop computers (Pilot m105, Palm, Sunnyvale, California) with custom software to collect EMA data (developed using Satellite Forms 6.0, Thacker Network Technologies Inc., Lacombe, Alberta), participants reported momentary experiences following a signal-contingent design (i.e. when notified by a schedule of beeps) five times a day for one week. Signals were based on a stratified interval, such that the total sampling time (8:00 am to 9:00 pm) was divided by the number of beeps (five) and one signal beep was randomly located within each interval to ensure sampling throughout each day (see Smyth & Heron, 2012). When prompted, participants completed surveys assessing mood, activities, location, interaction with others, stressful occurrences, symptom interference/restrictions, disease-specific symptom severity, peak

flow ratings (patients with asthma), use of medication and consumption of caffeine, alcohol and tobacco. This report uses only the measures of mood, stressful occurrences, symptom interference/restrictions and diagnosis-specific symptom severity.

Stressful experiences

Both recently experienced stress and stressor severity were reported. The occurrence of stress was assessed by the following question, 'Since the last beep, has anything stressful occurred?' ('0' for no and '1' for yes). Participants then recorded how stressful it was on a scale from 0 (*not at all*) to 6 (*extremely*). This approach has been used successfully in previous studies (e.g. Smyth et al., 1998, 2007) and has previously demonstrated validity (e.g. in relating reports of stress obtained with this method to cortisol levels; Smyth et al., 1998).

Positive and negative mood

Levels of mood were assessed by rating nine adjectives (4 reflecting positive mood and 5 reflecting negative mood) derived from the Positive and Negative Affect Schedule (Watson, Clark & Tellegen, 1988). On a seven-point rating scale ranging from 0 (*not at all*) to 6 (*extremely*), participants rated their current mood using the following adjectives: happy, depressed, joyful, unhappy, enjoyment, angry, frustrated, pleased and worried. Given the multilevel nature of the data, to test for internal consistency, we employed procedures described in Wilhelm and Schoebi (2007). This involved specifying a three-level multilevel model (i.e. items for the proposed subscale, such as positive mood items, nested within measurement occasions, nested within individuals) and calculating the proportion of latent to total variation for the level of interest, in this case the measurement occasion level. The positive (.90) and negative (.78) mood subscales showed acceptable internal consistency; values can be interpreted similarly to a Cronbach's alpha.

Physical limitations and disease-specific symptom reporting

Symptom interference and activity restrictions were reported at each beep. All participants answered the following questions (with only the appropriate disease classification indicated) scaled from 0 (*not at all*) to 6 (*extremely*): 'How much did your [asthma or arthritis] interfere with your daily routine since the last beep?' and 'How much did your [asthma or arthritis] force you to restrict activities since the last beep?' These 2 items were highly correlated ($r = .95$, $p < .001$) and were averaged to create a measure of physical limitations (the two items demonstrated acceptable internal consistency at the measurement occasion level, .82.).

Each participant also answered disease-specific questions. Participants with asthma answered reported symptoms (i.e. 'How bad was your coughing/wheezing since last beep?') on a scale from 0 (*not at all*) to 6 (*extremely*), as well as measured and recorded peak flow ratings by blowing into a peak flow metre three times at each EMA report (the highest value was used to represent each sampling moment.).

Patients with RA answered the following questions: 'Rate severity of stiffness as you were beeped'; 'Rate severity of pain as you were beeped'; 'Rate severity of joint

tenderness/swelling as you were beeped' on a scale from 0 (*not at all*) to 6 (*extremely*). These items were averaged together to form a composite index of momentary RA symptom severity (the three items demonstrated acceptable internal consistency at the measurement occasion level, .72.).

Data analyses

We performed two sets of analyses with multilevel models using PROC MIXED in SAS v.9.2 to test the main effect and stress-buffering hypotheses. First, for the main effect model, we examined whether social support (Level 2) predicted mood and symptoms (Level 1). This model tests whether greater levels of perceived social support are related to better overall mood and/or fewer overall symptoms (between individuals, and regardless of the presence of a stressor). Second, for the stress-buffering model, perceived social support (Level 2), momentary stress (Level 1) and their interaction were entered as predictors, and mood and symptoms (Level 1) as outcomes. Thus, this model tests whether between-person differences in social support moderate the within-person associations between stress and mood and symptoms. Social support, mood and health were analysed as continuous variables; stress was a binary predictor. For all models, social support was grand mean centred.

All modelling decisions were informed by Snijders and Bosker (1999). In general, multilevel approaches are robust to missing data and are recommended for EMA data. Although the data were collected over time, the days and specific time periods were not consistent across participants. Thus, the error variance-covariance matrix is not expected to fit a typical autoregressive matrix as would be expected if time points were consistent across participants. Also, there are no hypotheses specific to patterns of effects across time (e.g. accumulation effects). Thus, all analyses allowed for an unstructured error covariance matrix.

Only random intercepts (but not slopes) were observed in preliminary analyses for all DVs (Level 1). Thus, random intercepts were specified to account for individual differences in overall mood and symptom reporting when examining relationships with perceived social support. All participants were included in the analyses of non-disease-specific outcomes (i.e. stress experiences, mood and physical limitations). Only asthma participants were included in the analyses for coughing/wheezing and peak flow. Only RA participants were used in analyses on the symptom composite including pain, stiffness and swelling (i.e. RA symptom severity). Effect size information is provided as percent of variance explained at Level 2 (for main effects) or Level 1 (for stress-buffering model tests).

As expected, the mean age for patients varied systematically by diagnosis (42.28 years for asthma patients; 50.03 years for RA patients; $p < .01$). Importantly, age was not directly related either to social support ($r = .04$, $p = .64$) or symptom reports (all p 's $> .05$). Because age was unrelated to both the predictor and outcomes in our models, we did not include age as a control variable in reported analyses (we did examine analyses conducted with age as a covariate but there was no impact on the observed results.). Asthma and RA patients did not differ significantly on education, $t(126) = .38$, $p = .71$; income, $t(121) = -.66$, $p = .51$; Satterthwaite correction, $t(99.7) = -1.15$, $p = .25$; ethnicity, $\chi^2(1) = .13$, $p = .73$, $\phi = .03$; or gender, $\chi^2(1) = .05$, $p = .82$, $\phi = .02$. RA participants reported significantly more physical limitations than asthma patients,

$t(3519) = 4.53, p < .001$, but did not significantly differ on positive or negative mood. As noted below, none of the hypothesised relationships differed by disease type. Descriptive statistics for the entire and disease-specific samples can be found in Table 1.

Results

In preliminary analyses, we examined whether disease type (asthma vs. RA) moderated the main and stress-buffering effects of social support on outcomes (i.e. positive and negative mood and physical limitations). The role of social support in reported positive mood, negative mood and physical limitations did not differ between asthma and RA patients (i.e. no significant interactions between social support and disease type in either the main effect or stress-buffering models). As a result, we collapse across disease type for analyses reported below. In addition, we explored whether results differed across gender. Gender was not related to any outcome variables and as a result we collapse across participant gender.

Main effect outcomes

The main effect model predicts that social support impacts health regardless of the presence of a stressor. As predicted by the main effect hypothesis, individuals higher in perceived social support reported less negative mood and showed a trend for increased positive mood (see Table 2). Social support was not, however, associated with reports of physical limitations in daily routine (see Table 2). Finally, social support did not predict reported coughing and wheezing (among asthma patients) or RA symptom severity (among RA patients). We also performed supplemental analyses to examine whether there was a main effect of social support on reported stress. Social support was not associated with frequency of stress reports, $b = -.12, SE = .18, t(3474) = -.68, p = .496$ (this analysis used a binary outcome variable and, thus, required an analysis using PROC NLMIXED to specify the binomial distribution for the outcome.). Social support did, however, significantly predict lower reported stress severity, $b = -.42, SE = .20, t(690) = -2.16, p = .031$.

Stress-buffering effects

In order to investigate stress-buffering effects, multilevel models tested whether the relationship between social support and the outcome variables was different when stress was, or was not, experienced. Thus, each model included social support, stress, and the interaction of social support and stress (testing buffering effects) in the prediction of mood and symptoms. For those not experiencing stress in the moment, social support predicted less negative mood and marginally more positive mood and less RA symptom severity. Social support was unrelated to physical limitations, coughing/wheezing and peak flow. For those low on social support, stress had a consistent effect such that, when stress was reported, individuals reported less positive mood, more negative mood, more physical limitations, more coughing and wheezing (among asthma patients) and more RA symptom severity (among RA patients) (see Table 2); momentary stress was unrelated to peak flow among asthma patients. Looking at stress-buffering effects, social

Table 2. Regression analysis summary of social support's influence on positive and negative affect, physical limitations, and disease-specific symptoms in both the main effect and stress-buffering models – unstandardised estimates (standard error).

	Main effect			Stress buffering		
	Social support <i>b</i> (SE)	% of Level 2 variance explained	Social support <i>b</i> (SE)	Stress <i>b</i> (SE)	Social support X stress <i>b</i> (SE)	% of Level 1 variance explained
Positive affect	1.18 ⁺ (0.64)	9.6	1.19 ⁺ (0.63)	-2.87 ^{***} (0.18)	-0.26 (0.38)	5.85
Negative affect	-3.17 ^{***} (0.68)	15.3	-2.97 ^{***} (0.67)	4.39 ^{***} (0.17)	-0.49 (0.35)	15.92
Physical limitations	-0.37 (0.24)	1.3	-0.35 (0.24)	0.20 ^{***} (0.04)	-0.08 (0.07)	0.32
Coughing (Asthma only)	-0.27 (0.23)	<0.1	-0.21 (0.23)	0.21 ^{***} (0.04)	-0.19 [*] (0.08)	1.34
Peak flow (Asthma only)	29.26 (20.81)	5.6	30.10 (20.54)	1.78 (2.85)	-2.79 (2.77)	0.37
RA severity (RA only)	-0.91 ⁺ (0.49)	10.9	-0.86 ⁺ (0.49)	0.24 ^{***} (0.07)	-0.33 [*] (0.15)	0.59

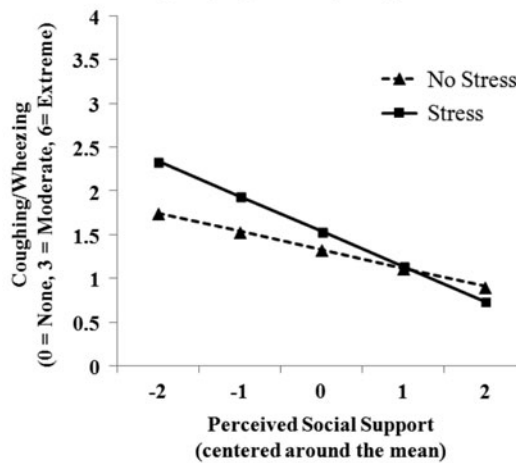
Notes: ⁺ $p < .10$. ^{*} $p < .05$. ^{***} $p < .001$. Main effect refers to main effect of social support predicting each of the dependent outcomes. Unstandardised estimates are provided with standard errors (parentheses) and percent of Level 2 variance explained by the main effect. Stress-buffering refers to the stress*social support interaction predicting each of the dependent variables. The unstandardised estimates are accompanied by standard errors (parentheses) and percent of the Level 1 variance explained by the stress-buffering model.

support did not moderate the relationship between stress and positive mood, negative mood, physical limitations or peak flow. In contrast, stress-buffering effects of social support on coughing and wheezing (asthma patients) and RA symptom severity (RA patients) were observed (Table 2). As predicted, stressful experiences were associated with reports of greater coughing and wheezing for asthma patients with lower levels of perceived social support (Figure 1, Panel 1A); similarly, stressful experiences were associated with greater RA symptom severity for RA patients with lower levels of perceived social support (Figure 1, Panel 1B). Moreover, stress was not related to greater reported symptom severity for patients with asthma or RA reporting high levels of perceived social support.

Exploratory analyses

Although our analytic method removed person level differences in typical/average reports of negative mood, we also tested whether results were being driven by a more global negative reporting bias. All reported analyses were rerun whilst controlling for overall reported negative affect at baseline, but this did not substantially alter our results. Similarly, we reran analyses controlling for overall anxiety at baseline; all results exhibited similar patterns (as reported in Table 2) except for negative affect. When controlling for baseline anxiety, the relationship between social support and negative affect was no longer significant ($b = -.83$, $i = .90$, $t(3411) = -.92$, $p = .357$); however, the predicted social support by

Panel 1A. Predicting Coughing/Wheezing among Asthma Patients



Panel 1B. Predicting RA Symptom Severity among RA Patients

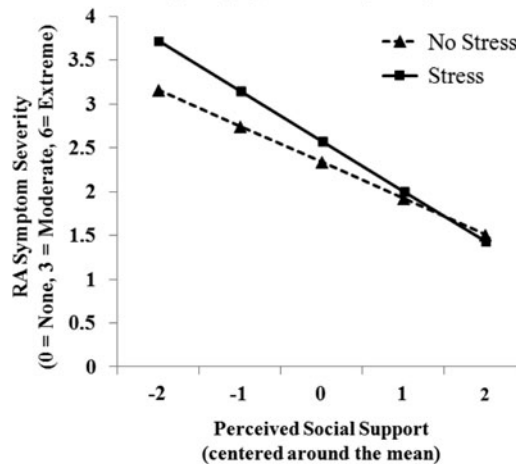


Figure 1. Buffering effects of social support on coughing/wheezing in asthma patients (Panel 1A) and RA symptom severity in arthritis patients (Panel 1B).

stress interaction affect was marginally significant ($b = -.62$, $SE = .36$, $t(3409) = -1.75$, $p = .080$). We also tested a within-day, one-moment lag (i.e. one assessment to the next, within the same day) model, examining whether social support buffered the impact of stress experiences on mood and symptom reports several hours later. Stress experienced at one moment predicted more negative mood ($p < .001$), less positive mood ($p < .001$) and higher reported stress severity ($p < .001$) at the next moment. Stress at one moment, however, did not predict disease-specific symptoms at the next moment. Also, none of the lagged models showed statistically significant buffering effects (all p 's $> .19$). Thus, the social support buffering effects observed in this study were specific to the moment when the stress was reported and did not persist until the subsequent assessment (i.e. the buffering effects dissipated within a few hours).

Discussion

This study investigated the relationship between perceived social support and ‘real-time’ measures in daily life through the use of EMA, testing both the main effect and buffering models of social support. Interestingly, ecologically valid support for some benefit of perceived social support was provided for both models, suggesting that each model has merit for describing social support’s effects on health. This may, however, depend on the type of outcomes under examination. As we discuss below, these results provide preliminary evidence that social support may have clearer direct effects on psychological states (e.g. mood) and greater stress-buffering effects on disease states (e.g. symptoms) when assessed in daily life. More broadly, these results suggest the importance of measuring the effects of social support at both between- and within-person levels in order to better understand its effects on health and well-being.

Main effect model

Social support was significantly related to less negative mood and (marginally) more positive mood. Based on these and other findings, future work may consider examining mood as a mediator between social support and health outcomes. Prior research has provided evidence for the relationship between social support and mood, such that mood may improve as a result of social support (e.g. Janisse, Nedd, Escamilla, & Nies, 2004). In addition, mood (Affleck et al., 1999, 2000) and psychological functioning (Aspinwall & Tedeschi, 2010) have been implicated in health-related outcomes. Mood states have been shown to predict asthmatic symptoms, and negative mood has been identified as exacerbating asthma-related outcomes through increased self-rumination (Affleck et al., 2000). The link between social support and health may be explained in part by the decrease in negative mood and/or increase in positive mood provided by perceptions of social support (Berkman, Glass, Brissette, & Seeman, 2000; Uchino, 2004), although a recent review found little existing support for this view (Uchino, Bowen, Carlisle, & Birmingham, 2012). The continued use of momentary (within person) approaches may help to clarify this issue.

We found relatively little support for a main effect of perceived social support on disease-related symptoms. The only significant main effect, higher perceived social support related to less joint problems among RA patients, was qualified by a trend towards a significant interaction with stress. Although previous work has found evidence of main effects of social support on health, such work has utilised very different designs. For instance, RA patients with more social support had fewer symptoms at 3- and 5-year follow-ups (Evers et al., 2003). The main effect model may not reflect social support’s effect on symptoms on a within-day basis, which may be more suitably tested using within-person data and analyses (i.e. how does more or less social support influence symptom experiences in the moment). The longer-term health effects of these momentary relationships likely play out over time and may be mediated via different behavioural and/or physiologic pathways (e.g. Evers et al., 2003).

Stress-buffering model and symptom reporting

We did not find support for the stress-buffering model for mood outcomes. This was surprising as mood was conceived as a more dynamic variable than symptom assess-

ment, and thus perhaps more susceptible to environmental changes (e.g. stress). This null finding does not appear to simply reflect poor measurement – our stress assessments were strongly predictive of all momentary outcomes in expected directions (i.e. momentary stress predicted significantly more negative mood, less positive mood and more disease-specific symptoms), thus increasing our confidence that we accurately assessed stress and mood using our momentary reports and have appropriately measured data to test for moderation by social support.

There was some support for a stress-buffering pathway in the disease-specific symptom reporting. Our results indicated an attenuation of the relationship between stress and exacerbations of symptoms during daily life for those high in social support. Among all patients those low in social support reported greater disease-related symptoms when a stressor was present. In contrast, for patients higher in social support, stress was not related to increased symptom severity (i.e. social support appeared to buffer them from the deleterious effects of stress on somatic complaints). These results are consistent with prior work suggesting social support enhances physical functioning by alleviating stress in patients with arthritis (Goodenow et al., 1990) and relating to better immune functioning among asthmatics during times of stress compared to non-stressed periods (Kang et al., 1998). Finally, it was initially predicted that social support would be unrelated to outcomes when stress was not present. This was what was found for asthma symptoms, although there appeared to be some general benefit (a marginal main effect) of perceived social support on RA symptom severity. Yet, a significant interaction suggested that, as predicted, social support was especially beneficial for RA patients at moments when stress was experienced.

Implications

Prior work indicates that perceived social support is beneficial for various psychological and physical outcomes, yet this work has largely demonstrated this benefit in a between-person fashion (that is, those individuals with more support are those individuals who also have better health/well-being outcomes). The present study was the first of its kind to demonstrate the positive effects of global levels of perceived social support on within-person momentary health and well-being. In other words, this study tested the effect of person (i.e. trait social support, between persons) by context (i.e. presence of stress, within person) interactions, finding that social support buffers symptom reporting especially when stress is present. Such a mixed level analysis can be conceived of as a stringent test of the buffering hypothesis, and one that pushes the boundaries of what can be assessed with a fully between-person analysis (e.g. when measures of stress or social support are one time survey assessments). The between-person analyses can indicate how relative levels of social support and stress relate to relative levels of health across individuals, but they are less suited to test what happens in the moment when a person high in social support (vs. one low in social support) experiences a stressor. Put another way, the between-person analyses can reveal general patterns across stress, social support and health, but the mixed method approach that EMA affords allows the researcher to begin to examine the mechanistic effects of social support on stress and daily health.

As such, these within-person results suggest that altering patient's social support may be a mechanism of action for improved health, and more broadly that perceived

social support could be a valuable component in the assessment and treatment of chronic illness. Those patients reporting low perceived social support appear at risk for worse ambulatory well-being and may be differentially sensitive to the negative effects of stress. This may in turn have implications for ongoing self-care, social interactions and other disease processes in a dynamic and recursive fashion. Interventions targeted at improving perceptions of, and actual, social support, as well as those aimed at stress management, may be useful adjuvant care for patients with chronic illness.

Finally, our results also have implications for understanding how social support functions as a resource via appraisal theory (Lazarus & Folkman, 1984). Simply, primary appraisals concern whether an experience or stimulus in the environment is labelled as stressful, whereas secondary appraisals are concerned with if one has sufficient resources to respond to the stressor (leading to a judgment of how 'stressful' the stressor is). Social support did not strongly impact the frequency of stressors but rather influenced the reported severity perceptions of stressors. Moreover, social support exerted its positive (stress-buffering) effects on symptom reports primarily in times of need (i.e. when stressors were present). Thus, social support seems to most clearly function as a secondary appraisal resource for mood effects, and the stress-buffering results further suggest that global perceptions of social support may largely operate through a secondary appraisal process to improve momentary health outcomes. Given that coping resources impact the influence of stress (Schneiderman, Ironson, & Siegel, 2005), it may be important to implement interventions on helping patients be aware of available resources, such as social support. This is also consistent with our view that intervention delivery can be dynamically tailored to moments of stress (or other risk factors); in this case, providing or enhancing perceptions of 'micro' support (in the moment) may be a useful intervention in the management and/or prevention of stress (e.g. Heron & Smyth, 2010; Smyth & Heron, 2012).

Limitations and future directions

Although we prospectively measured social support prior to measuring mood and symptoms with EMA, the association between stress, mood and disease-related symptoms is one of co-occurrence. Thus, the direction of the relationships found between stress and symptom reporting (as moderated by social support) cannot be confidently determined. That is, an alternative explanation to our findings (although one we view as less plausible) is that the perception and report of symptoms leads to increased stress and perceived social support moderates this relationship. More broadly, we examined only a small longitudinal slice of presumed dynamic processes. Future work is needed to examine, over a longer period of time, how these different parameters might recursively influence each other over time.

The current study used global perceptions of social support in predicting momentary health-related outcomes (particularly in response to changing environmental stressors). We recognise that other aspects of social support (e.g. instrumental support) are important for study and may have differing effects depending on the form it takes. For example, workplace social support has been generally found to reduce job strain, but support that results in a person focusing on how stressful the workplace is has been related to increased workplace strain (Beehr, Bowling, & Bennett, 2010). Thus, the results of the

current study may not hold across all contexts, and may be strengthened, weakened, or even reversed depending on which aspects of social support are assessed. In particular, examining the ‘match’ or ‘fit’ between provided/obtained instrumental support and environmental/personal need may prove promising. Unfortunately, instrumental support is difficult to study using momentary approaches as the dynamics of daily life within persons, and differences between persons make for serious measurement problems. Some limited attempts can be made (e.g. to have people report back on some prior stressor as to what instrumental support was provided, by whom, and to what degree such support was helpful), but these reports become highly reliant on participant retrospective recall and are also nearly impossible to verify. As such, we feel that this important issue is best studied with different methodologies.

Finally, some aspects of our sample may limit generalisability to the general population. For example, we measured two chronic disease types, asthma and RA. Although we found no differences in how social support related to positive and negative mood and physical limitations among these two disease groups, it is unclear whether such finding would extend to other chronic diseases. Approximately three quarters of our sample consisted of female participants. Some research suggests that although both women and men benefit from social support, these benefits are greater for men than women (e.g. Monin & Clark, 2011; Orth-Gomér, 2009); if true, our results may reflect conservative estimates. Future research would benefit by examining the impact of social support on momentary health for a broader range of diseases and demographics.

Overall conclusion

The current study related global reports of perceived social support to ecologically valid measures of ambulatory mood and disease states in the daily lives of patients with chronic illness. Specifically, this study demonstrated that global perceptions of social support are predictive of better ambulatory psychological well-being in general (i.e. regardless of stress levels), as well as in reducing the magnitude of the negative relationship between stress and disease-specific symptoms in individuals diagnosed with asthma and arthritis. The results of this study thus provide naturalist and ambulatory evidence in patients with chronic illness linking global perceived social support to health via both direct and buffering pathways.

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