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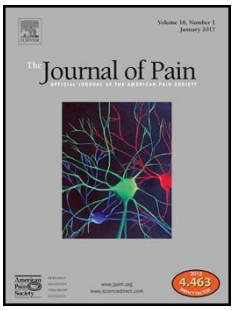

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Author: Mari Glette, Tormod Landmark, Mark P. Jensen, Astrid Woodhouse, Stephen Butler, Petter C. Borchgrevink, Tore C. Stiles

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Catastrophizing, solicitous responses from significant others and function in individuals with neuropathic pain, osteoarthritis or spinal pain in the general population

Mari Glette[1,2*], Tormod Landmark[2,3], Mark P. Jensen[4], Astrid Woodhouse[1,2], Stephen Butler[2,5,6], Petter C. Borchgrevink[1,2] & Tore C. Stiles[2,3]

[1]Department of Circulation and Medical Imaging, Norwegian University of Science and Technology, Trondheim, Norway, [2]National Competence Centre for Complex Symptom Disorders, St. Olav's University Hospital, Trondheim, Norway, [3]Department of Psychology, Norwegian University of Science and Technology, Trondheim, Norway, [4]Department of Rehabilitation Medicine, University of Washington, Seattle, USA, [5] Pain Center, University Hospital of Uppsala, Sweden, [6] Department of Public Health and Caring Sciences, Uppsala University, Sweden

*Corresponding author:

Mari Glette

E-mail: mari.glette@ntnu.no

Phone: +47 48034194

Address: Department of Circulation and Medical Imaging, Faculty of Medicine, NTNU, P.O. Box 8905 MTFS, 7491 Trondheim, Norway

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Disclosures

The Nord-Trøndelag Health Study (The HUNT Study) is a collaboration between HUNT Research Centre (Faculty of Medicine, Norwegian University of Science and Technology, NTNU), Nord-Trøndelag County Council, Central Norway Health Authority, and the Norwegian Institute of Public Health. The HUNT pain study was funded by the Research Council of Norway. This current study was funded by the Liaison Committee between the Central Norway Regional Health Authority and NTNU (Grant number: 46056914). The authors declare no conflict of interest.

Highlights

- Pain catastrophizing is associated with less psychological and physical function
- Solicitous responding to pain is associated with less insomnia severity
- A neuropathic pain diagnosis is associated with higher levels of insomnia severity
- Neuropathic or spinal pain is associated with higher levels of psychological distress

Abstract

That certain psychological factors are negatively associated with function in patients with chronic pain is well established. However, few studies have evaluated these factors in individuals with chronic pain from the general population. The aims of this study were to (1) evaluate the unique associations between catastrophizing and perceived solicitous responses and psychological function, physical function and insomnia severity in individuals with neuropathic pain, osteoarthritis or spinal pain in the general population and to (2) determine if diagnosis moderates the associations found. Five-hundred-and-fifty-one individuals from the general population underwent examinations with a physician and physiotherapist, and a total of 334 individuals were diagnosed with either neuropathic pain (n=34), osteoarthritis (n=78) or spinal pain (n=222). Results showed that catastrophizing was significantly associated with reduced psychological and physical function, explaining 24% and 2% of variance respectively, while both catastrophizing and perceived solicitous responding were significantly and uniquely associated with insomnia severity, explaining 8% of the variance. Perceived solicitous responding was significantly negatively associated with insomnia severity. Moderator analyses indicated that (1) the association between catastrophizing and psychological function was greater among individuals with spinal pain and neuropathic pain than those with osteoarthritis and (2) the association between catastrophizing and insomnia was greater among individuals with spinal

pain and osteoarthritis than those with neuropathic pain. No statistically significant interactions including perceived solicitous responses were found. The findings support earlier findings of an association between catastrophizing and function among individuals with chronic pain in the general population, and suggest that diagnosis may serve a moderating role in some of these associations.

Perspective

When examining persons with pain in the general population, catastrophizing is associated with several aspects of function, and diagnosis serves as a moderator for these associations. The replication of these associations in the general population support their reliability and generalizability.

Keywords: catastrophizing, solicitous responses, osteoarthritis, spinal pain, neuropathic pain

Chronic pain is a major health problem worldwide [67]. Estimates of prevalence vary from 11% to 64% in the general population, depending on methodology and definitions being used [6, 9, 17], and 30% report moderate pain or more lasting at least six months in the Norwegian population [38]. Common chronic pain conditions are ranked amongst the nine leading specific causes of years lived with disability [71] and have in addition to the physical and emotional burden, engendered large costs for society, caused loss of work capacity and elevated health care use. Chronic pain is often found to be associated with reduced psychological and physical function, and is known to be associated with sleep difficulties. Although reciprocally related, studies have found that as many as between 50% - 88% of persons having chronic pain also report sleep disturbance [20, 60, 61].

Identifying modifiable risk factors that might serve as intervention targets is important. Pain catastrophizing, defined as an exaggerated negative orientation towards pain [63], has been identified as a key target for interventions as it mediates the outcome of physical and cognitive-behavioral treatments in patient populations [25, 58]. It is also consistently found to be associated with physical disability and psychological distress [34, 50]. These findings are robust in mixed populations of chronic pain patients [64, 68] and diverse pain-related conditions (e.g. rheumatoid arthritis [33], fibromyalgia [26, 44], osteoarthritis [32], spinal cord injury [69], phantom limb pain [30] and post-herpetic neuralgia [28]). Although levels of catastrophizing in the general population are generally low, they have been found to be associated with increased specialist consultation and medication use [56]. Further, solicitous responses from significant others (i.e. expressions of support and providing assistance) are another factor that is hypothesized to impact function [21], and have been shown to be associated with increased disability in individuals with chronic pain in patient samples [7, 52]. Recent reviews have emphasized the need for more information on

factors that might moderate associations between perceived solicitous responding and different aspects of function [4].

However, the role that catastrophizing and perceived solicitous responding play in adjustment in individuals with chronic pain in the general population is not well-known. This knowledge is important as only a minority of individuals with pain (~2%) receive treatment in pain clinics [10]. Replicating the associations in a large sample of individuals with chronic pain in the general population would increase external validity of previous findings. Also, examining whether diagnosis may moderate the association between catastrophizing and pain-related outcomes is important given the possibility that psychological factors may play a more important role in function among some diagnostic groups than others.

Given these considerations, the primary aim of this study was to evaluate the potential associations among catastrophizing and solicitous responses from significant others with psychological function, physical function and insomnia severity in individuals with neuropathic pain, osteoarthritis and spinal pain in the general population. More specifically, we hypothesized that both catastrophizing and perceived solicitous responding would be significantly and uniquely associated with psychological function, physical function and insomnia severity in the study sample. A second aim was to determine if a diagnosis of neuropathic pain, osteoarthritis or spinal pain would moderate the associations between psychological factors and function. Given the lack of theory and previous research examining this latter study aim, we viewed these moderator analyses as exploratory.

Methods

Study design and procedures

This study is a cross-sectional descriptive study that is part of a larger epidemiological study: the HUNT Study. The HUNT study is an ongoing population based database for medical and health-related research, and all citizens residing in the Nord-Trøndelag county in central Norway are invited to participate. To date, three HUNT studies have been conducted: HUNT 1 (1984–86), HUNT 2 (1995–97), and HUNT 3 (2006–08). The overall participation rates in the studies has been 90%, 70%, and 54%, respectively [37]. In HUNT 3, the response rate was higher among women (59%) than men (50%) and lowest among the youngest age groups (31% for the age group 20 to 29). A nonparticipation analysis has shown that nonparticipants had lower socioeconomic status, higher mortality, and higher prevalence of several chronic diseases, relative to participants, and that participants reported a higher prevalence of musculoskeletal pain, urine incontinence, and headache, relative to nonparticipants [39]

Two months after HUNT 3, a random sample of 6419 participants from two municipalities (Levanger & Verdal) was asked to report pain every year for four years consecutively. This is the HUNT pain study [38]. Participants for the current study were randomly selected from 3407 subjects who had responded to the fourth annual questionnaire of the HUNT pain study. They were invited to undergo a multidisciplinary examination at Levanger Hospital. Examinations were completed during seven cycles of one week between October 2013 and May 2014. To ensure both the inclusion of low prevalent chronic pain diagnoses and population representativeness, participants were randomly selected in two samples. The chronic pain sample included those who had reported pain lasting six months or more and with at least moderate severity on the final HUNT pain study questionnaire. A total of 587 persons from the

chronic pain sample were invited by mail, and 374 responded positively to participate in the clinical examination study. The general population sample was randomly selected participants from the HUNT Pain study. A total of 364 persons from this sample were invited, and 209 responded positively. Of the 583 who responded positively, 26 withdrew before the examination, and four did not come at the scheduled time, resulting in a total of 553 participants. Two participants were excluded from the study. Both of these had a medical condition that made it difficult to complete the examination (cardiac event and aphasia). Altogether, 551 participants completed the examinations, resulting in a participation rate of 58%. The study was approved by the Regional Committees for Medical and Health Research Ethics in mid-Norway (id: 2013/443) and the data Inspectorate as part of HUNT3. All participants provided written informed consent to participate in the study. See Figure 1 for a diagram illustrating the flow of study recruitment.

[Insert Figure 1 here]

Structured interview, physical examination and diagnostic groups

The physical examinations were conducted by both a physician and physiotherapist. Semi-structured interviews and standardized examinations were used to evaluate complaints of neck pain, back pain, upper and lower extremity pain, headache, temporomandibular dysfunction, irritable bowel syndrome, and chronic pain due to an operation among others. This information was used to establish ICD-10 criteria pain diagnoses [77]. When multiple pain problems were reported, the pain-related diagnoses were ranked by severity. Pain intensity and pain duration were assessed for each pain condition.

The study populations used for the current analyses were limited to those who had been diagnosed with either neuropathic pain, osteoarthritis or spinal pain. If a participant had more than one pain problem, they were classified based on what they reported as their main pain

problem. Only pain conditions lasting six months or more were included. The Douleur en Quatre Questions (DN4) [8] was used to screen for neuropathic pain as a component of the pain problem. A subsample of 73 subjects responding positively to the initial DN4 evaluation of signs or symptoms indicating neuropathic pain in the initial examination received an additional examination with two neurologists to confirm whether a neuropathic pain diagnosis was present. After the neurologists' examinations, a total of 34 subjects were diagnosed with a neuropathic pain condition, which was classified as "possible" (n=10), "probable" (n=17), or "definite" (n=7) neuropathic pain based on the Treede et al. (2008) definitions [66]. The physicians who diagnosed osteoarthritis (n=78) had access to hospital records, and this diagnosis had to be confirmed by a history of localized chronic pain and x-ray. Diagnoses in this group were mainly M16.0 coxarthrosis, M17.0 gonarthrosis, and M18.0 arthrosis of the first carpometacarpal joints. Participants were classified as having spinal pain (n=222) if they had a diagnosis of M54.5 low back pain, M53.1 cervicobrachial syndrome (neck and shoulder pain combined) or M54.2 neck pain.

Instruments

Demographic information

Information about demographic characteristics was obtained by a questionnaire administered to the participants prior to the clinical examination. Educational level was classified into three levels based on highest completed education; primary, secondary and tertiary, with primary defined as having at least 10 years of education, secondary as having at least upper secondary school education, including vocational studies (13 years), and tertiary as having a college or university degree [45].

Pain intensity

Pain intensity was assessed via response to the physician's clinical interview question asking: "*How much bodily pain have you had during the past week?"* The question is included in the SF-8 and the SF-36 health surveys, and has evidence supporting its validity as a single item measure of pain intensity [72]. Responses are provided on a 6-point categorical scale (i.e., None, Very mild, Mild, Moderate, Severe, or Very severe). The scale was transformed using standard scoring procedures, providing an average score close to 50 and a standard deviation close to 10 based on US normative data. A higher score indicates less pain intensity.

Psychological function

Psychological function was assessed using the five item version of the Mental Health Inventory (MHI-5) which includes three questions assessing depression and two assessing anxiety symptoms [5]. The questions are included in the Medical Outcomes Study (MOS) 36-item Short Form Survey Instrument (SF-36 [74]), and are published as an independent screening test [5]. The items are scored on a 6-point Likert scale (1 = "*All of the time*" to 6 = "*None of the time*"). A total score is calculated by reversing the third and fifth item and summing the ratings and the score is then transformed to a scale from 0-100 using a standard linear transformation where a higher score indicates better mental health. The MHI-5 is validated as a screening tool for detecting mood disorders [14, 53]. The Norwegian version of the MHI-5 has been validated and has shown good psychometric properties [62]. The Cronbach α for the MHI-5 in the current sample was .81, indicating good reliability.

Physical function

Physical function was assessed using the one-week recall question from the SF-8 health survey [72]. The question asks: "*During the past week, how much did physical health problems limit your usual physical activities (such as walking or climbing stairs)?"* Responses are

provided on a 5-point categorical scale (1 = "*Cannot perform usual physical activities*"; 5 = "*No limitations in performing usual physical activities*"). The scale was transformed using standard scoring procedures, providing an average score close to 50 and a standard deviation close to 10 based on US normative data. A higher score indicates less physical disability [42, 73].

Insomnia severity

Insomnia severity was assessed using the Insomnia Severity Index (ISI), which measures the nature, severity, and impact of sleep difficulties [2]. It consists of seven items that evaluate sleep problems during the past two weeks, and the items are rated on a 5-point Likert scale (0 = "*None*" to 4 = "*Very severe*"). The total score can range from 0 to 28 [46]. The ISI has been validated against both objective (polysomnography) and subjective (clinical interviews and sleep diary data) measures of insomnia for reliability and validity in both clinical and community samples [2, 46]. The Norwegian version has shown good internal consistency and sensitivity for change [49]. The Cronbach α for the ISI in the current sample was .89, indicating good reliability.

Pain catastrophizing

Pain catastrophizing was assessed using the 13-item Pain Catastrophizing Scale (PCS) [63]. The PCS items assess the frequency of three domains of very negative thoughts or feelings about pain: rumination, helplessness and symptom magnification. Each item is rated on a 5-point Likert scale (0 ="*Not at all*" to 4 = "*All the time*"), yielding a score that can range from 0 to 52 [65]. The PCS has shown good internal consistency and discriminant validity [47, 48]. The Norwegian version has been validated in a sample of patients with low back pain [19]. The Cronbach α for the PCS in the current sample was .91, indicating excellent reliability.

Solicitous responses from significant others

Solicitous responses from significant others were assessed using the 6-item subscale from West Haven-Yale Multidimensional Pain Inventory (WHYMPI) – Part II Responses of Significant Others [36]. Each item is rated on a 7-point Likert scale (0 = "*Never*" to 6 = "*Very often*"), where higher scores indicate greater levels of solicitous responses. The solicitous responses subscale has been shown to be positively associated with reported pain behaviors [35] and observed solicitous responses from partners [52]. The total score is divided by the number of items to calculate an average score. The solicitous responses subscale has shown good internal consistency and stability [36, 51]. The Cronbach α for the solicitous responses subscale in the current sample was .80, indicating good reliability.

Statistical analyses

The study variables were first summarized for descriptive purposes using means and standard deviations for continuous variables and frequencies for categorical variables. Then Pearson Product–Moment correlations between the study variables were computed to evaluate their bivariate associations. A coefficient ranging from .10 to < .30 is considered small, .30 to < .50 medium, and .50 to 1.0 large [13].

To test the study hypotheses regarding the associations between catastrophizing and solicitous responses from significant others and psychological function, physical function and insomnia severity symptoms, we performed three multiple linear regression analyses; one for each of the three symptom measures as the criterion variable [75]. Preliminary analyses were first conducted to ensure there was no violation of the assumption of normality, linearity, multicollinearity or homoscedasticity in the study variables. No significant skew (<2.0) or kurtosis (<2.0) were detected. One influential extreme outlier was identified in the neuropathic pain group that had a high score on the insomnia severity scale (i.e., ≥ 3 SD from the mean); this

case was therefore removed prior to final modeling. Visual inspection of the scatter plots of residuals indicated that the assumption of linearity was met with no substantial heteroscedasticity within the data. Further, no substantial multicollinearity was detected, as the variance inflation factor (VIF) did not exceed 1.64 in any of the analyses, which is lower than the recommended maximum values [27]. In order to prevent the possible problem of multicollinearity between independent variables and interaction terms, all independent variables were first centered by subtracting the sample mean from all individual scores [1]. The multiple linear regression analyses were performed in five steps. Age and sex was first entered in step 1 and pain intensity in step 2 to control for the potential confounding role of both the criterion and primary independent variables. In step 3, diagnostic status was entered as two separate variables. The first diagnostic variable was labelled neuropathic pain where a diagnosis of neuropathic pain was coded 1 and a diagnosis of osteoarthritis or spinal pain was coded 0. The second variable was labelled osteoarthritis where a diagnosis of osteoarthritis was coded 1 and a diagnosis of neuropathic pain or spinal pain was coded 0. Those two dichotomized diagnostic variables were entered simultaneously in step 3. To test the first study hypothesis, the centered scores of pain catastrophizing and perceived solicitous responding were entered in step 4. In order to assess the potential moderating effects of diagnostic status four interaction variables were entered simultaneously in step 5. Those were the interaction between neuropathic pain and catastrophizing, between neuropathic pain and perceived solicitous responding, osteoarthritis and catastrophizing and osteoarthritis and perceived solicitous responding. Post-hoc probing was planned for any statistically significant two-way interactions that emerged, using graphic illustrations. The graphs in Figures 2 and 3 show regression lines for the criterion variables (psychological function, physical function and insomnia severity) separately for each pain

diagnosis group. This is a standard way to visualize and understand significant moderation effects [1, 29].

The level of significance for all statistical tests was set at $p < 0.05$, and all analyses were completed using PASW (Version. 22, IBM Corp., Armonk, NY, USA). The f^2 statistic provides an assessment of model fit. It compares the variance of two group means to assess if they are significantly different from one another. In regression, it is used to compare the variance of the mean criterion value as it appears in the model versus the criterion without model adjustments. A statistically significant difference indicates that the regression model was better (then chance) at predicting the true value of the criterion, relative to a model without the primary independent variables added. The size of this effect is represented by the f^2 statistic, with .02 to < .25 indicating a small effect, .25 to < .40 a medium effect, and > .40 a large effect [13].

Missing data: The proportion of missing data was very small (< 1%), except for the ISI (13%), where the missing data were due to the fact that the ISI items were inadvertently left off the questionnaires administered during one week of sampling, thus giving a smaller sample size in the analyses including ISI. In order to prevent additional loss of statistical power, we used an imputation approach to handle missing data where one or two items were missing (<2% of the participants) by imputing the participants' average score based on the responded items.

Results

Descriptive statistics and correlations

The study participants were more likely to be female (63%), than male (37%) and this gender distribution was similar across the diagnostic groups (62%, 62% and 64%, respectively). Participants were most frequently between 45-64 years (48%), and this age distribution was seen in osteoarthritis and spinal pain group, whereas participants with neuropathic pain were more

likely to be 65 years or older. One third of the participants (33%) had completed a higher-level education. The majority (78%) were married or lived with a partner.

[Insert Table 1 about here]

The mean pain intensity score in the study sample was 39.09 (SD 6.05, keeping in mind that a higher score on this measure indicates less pain severity) and the mean scores in the diagnostic groups were all more than one standard deviation lower than that of the US norms [35]. The average physical function score in the sample was 44.54 (SD 7.35), and was at least half a standard deviation lower than the mean compared to the US norm data in all groups [72]. The sample reported an average score of 78.07 on psychological function, 12.32 (SD 8.39) on catastrophizing, 7.62 (SD 5.12) on insomnia severity symptoms and 2.03 (SD 1.3) on the subscale measuring solicitous responses from significant others. Table 2 summarizes the clinical characteristics of the three diagnostic groups.

[Insert Table 2 about here]

The Pearson Product-Moment correlations coefficients among the continuous variables are presented in Table 3. As can be seen, pain intensity showed weak to moderate associations with all criterion variables, that is, psychological function, physical function and insomnia severity, thus showing the importance of controlling for pain intensity in further analyses. Pain catastrophizing showed associations with all measures, including weak associations with physical function and perceived solicitous responding, a moderate association with insomnia severity, and a strong association with psychological function. Insomnia severity showed a moderate association with psychological function and physical function.

[Insert Table 3 about here]

Psychological function

The results of the regression analysis with psychological function as the criterion variable are summarized in Table 4. After controlling for sex, age and pain intensity, pain diagnosis was not associated with psychological function. In the fourth step, after controlling for sex, age, pain intensity and diagnosis, pain catastrophizing and perceived solicitous responding contributed to an additional 24% of the variance in the prediction of psychological function ($F_{7, 312} = 17.11$, $p < .001$, $\Delta R^2 = .24$), which can be considered a medium effect ($f^2 = 0.32$) [13]. Within the block, pain catastrophizing was statistically significant, while perceived solicitous responding was not. The term representing the interaction between a diagnosis of osteoarthritis compared to neuropathic or spinal pain and pain catastrophizing was statistically significant for psychological function ($F_{11, 308} = 12.14$, $p = .027$, $\Delta R^2 = .03$). The interaction effect contributed with additional 3% of the variance, indicating a small effect ($f^2 = 0.03$). An illustration of the interaction effect between osteoarthritis and pain catastrophizing in predicting psychological function is shown in Figure 2. As can be seen in the figure, for participants with neuropathic pain and spinal pain, there was a strong negative association between catastrophizing and psychological function scores (recall that a lower score indicates worse psychological function), while for participants with osteoarthritis, this association was significantly less strong.

[Insert Table 4 and Figure 2 about here]

Physical function

The results of the regression analysis with physical function as the criterion variable are summarized in Table 5. After controlling for sex, age and pain intensity, entering pain diagnosis did not contribute significantly to the model ($F_{5,315} = 15.45$, $p = .112$, $\Delta R^2 = .01$). However, within the block, a diagnosis of osteoarthritis was significantly associated with more physical disability compared to spinal pain and neuropathic pain. In the fourth step, after controlling for

age, sex, pain intensity and diagnosis, pain catastrophizing and perceived solicitous responding contributed with an additional 2% variance in physical function ($F_{7, 313} = 12.24$, $p = .007$, $\Delta R^2 = .02$), which can be considered a small effect ($f^2 = 0.03$) [13]. Within the block, pain catastrophizing was statistically significant, while perceived solicitous responding was not. None of the interaction terms were statistically significant for the prediction of physical function.

[Insert Table 5 about here]

Insomnia severity

The results of the regression analysis with insomnia severity as the criterion variable are summarized in Table 6. After controlling for sex, age and pain intensity, entering pain diagnosis did not contribute significantly to the model in terms of an increase in R^2 ($F_{5,274} = 5.45$, $p = .164$, $\Delta R^2 = .01$). In the fourth step, after controlling for sex, age, pain intensity and diagnosis, pain catastrophizing and perceived solicitous responding contributed to an 8% additional variance in insomnia severity ($F_{5, 274} = 7.85$, $p < .001$, $\Delta R^2 = .08$), which can be considered a small effect ($f^2 = 0.1$) [13]. Within the block, both pain catastrophizing and perceived solicitous responding were statistically significant. While catastrophizing showed a positive association, perceived solicitous responding showed a negative association with insomnia severity, indicating that less perceived solicitous responding from significant others was associated with a higher degree of insomnia severity. The term representing an interaction between a diagnosis of neuropathic pain and pain catastrophizing was significant for insomnia severity ($F_{11,268} = 6.03$, $p = .039$, $\Delta R^2 = .03$). The interaction effect contributed with additional 3% variance, indicating a small effect ($f^2 = 0.03$). An illustration of the interaction effect between neuropathic pain and pain catastrophizing is shown in Figure 3. As can be seen in the figure, there was a strong positive association between catastrophizing and insomnia severity symptoms for participants with

osteoarthritis and spinal pain. For participants with neuropathic pain, there was no association present.

[Insert Table 6 and Figure 3 about here]

Discussion

The first study aim was to test the hypothesis that both catastrophizing and perceived solicitous responding would make significant and unique contributions to measures of function in persons with chronic pain in the general population after controlling for age, sex, pain intensity and pain diagnosis. Partial support was found for this hypothesis, as catastrophizing was strongly associated with all function measures, while perceived solicitous responding was associated with reduced insomnia severity. The association between catastrophizing and pain-related outcomes is a robust finding in patient samples [50], and associations with general health status have been confirmed in persons with pain in the general population [55]. In contrast, perceived solicitous responding has, with the exception of one study examining perceived solicitous responding as a predictor of function in persons with spinal cord injury in the community [69], not yet been studied in persons with pain in the general population.

The predictive value of catastrophizing and solicitous responses together varied from 2% - 24% across different measures of function in this study, the strongest being for psychological function where they explained 24% of the variance, even when controlling for demographic factors and pain intensity. Catastrophizing as a construct originated in theories of depression [3, 18], and it has been proposed as being a component of depressive symptomatology [64]. However, research has confirmed that pain catastrophizing is distinct from depression, given that it has been shown to predict negative pain-related outcomes even after controlling for depression [24, 40].

This finding is in line with earlier studies indicating that the role of catastrophizing is more strongly related to psychological function than other aspects of health, although the predictive value in the current study is somewhat stronger than earlier findings ranging from 8% -18% across different pain types [55]. The current findings add important new knowledge regarding the association of catastrophizing and function in a community sample, by showing that catastrophizing is an even stronger predictor of function outcomes in a sample that is thoroughly assessed using a standardized protocol, and diagnosed with one of three potentially highly disabling chronic pain conditions.

Catastrophizing and perceived solicitous responding together accounted for 8% of variance in insomnia severity across diagnostic groups. However, while catastrophizing was associated with increasing insomnia severity symptoms, perceived solicitous responding was associated with less insomnia symptoms. Catastrophizing's role in sleep difficulties in persons with chronic pain has not gained a large amount of attention, which is surprising taking into account that rumination prior to sleep in general has consistently been associated with sleep disturbance [78]. Some findings suggest that pain catastrophizing and pain-related cognitions are associated with sleep disturbance [11], even after controlling for pain severity ratings and depressive symptoms [59]. Surprisingly, perceived solicitous responses was associated with less insomnia severity symptoms. It is possible that subjects having spouses who provide higher levels of solicitous responses may feel, in some ways, more relaxed ("supported") which could contribute to higher quality sleep. This idea, however, is speculative at this point and in need of replication and empirical confirmation.

The second aim of this study was to determine if a diagnosis of neuropathic pain, osteoarthritis or spinal pain moderates the associations between catastrophizing or perceived

solicitous responding to psychological function, physical function and insomnia severity. The statistically significant interaction effect between a diagnosis of osteoarthritis compared to the other two diagnostic groups and catastrophizing in predicting psychological function indicates that individuals with spinal pain and neuropathic pain exhibit a significantly larger decrease in psychological function (meaning higher levels of anxiety and depression) when the amount of pain catastrophizing increases, compared to those with osteoarthritis. This moderating effect of pain diagnosis suggests that interventions that target catastrophizing to reduce psychological distress are important in all three diagnostic groups, but they may be less important in those with osteoarthritis than those with neuropathic pain or spinal pain, and that more research on psychological functioning in neuropathic pain conditions is warranted.

In the analysis with insomnia severity as the criterion variable, there was a statistically significant interaction effect between a diagnosis of neuropathic pain compared to the other two diagnostic groups and catastrophizing. Post-hoc analyses indicated that participants with neuropathic pain reported higher levels of insomnia severity irrespective of levels of catastrophizing, while the other pain groups exhibit higher levels of insomnia severity as the amount of pain catastrophizing increased. Longitudinal studies suggest that pain exacerbates sleep difficulties, and that more than 50% of persons report sleep difficulties in both chronic low back pain [43] and osteoarthritis samples [76]. Randomized controlled trials of cognitive behavioral interventions (CBT) for co-morbid insomnia and chronic pain found that CBT is effective in mixed chronic pain populations[15, 31, 54], fibromyalgia[16] and osteoarthritis[60, 70]. More research to examine the effect of reducing catastrophizing to treat insomnia, especially in individuals with osteoarthritis and spinal pain, is warranted.

While the current study shows moderating effects of pain diagnosis on catastrophizing and measures of psychological function and insomnia severity, this pattern has not been demonstrated in earlier studies. A major limitation of earlier studies from the general population is the conceptualization of diagnosis only assessing pain site by self-report [55]. Although studies of clinical samples give the opportunity to look at clearly defined groups with high diagnostic specificity, findings in such samples have not indicated moderating effects [57]. Diagnosis has been limited to musculoskeletal pain such as low back pain compared to pain in other areas of the body. We emphasize the use of clearly defined diagnostic groups which take pain etiologies and mechanisms into account to make moderating effects meaningful.

This study has a number of important limitations that should be considered when interpreting the results. As it used a cross-sectional design, causal relationships cannot be inferred from the significant associations found. Results showed that catastrophizing was significantly associated with reduced psychological and physical function, explaining 24% and 8% of variance, which can be considered as medium and small effects, respectively. Both catastrophizing and solicitous responses were significantly associated with insomnia severity, independently of each other, although both of these associations represented small effects. This suggest that although catastrophizing may be an important factor, a large improvement in sleep and physical function would not be expected with less catastrophizing and more social support, while a larger effect of a change in catastrophizing would perhaps emerge on psychological function. Prospective studies do suggest that catastrophizing precedes development of chronic pain rather than the opposite [12, 41, 56], and the current correlational findings are consistent with these results, but do not provide support for causal associations. As stated above, more research is needed to determine the extent to which these associations are causal, as the current study is

cross-sectional. A second limitation is the extensive clinical examinations which were time-consuming and may have affected who accepted an invitation to participate in the study, thus creating a potential selection bias. On the other hand, this design feature must after all be considered a methodological strength since it provided for more confidence in the reliability of the clinical diagnoses of the study participants. A third limitation is that the participants of this study represent 58% of those from the original HUNT pain study which itself had a participation rate of 52%. Thus, the participants can be considered a very selected group, which could further limit the generalizability of the findings. However, research suggests that declines in participation rates of survey studies are not likely to have substantial influence on studies of associations [23]. Still, further research in other populations (e.g., populations of individuals with chronic pain presenting with more impairment, other cultural groups) is needed to determine the generalizability of the current findings. A fourth limitation is that the number of participants in the neuropathic pain group was relatively small which may heighten the risk of type II errors of analyses involving this group, and uneven sample size in groups may affect results when doing moderator analyses [22]. Further, 15% of the participants had more than one pain complaint, making them potentially qualified for more than one group membership. Using stringent criteria to exclude all comorbidity would, however, have made smaller groups for analyses and might not have reflected the actual study population, thus compromising the ecological validity of the study. It remains important to replicate the present findings in studies with larger sample sizes and longitudinal study designs. Lastly, the level of significance for all statistical tests was set at $p < 0.05$. While such an alpha level is appropriate for exploratory tests in order to reduce the risk for type II errors (concluding that a relationship does not exist in the population when in fact it does), lack of alpha control does increase the risk for type I errors (concluding that a relationship

exists in the population when in fact it does not). This provides more support for the importance of replicating the current findings in additional samples.

Despite the study limitations, the findings provide important new information regarding the role that psychological factors have in the prediction of function in individuals with chronic pain from the community. The results replicate the findings of other research showing that pain catastrophizing is more strongly associated with psychological function than other health aspects in the general population [55, 57]. Moreover, this study is the first that we are aware of that assesses perceived solicitous responses from significant others in a sample of individuals with chronic pain in the general population, and adds important information about the moderating role of pain diagnosis on the associations found. This was made possible by the careful diagnosis using a structured protocol which allowed for moderator analyses with high diagnostic specificity. The findings suggest the possibility that reducing catastrophizing in the treatment of psychological distress might be more effective in spinal pain conditions relative to other pain conditions. Research to examine this hypothesis using experimental procedures is warranted. Altogether, this study adds important information regarding the associations of pain catastrophizing and perceived solicitous responding and function in individuals with thoroughly diagnosed chronic pain conditions in the general population.

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Table 1. *Demographic characteristics in neuropathic pain, osteoarthritis and spinal pain.*

Table 2. *Clinical characteristics in neuropathic pain, osteoarthritis and spinal pain.*

Table 3. *Bivariate Pearson correlation coefficients between continuous pain characteristics, psychological and psychosocial variables.*

Table 4. *Results of the regression analysis for psychological function.*

Table 5. *Results of the regression analysis for physical function.*

Table 6. *Results of the regression analysis for insomnia severity symptoms.*

Figure 1. Flow chart illustrating the process of study inclusion.

Figure 2. Illustration of the predicted psychological function scores for individuals with neuropathic pain, osteoarthritis and spinal pain at increasing levels of pain catastrophizing

Figure 3. Illustration of the predicted insomnia severity scores for individuals with neuropathic pain, osteoarthritis and spinal pain at increasing levels of pain catastrophizing

Table 1. *Demographic characteristics in neuropathic pain, osteoarthritis and spinal pain.*

	Pain diagnoses					
	Neuropathic pain (n = 34)		Osteoarthritis (n = 78)		Spinal pain (n =222)	
	n	*(%)*	*n*	*(%)*	*n*	*(%)*
Female gender	21	(62)	48	(62)	142	(64)
Age (years)						
29-44	6	(18)	0	0	17	(8)
45-64	9	(27)	52	(67)	104	(47)
65 +	19	(56)	26	(33)	101	(46)
Education						
Primary and lower secondary	9	(26)	15	(20)	37	(17)
Upper secondary	17	(50)	39	(51)	102	(47)
Tertiary (college/university)	8	(24)	22	(29)	76	(35)
Marital status						
Unmarried	5	(15)	2	(3)	22	(10)
Married/cohabitant	27	(79)	63	(81)	171	(77)
Divorced	0	0	3	(4)	12	(5)
Widowed	2	(6)	10	(13)	17	(8)

Table 2. *Clinical characteristics in neuropathic pain, osteoarthritis and spinal pain.*

	Pain diagnoses						
	Neuropathic pain (n = 34)		Osteoarthritis (n = 78)		Spinal pain (n = 222)		
	Mean	*(SD)*	*Mean*	*(SD)*	*Mean*	*(SD)*	*p-value*
Pain intensity (SF-8 BP)	37.16	(5.11)	39.73	(6.23)	39.20	(6.10)	$p = .087$
Psychological function (MHI-5)	73.91	(17.21)	81.06	(12.71)	77.67	(16.87)	$p = .079$
Physical function (SF-8 PF)	43.85	(7.50)	43.52	(6.97)	45.00	(7.45)	$p = .263$
Insomnia (ISI)	9.23	(4.29)	7.72	(5.59)	7.33	(5.04)	$p = .158$
Catastrophizing (PCS)	13.54	(9.57)	11.47	(7.75)	12.43	(8.42)	$p = .465$
Solicitous responses (WHYMPI)	2.09	(1.00)	1.95	(1.26)	2.06	(1.35)	$p = .782$

Note. SF-8 BP = bodily pain, MHI-5 = Mental Health Inventory – 5, SF-8 PF = Physical function; ISI = Insomnia severity index; PCS = Pain catastrophizing scale; WHYMPI = West Haven-Yale multidimensional pain inventory, Solicitous responses from significant others.

Table 3. *Bivariate Pearson correlation coefficients between continuous pain characteristics, psychological and psychosocial variables.*

	Pain intensity (SF-8 BP)	Psychological function (MHI-5)	Physical function (SF-8 PF)	Insomnia (ISI)	Catastrophizing (PCS)	Solicitous responses (WHYMPI)
Pain intensity (SF-8 BP)	----	.15**	.42***	-.29***	-.32***	-.16**
Psychological function (MHI-5)		----	.12*	-.33***	-.51***	-.05
Physical function (SF-8 PF)			-----	-.20***	-.25***	-.12*
Insomnia (ISI)				-----	.32***	-.01
Catastrophizing (PCS)					----	.21***
Solicitous responses (WHYMPI)						---

Note. SF-8 BP = bodily pain, MHI-5 = Mental Health Inventory – 5, SF-8 PF = Physical function; ISI = Insomnia severity index; PCS = Pain catastrophizing scale; WHYMPI = West Haven-Yale multidimensional pain inventory, Solicitous responses from significant others. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 4. *Results of the regression analysis for psychological function.*

Step and variable	R^2	ΔR^2	ΔF	β	95% Confidence interval	
					Lower bound	Upper bound
Step 1: Demographic variables	.01	.01	1.20			
Sex				.08	-1.09	6.36
Age				.03	-.13	.20
Step 2: Pain intensity	.03	.02	6.25**	.14**	.08	.68
Step 3: Diagnosis	.04	.01	1.68			
Neuropathic pain				-.06	-9.35	2.81
Osteoarthritis				.07	-1.51	7.12
Step 4: Psychological factors	.28	.24	52.00***			
Pain catastrophizing				-.53***	-1.21	-.82
Solicitous responses				.07	-.39	2.10
Step 5: Interactions	.30	.03	2.77*			
Neuropathic pain x PCS				.08	-.14	1.08
Osteoarthritis x PCS				.16**	.21	1.17
Neuropathic pain x SR				-.08	-9.22	1.18
Osteoarthritis x SR				-.03	-3.65	2.31

Note. PCS = pain catastrophizing, SR = solicitous responses. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 5. *Results of the regression analysis for physical function.*

					95% Confidence interval	
Step and variable	R^2	ΔR^2	ΔF	β	Lower bound	Upper bound
Step 1: Demographic variables	.04	.04	6.68***			
Sex				.17**	.93	4.21
Age				-.14**	-.16	-.02
Step 2: Pain intensity	.19	.15	56.58***	.39***	.34	.58
Step 3: Diagnosis	.20	.01	2.21			
Neuropathic pain				-.04	-3.41	1.55
Osteoarthritis				-.11*	-3.61	-.09
Step 4: Psychological factors	.22	.02	4.60**			
Pain catastrophizing				-.15**	-.22	-.04
Solicitous responses				-.04	-.79	.36
Step 5: Interactions	.22	.00	0.13			
Neuropathic pain x PCS				-.01	-.31	.22
Osteoarthritis x PCS				.00	-.23	.22
Neuropathic pain x SR				-.02	-2.87	2.03
Osteoarthritis x SR				-.04	-1.85	.97

Note. PCS = pain catastrophizing, SR = solicitous responses. * $p < .05$, *** $p < .001$.

Table 6. *Results of the regression analysis for insomnia severity symptoms.*

					95% Confidence Interval	
Step and variable	R^2	ΔR^2	ΔF	β	Lower bound	Upper bound
Step 1: Demographic variables	.02	.02	2.39			
Sex				-.13*	-2.54	-.10
Age				-.01	-.06	.05
Step 2: Pain intensity	.08	.06	18.44***	-.25***	-.31	-.12
Step 3: Diagnosis	.09	.01	1.82			
Neuropathic pain				.11	-.13	3.64
Osteoarthritis				.05	-.80	2.04
Step 4: Psychological variables	.17	.08	12.63***			
Pain catastrophizing				.29***	.10	.25
Solicitous responses				-.13*	-.93	-.06
Step 5: Interactions	.20	.03	2.53*			
Neuropathic pain x PCS				-.14*	-.45	-.04
Osteoarthritis x PCS				.11	-.03	.32
Neuropathic pain x SR				.02	-1.51	2.01
Osteoarthritis x SR				-.05	-1.41	.67

Note. PCS = pain catastrophizing, SR = solicitous responses. *$p < .05$, ** $p < .01$, *** $p < .001$.

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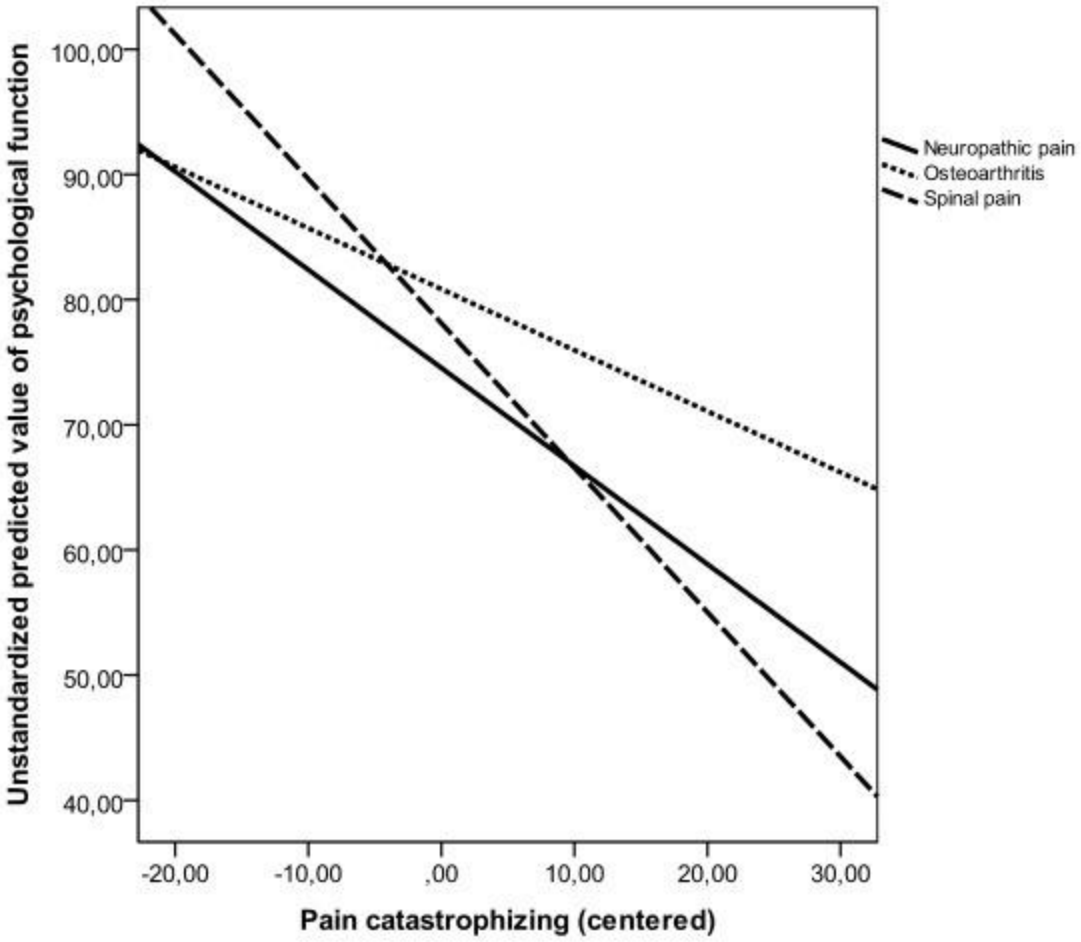

Figure 2 Psychological function.tif

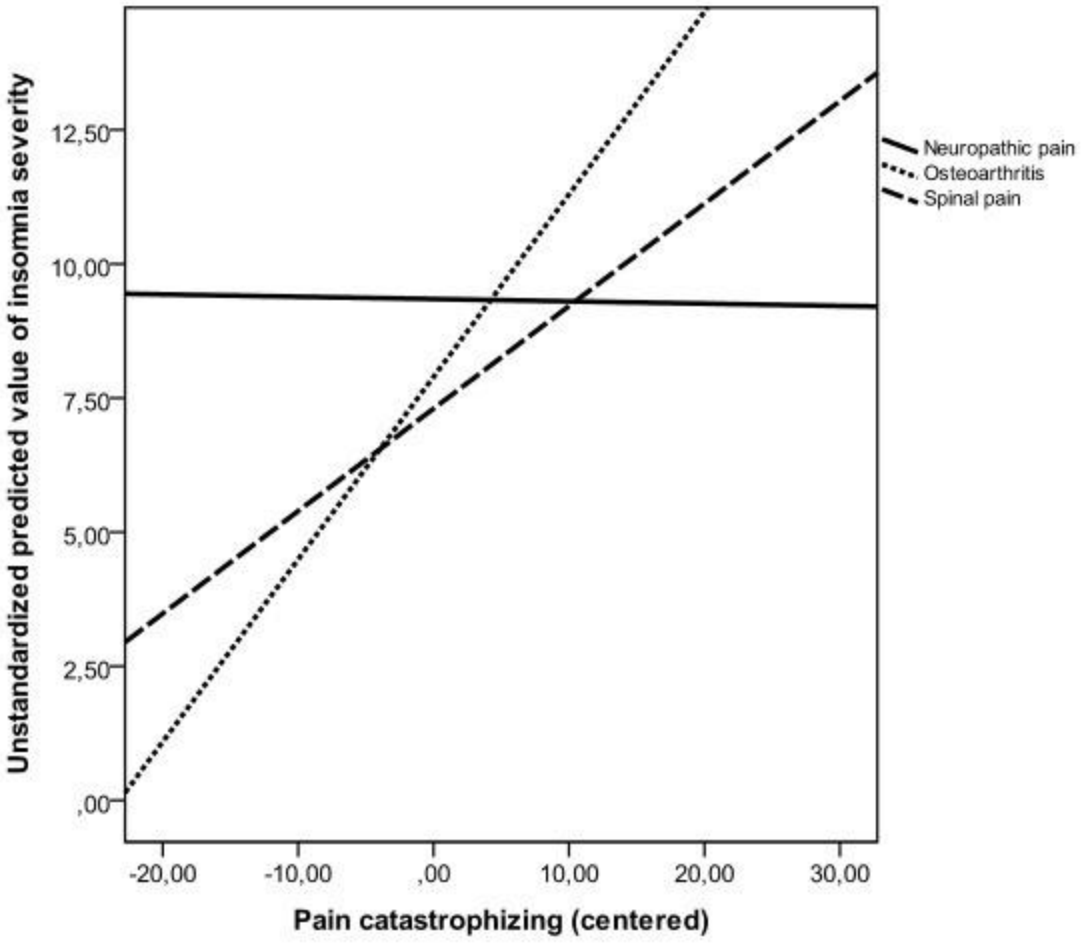

Figure 3 Insomnia severity.tif