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ORIGINAL ARTICLE

Insomnia is a risk factor for spreading of chronic pain: A Swedish longitudinal population study (SwePain)

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Abstract

Background: Recent evidence suggests that insomnia negatively influences the occurrence of generalized pain. This study examined whether insomnia is a risk factor for the transition from local pain (LP) to generalized pain (i.e. spreading of pain).

Methods: This longitudinal study, with a follow-up of 24 months, included 959 participants (mean age: 55.8 years; *SD*: 13.9) with local or regional pain at baseline. Participants were grouped by insomnia symptoms as measured by the Insomnia Severity Index. Spreading of pain was measured by body manikins based on the spatial distribution of pain on the body. We defined two outcome categories; one with relatively localized pain (i.e. LP and moderate regional pain [MRP]), and one with relatively generalized pain (i.e. substantial regional pain and widespread pain [WSP]). Baseline age, sex, education, depressive symptoms, anxiety symptoms, catastrophizing, pain intensity and spread of pain were also included in the Generalized Linear Model analysis.

Results: The unadjusted model showed that the risk of spreading of pain increased with an increase in insomnia symptoms (no insomnia: 55.4%; subthreshold insomnia: 25.4% moderate insomnia: 16.5% and severe insomnia: 2.7%). The risk increased in a dose-dependent manner; moderate insomnia risk ratio (RR) 2.34 (95% confidence interval [CI]: 1.34–4.09) and severe insomnia RR 4.13 (95% CI: 1.56–10.92). The results were maintained in the fully adjusted model although MRP was the strongest predictor RR 6.95 (95% CI: 3.11–15.54).

Conclusion: Our findings show a strong prospective relationship between insomnia symptoms and the transition from relatively localized to generalized pain.

Significance: This study shows that people with LP conditions are at much higher risk of developing WSP if they also have significant insomnia symptoms. The elevated risk is evident after 24 months and increases in a dose-dependent manner regarding the degree of exposure to insomnia symptoms. Local pain conditions are quite common in primary care, and an evaluation of the insomnia symptoms is highly recommended since the most common sleep problems can be treated effectively if detected.

1 | INTRODUCTION

Chronic pain is a very common condition and affects about 20% of the European population (Breivik, Collett, Ventafridda, Cohen, & Gallacher, 2006). However, based on the spatial distribution of pain on the body, chronic pain constitutes a spectrum from *local* pain (LP; e.g. low-back pain) to generalized or *widespread* pain (WSP; e.g. fibromyalgia; Viniol et al., 2015). Many patients with WSP, indeed, report that their pain started as local condition (Graven-Nielsen & Arendt-Nielsen, 2010; Viniol et al., 2015). The mechanisms for the transition from local to WSP is poorly understood, as no well-replicated risk factors have been attributed to this transition (Larsson, Bjork, Borsbo, & Gerdle, 2012).

The cross-sectional association between insomnia symptoms and chronic pain has been repeatedly reported (Alfoldi, Dragioti, Wiklund, & Gerdle, 2017; Ohayon, 2005). For instance our group showed that insomnia symptoms are common in patients seeking care in specialized pain clinics (Alfoldi, Wiklund, & Gerdle, 2014). However, few have examined the role of insomnia symptoms as a risk factor in the transition from local to WSP longitudinally. A review of longitudinal studies (Smith & Haythornthwaite, 2004), suggested a reciprocal relationship between pain (both acute and chronic) and insomnia symptoms. A more recent review concluded that insomnia symptoms predict and worsen chronic pain rather than the other way round (Finan, Goodin, & Smith, 2013). Moreover, sleep problems increase the risk of developing chronic WSP over 15 months, both in individuals with and without pain at baseline (Gupta et al., 2007). Another longitudinal cohort study (HUNT 1 and 2) of pain-free women showed a large increase in the risk of developing fibromyalgia in women reporting sleeping problems *often* or *always* 11 years earlier and especially in women over 45 years of age (Mork & Nilsen, 2012). More recent results from the HUNT study (HUNT 2 & 3) showed that sleeping problems together with anxiety, depression, smoking and high body mass index were significant risk factors for developing chronic WSP (also including stiffness) 11-year post-baseline (Mundal, Grawe, Bjorngaard, Linaker, & Fors, 2014). However, none of these studies used a validated sleep measure. Most of them used single questions measuring sleep problems or disturbances, rather than insomnia severity (Mork & Nilsen, 2012; Mundal et al., 2014) resulting in dichotomous exposure variables, unable to investigate a possible dose dependence.

Furthermore, both chronic pain and insomnia symptoms are two conditions that are associated with several other symptoms and sociodemographic features, that is anxiety and depressive symptoms (Espie, 2002; Linton, 2000; Mundal et al., 2014), female sex (Bevenius-Carrick, 2010; Breivik et al., 2006), age (Breivik et al., 2006; Sivertsen, Krokstad, Overland, & Mykletun, 2009) and socioeconomic factors (Bevenius-Carrick, 2010) such as education (Grimby-Ekman, Gerdle, Bjork, & Larsson, 2015). Catastrophizing is also known as an aggravating factor in chronic pain (Linton et al., 2011), but in recent years, it has also been acknowledged as a potential key factor for insomnia maintenance (Jansson-Frojmark, Harvey, & Flink, 2019). Thus, adjusting for those factors is crucial when examining the association between pain and insomnia.

This study was motivated by the above-identified knowledge gaps concerning risk factors and especially the role of insomnia symptoms in the spreading of LP conditions. Unlike the few previous longitudinal studies on sleep disturbance and spreading of pain (Mork & Nilsen, 2012; Mundal et al., 2014), this study measured insomnia symptoms using a validated insomnia scale (Bastien, Vallieres, & Morin, 2001; Morin, Belleville, Belanger, & Ivers, 2011). This also made it possible to determine the risk of different severity levels of insomnia symptoms. Hence, this study aimed to examine the predictive association of insomnia symptoms with the transition from relatively localized to generalized pain over a period of 2 years. We hypothesized that the severity of insomnia symptoms is a risk factor for spreading of pain and that higher levels of insomnia symptoms increase the risk of generalized pain.

2 | METHODS

2.1 | Participants and procedures

This study was based on a stratified random representative sample of 9,000 out of a total of 404,661 inhabitants of the adult population (16–85 years) living in south-eastern Sweden. A computerized/postal survey was sent to this sample and 4,774 (53.0%) completed the survey. A total of 2,983 (62.5%) of those reported pain during the last 7 days (Figure 1). Then, an extended questionnaire (baseline survey) was sent only to those who had pain covering aspects of pain, insomnia and psychological comorbidity. This baseline survey was answered and returned by 1,939 (65.0%) subjects. The collection of baseline survey ended in June 2012. These 1,939 were then followed up 2 years later and 1,485 (77.3%) completed the follow-up survey (Figure 1). The collection of the follow-up data ended in August 2014. For this study, only individuals who answered at both surveys and had relatively localized pain were considered eligible ($n = 959$). Hence, we excluded 526 individuals who had generalized pain at baseline (Figure 1). Of the 959 eligible subjects, 93.1% reported pain duration >3 months.

All data were collected by Statistics Sweden (SCB). The study was conducted following the Helsinki Declaration and Good Clinical Practice and approved by the Ethical Review Board in Linköping (Dnr: 2011 72/31).

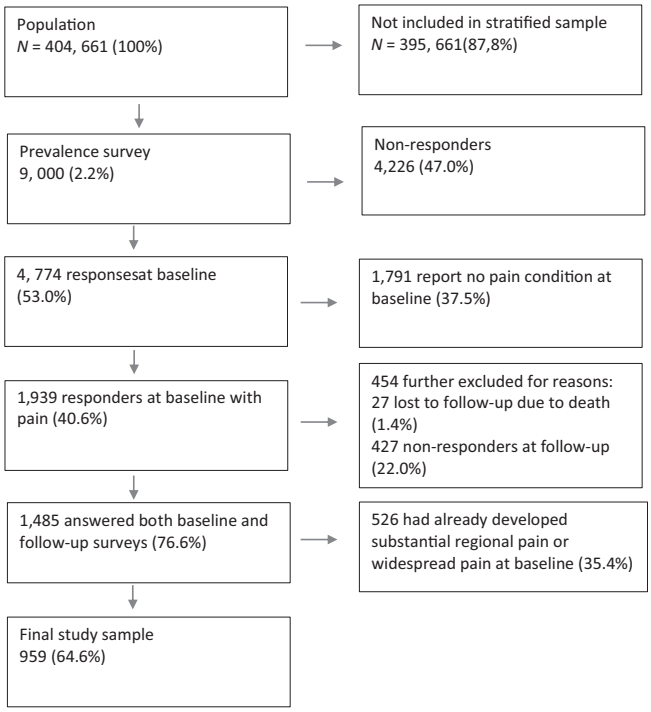

FIGURE 1 Flowchart outlines the inclusion of participants in this study

2.2 | Measurement

2.2.1 | Outcome variable

Spreading of pain

The spread of pain was assessed by having the respondents mark the sites of their pain during the previous 7 days on a body manikin divided into a total of 45 sections on the front and the back (Figure S1; Margolis, Tait, & Krause, 1986). Based on these 45 sections, 23 anatomical regions were determined and a total pain index score, ranging from 0 to 23, was calculated (Figure S2; Dragioti, Larsson, Bernfort, Levin, & Gerdle, 2017). Then, based on these 23 anatomical regions, we defined four categories of spreading of pain, as previously described (Dragioti, Larsson, Bernfort, Levin, & Gerdle, 2016; Larsson, Dragioti, Grimby-Ekman, Gerdle, & Björk, 2019). Local pain was designated for participants who marked one or two anatomical regions (Dragioti, Gerdle, & Larsson, 2019; Larsson et al., 2019). Moderate regional pain (MRP) was designated for participants who marked three up to six anatomical regions (e.g. cervicobrachial syndrome). Substantial regional pain (SRP) was designated for participants who marked 7 up to 17 anatomical regions but did not fulfil the criteria of WSP as follows. WSP was designated for participants who had pain in at least two sections in two contralateral limbs and the axial skeleton that was equally marked on the front and the back of the manikin (Dragioti et al., 2016; Larsson et al., 2019). Thus, we used a slightly modified definition of WSP developed by MacFarlane and co-workers (MacFarlane, Croft, Schollum, & Silman, 1996). MacFarlane et al., 1996 define WSP in limbs to be present "if there are at least two painful sections (in two contralateral limbs)", a definition that does not require pain to be marked equally on the front and back of the body (MacFarlane et al., 1996).

In this study, participants with LP or MRP were investigated 2 years later concerning the spreading of pain—that is whether their pain shifted from LP or MRP to SRP or WSP. The spread of pain was measured at both time points, that is baseline and follow-up.

2.2.2 | Predictor variables

Severity of insomnia symptoms

First, the baseline severity of insomnia symptoms was measured using *one* single question: *Do you have trouble falling or staying asleep? (Yes or No)*. Then, those who answered "yes" also filled out the Insomnia Severity Index (ISI) to quantify perceived insomnia severity. ISI is a valid instrument to capture the severity and impact of insomnia symptoms with excellent internal consistency (Bastien et al., 2001; Morin et al., 2011). The seven items of ISI are rated on a five-point Likert scale (0–4). The scores of the seven items are added as the total score of ISI (max = 28). The score is divided into four categories: no insomnia (ISI: 0–7); sub-threshold insomnia (ISI: 8–14); moderate insomnia (ISI: 15–21) and severe insomnia (ISI: 22–28). The participants who answered "No" on the first question regarding sleeping problems were assigned to the *no insomnia* group.

2.2.3 | Covariates

The survey also included the following baseline parameters as potential covariate variables.

Sociodemographic data

Sex and *age* data were collected from the Population Registry in Sweden by Statistics Sweden (SCB). At the time of the data collection, *sex* was coded as binary—either men or women. *Age* refers to the age at baseline. Based on Mork and Nilsen's work, we classified *age* into two categories: either 45 years old and older or younger than 45 years old (Mork & Nilsen, 2012). We used this categorization, because it has been proven that the association between sleep problems and WSP development is stronger among middle-aged and older women compared to younger women (Mork & Nilsen, 2012). Level of education was self-reported as either *elementary school*, *upper secondary school* or *university*. In the analyses, *elementary school* and *upper secondary school* were combined into the new binary variable *University yes/no*.

Depression and anxiety

The General Well-being Schedule (GWBS) was originally developed for the National Centre for Health Statistics (Fazio, 1977). We used the GWBS to capture psychological distress. The GWBS consists of 18 items (items 1–14 have a score between 1 and 6, and items 15–18 have a score between 0 and 10). Six subscales can be calculated from the GWBS (McDowell, 2006): Tension-Anxiety, Depression, Positive well-being, Self-control, Vitality and General health. We used the Tension-Anxiety subscale (denoted Anxiety) and the Depression subscale (denoted Depression). The instrument has been used in several population-based studies and has demonstrated good internal consistency (Leonardson et al., 2003; Wang et al., 2016).

Pain Catastrophizing Scale

The PCS measures three dimensions of catastrophizing—rumination, magnification and helplessness (Miro, Nieto, & Huguet, 2008; Sullivan, Bishop, & Pivik, 1995)—based on 13 items (with anchors from 0: not at all to 4: all the time), resulting in a PCS total possible score of 52. The higher the score, the more catastrophizing thoughts are present. The instrument has provided good internal consistency, test–retest reliability and validity (Kemani, Grimby-Ekman, Lundgren, Sullivan, & Lundberg, 2019). However, in this study due to a printing issue, the most negative alternative (4: "all the time") was not included in the questionnaire. Thus, in our study, the PCS resulted in a total possible score of 39. Additionally, to overcome this issue we re-estimated the internal consistency of the instrument in our sample by calculating the Cronbach alpha (α) and it was found good ($\alpha = 0.85$). The total score was denoted PCS total.

2.3 | Pain intensity

A numeric rating scale with anchor points 0 (denoted no pain) and 10 (denoted the worst imaginable pain) was used to capture the average pain intensity for the previous 7 days.

2.4 | Statistics

Statistical analysis was performed using the SPSS statistical package (version 22.0; IBM Inc.). Data were reported as the mean with standard deviation (*SD*) or number with percentage based on the data distributions. Chi-square test and one-way ANOVA were used to examine univariate possible differences between baseline severity of insomnia symptoms and sociodemographic data.

A generalized linear model (GLM) for the binomial family was then used to estimate RRs and their confidence intervals (CI) for the prospective analysis. GLM is a flexible generalization of ordinary linear regression and can be used to analyse data with binary, discrete or continuous outcomes. It can also handle missing data (McCullagh & Nelder, 1989). In contrast to binary logistic regression, which estimates odds ratios, GLM also estimates RRs, which are preferable in prospective studies and easier to interpret (Marschner & Gillett, 2012). Furthermore, RRs are more suitable when outcomes are common (>10%; Cummings, 2009). In this study, we present three models: one unadjusted; one adjusted for baseline age, sex, level of education, depressive symptoms, anxiety symptoms, level of pain catastrophizing and pain intensity; and one fully adjusted for all the above-mentioned baseline variables plus baseline spread of pain conditions (MRP vs. LP). To facilitate interpretation, reference categories were chosen so that RRs are always >1. A $p < 0.05$ was considered statistically significant in all analyses. We also performed a sensitivity analysis as a supplement analysis to examine the risk of developing MRP, that is those who shifted from LP to MRP, and the risk of developing SRP that is those who shifted from MRP to SRP.

3 | RESULTS

The drop-out analysis from respondents and non-respondents with pain at baseline showed that response rates decreased with younger age, having greater pain intensity, depression, anxiety and pain catastrophizing (Table S1).

The total sample consisted of 571 women (59.5%) and 388 men (40.5%) and the mean age was 55.8 (*SD* = 13.9) years. At baseline 383 (39.9%) participants had LP and 576 (60.1%) had MRP. At follow-up, 85 participants developed either SRP or WSP. For details regarding transitions between pain categories over time, please see Figure S3.

3.1 | Participant characteristics

Table 1 illustrates the baseline characteristics of the study sample stratified by the severity of insomnia symptoms. Of the participants investigated, about 33% were university educated, and on the group level, pain intensity was moderate (Table 1). At baseline, when subjects were divided into the different levels of insomnia severity categories (no insomnia: 55.4%; subthreshold insomnia: 25.4% moderate insomnia: 16.5% and severe insomnia: 2.7%), it was found that women were most prevalent in the sub-threshold insomnia category. University education was somewhat more common in those with moderate insomnia, whereas insomnia decreased with age (Table 1). Pain intensity, anxiety symptoms, depressive symptoms and catastrophizing showed positive significant dose relationships with insomnia (Table 1).

TABLE 1 Baseline characteristics of the total sample and comparisons between the severity of insomnia symptoms

Variables; mean (*SD*), unless otherwise stated	Total *n* = 959	No insomnia *n* = 531	Sub-threshold *n* = 244	Moderate *n* = 158	Severe *n* = 26	*p*-value[a]
Age	55.8 ± 13.9	56.7 ± 14.4	55.7 ± 13.4	53.8 ± 13.2	49.8 ± 10.5	*0.014*
Women (*n*, %)	571 (59.5)	302 (56.9)	158 (64.8)	96 (60.8)	15 (57.7)	0.216
University education (*n*, %)	294 (31.1)	165 (31.7)	69 (28.5)	53 (33.8)	7 (28.0)	0.691
Depression (GWBS)	5.77 ± 3.86	4.70 ± 3.33	5.81 ± 3.45	8.40 ± 3.81	11.1 ± 5.33	*<0.001*
Anxiety (GWBS)	8.00 ± 5.20	6.55 ± 4.74	7.95 ± 4.39	11.7 ± 4.90	15.6 ± 5.80	*<0.001*
Pain catastrophizing (PCS-total)	14.2 ± 6.68	12.8 ± 6.08	14.4 ± 6.36	17.2 ± 6.30	23.9 ± 8.92	*<0.001*
Pain intensity	4.85 ± 1.88	4.56 ± 1.84	4.87 ± 1.79	5.50 ± 1.84	6.68 ± 1.84	*<0.001*

Note: Characteristics categorized by level of exposure of insomnia symptoms at baseline.

Significant p-values are given in italics.

Abbreviations: GWBS, General Well-being Schedule; PCS, Pain Catastrophizing Scale; *SD*, standard deviation.

[a]*p*-values were calculated using one-way ANOVA for continuous variables and Chi-square test for categorical ones.

TABLE 2 Risk of developing spreading of pain over 2 years by baseline severity of insomnia symptoms and all covariates

	New cases of SRP & WSP		Unadjusted (*n* = 959; 0% missing data)			Adjusted (*n* = 684; 28.7% missing data)			Fully adjusted (*n* = 684; 28.7% missing data)		
ISI categories	(%)	*n*	(RR)	95% CI	*p*-value	(RR)	CI	*p*-value	(RR)	CI	*p*-value
Severe	6 (23.1)	26	4.13	1.56–10.92	*0.004*	3.98	1.20–13.22	0.024	4.26	1.27–14.35	*0.019*
Moderate	23 (14.6)	158	2.34	1.34–4.09	*0.003*	2.54	1.31–4.93	0.006	2.47	1.23–4.93	*0.011*
Sub-threshold	20 (8.2)	244	1.23	0.70–2.17	0.480	1.15	0.61–2.16	0.671	1.14	0.60–2.18	0.687
No insomnia	36 (6.8)	531	Ref		—	Ref		—	Ref		—
Total	85 (8.9)	959									
Covariates											
Age < 45 years			—	—	—	2.15	1.00–4.59	0.049	2.48	1.21–5.10	*0.013*
Female sex			—	—	—	2.95	1.65–5.27	0.000	2.67	1.49–4.77	*0.001*
No university education			—	—	—	1.94	1.04–3.65	0.039	2.15	1.15–4.01	*0.017*
Depression (GWBS)			—	—	—	0.97	0.88–1.07	0.511	0.98	0.89–1.08	0.643
Anxiety (GWBS)			—	—	—	1.04	0.97–1.12	0.266	1.02	0.95–1.11	0.550
Pain catastrophizing (PCS-total)			—	—	—	0.97	0.93–1.02	0.277	0.99	0.95–1.03	0.625
Pain intensity			—	—	—	1.25	1.09–1.44	0.002	1.07	0.92–1.25	0.376
MRP at baseline			—	—	—	—	—	—	6.95	3.11–15.54	*0.000*

Note: Adjusted = adjusted for age, sex, education, depressive symptoms, anxiety symptoms, level of pain catastrophizing, and pain intensity at baseline. Fully adjusted = adjusted for all above-mentioned baseline variables and baseline pain categories (MRP compared to local pain).

Significant p-values are given in italics.

Abbreviations: CI, Wald confidence interval; GWBS, General Well-being Schedule; ISI, Insomnia Severity Index; MRP, moderate regional pain; PCS, Pain Catastrophizing Scale; RR, risk ratio; SRP, Substantial Regional Pain; WSP, Widespread pain.

3.2 | Prospective analyses

The *unadjusted* model showed that moderate (RR = 2.34, 95% CI: 1.34–4.09) and severe insomnia (RR = 4.13, 95% CI: 1.56–10.92) were significantly associated with the transition from LP/MRP to SRP/WSP after 2 years (Table 2). These relationships persisted after adjustments, whereas the RRs for insomnia only differed slightly between the two

adjusted models (Table 2). In summary, moderate and severe insomnia increases the relative risk of developing SRP or WSP 2 years later in a dose-dependent manner in all models. (Table 2).

Furthermore, we found that female sex (RR = 2.67, 95% CI: 1.29–4.77), no university education (RR = 2.15, 95% CI: 1.15–4.01), age above 45 years old (RR = 2.48, 95% CI: 1.21–5.10) and MRP (RR = 6.95, 95% CI: 3.11–15.54) at baseline were also significant risk factors in the fully adjusted model. Particularly, the presence of MRP at baseline was the strongest risk factor. Sub-threshold insomnia symptoms do not entail any increase in risk compared to the reference category (no insomnia) in any of the models presented in Table 2.

The results of the sensitivity analysis are presented in Tables S2 and S3. The RRs for insomnia symptoms turned into non-significant, after adjustments for the transition from LP to MRP. For the transition from MRP to SRP only moderate insomnia and depression contributed to this transition (RR = 2.35, 95% CI: 1.03–5.38 and RR = 1.19, 95% CI: 1.07–1.33, respectively).

4 | DISCUSSION AND CONCLUSIONS

We found that baseline insomnia severity is a risk factor of spreading of pain at a 2-year follow-up. We also found that the risk increases in a dose-dependent manner for moderate and severe insomnia, after adjustments. This finding may indicate that there is an isolated and independent effect of insomnia symptoms on the risk of spreading of pain. Our study contributes valuable data in a sparse field of research. Jointly with the few other longitudinal studies (Gupta et al., 2007; Larsson et al., 2012; Mork & Nilsen, 2012; Mundal et al., 2014), this study suggests that insomnia is a risk factor for the transition from relatively localized to generalized pain. However, our results showed that MRP was the strongest risk factor for spreading of pain. A reasonable interpretation is that the occurrence of MRP may constitute a precursor to generalized pain (i.e. substantial regional or WSP). This has been demonstrated in several studies (Bergman, Herrstrom, Jacobsson, & Petersson, 2002; Elliott, Smith, Hannaford, Smith, & Chambers, 2002; Gupta et al., 2007) and more focus on this finding, therefore, is needed.

Moreover, we found that other factors such as female sex, age ≥45 years and low education were also independent risk factors for spreading of pain at the 2-year follow-up. Previous studies have shown mixed results regarding these risk factors but multiple pain sites, female sex and higher age are mentioned as possible risk factors specific to spreading of pain (Larsson et al., 2012). In accordance with a previous report (Mork & Nilsen, 2012), we found a significant effect of age (≥45 years). The prevalence of insomnia symptoms increases by age and the trajectory for women steepens in this age group (Sivertsen et al., 2009). Possibly, this is due to one or several common factors underling both outcomes. An increased risk of new-onset of chronic pain (regardless of spreading) has also been demonstrated in subjects with low level of education (Generaal, Vogelzangs, Penninx, & Dekker, 2017), whereas another recent study found the lowest risk of new-onset in subjects with intermediate level of education (10–12 years; Uhlig, Sand, Nilsen, Mork, & Hagen, 2018). This may reflect occupational conditions and might be affected by national differences with respect to education policies and the amount of physically strenuous jobs in the labour market. Mundal et al. (2014) showed that anxiety and depression were also significant risk factors for developing chronic WSP (or stiffness) at 11-year follow-up. However, our study did not confirm this finding as a previous study (Gupta et al., 2007). Similarly, no effect of pain catastrophizing was found in the longitudinal perspective, and it could be that catastrophizing is more important in the transition from acute to chronic pain than in the transition from local to WSP (Linton, 2000). An unexpected finding from sensitivity analysis was that only moderate insomnia and depression seem to affect the transitions between the specific spreading of pain categories; a finding not easy to interpret and requires more attention.

This study is the first prospective study that used a well-established validated sleep scale (ISI; Bastien et al., 2001; Morin et al., 2011) along other validated variables to assess the risk of transition from local to substantial regional and/or WSP in a population-based sample that included both sexes. Tiering by the exposure of insomnia symptoms enables demonstration of a dose-dependent RR for spreading of pain over 24 months for those who have moderate or severe insomnia. As with the study by Gupta et al., this study follows a selection of subjects with LP conditions over a relatively short period (i.e. 15 and 24 months, respectively; Gupta et al., 2007). This approach, with short follow-up in combination with no pain-free participants, offers high temporal resolution and increases the focus on the outcome of interest, namely the process of spreading of pain.

It is also important to note, that the outcome variable in this study was somewhat different in comparison to other relevant studies (Generaal et al., 2017; Gupta et al., 2007; Mork & Nilsen, 2012; Mundal et al., 2014). We assessed whether the self-reported spreading of pain (even limited, i.e. SRP) had occurred, whereas many other studies focused on whether participants eventually had developed only one type of spreading that is chronic WSP or fibromyalgia (Generaal et al., 2017; Gupta et al., 2007; Mork & Nilsen, 2012; Mundal et al., 2014). Our approach leaves out the temporal aspect and presence of generalized hyperalgesia as indicated by trigger points in favour of self-reported spreading of pain. In our study, the outcome variable included not only WSP but also pain that was relatively generalized but did not meet

the criteria for the former (i.e. SRP). Another difference was that we used an established scale to measure the exposure to insomnia symptoms—that is the ISI (Bastien et al., 2001; Morin et al., 2011). Our results, however, are in reasonable agreement with other longitudinal studies that investigated the role of sleep problems in the process of developing chronic WSP including fibromyalgia (Generaal et al., 2017; Gupta et al., 2007; Mork & Nilsen, 2012; Mundal et al., 2014). Mork and Nilsen found an overall RR of 3.43 for developing fibromyalgia over 11 years (Mork & Nilsen, 2012). An increased risk of developing WSP was also found by Generaal et al. (2017) in subjects with insomnia and/or short sleep duration.

Some other limitations should also be declared. First, because the participation rate is a concern in this study, our findings should be generalized with caution. Our results from drop out analysis, in general, show that participants with worse situations did not complete the survey. Thus, an attrition bias cannot be excluded. Furthermore, there are only 85 new cases of SRP/WSP during the course of this study and therefore CIs are wide. There can also be some cases where the particular pain regions reported have changed between baseline and follow-up, even when they are still categorized within the same pain category. The definitions of the pain categories are to some extent arbitrary and reflect relative degrees in the spread of pain; for example LP could have been defined in a different way. One might also argue that the categorization of continuous variables could influence the results. However, a supplementary analysis with classical logistic regression confirms significant results, although weakened. Likely, the weakened effect is due to a large number of people reporting no insomnia symptoms (43.5%).

To summarize, during this study, 23% of participants with severe insomnia symptoms developed spreading of pain. To address this problem, sleep facilitating efforts should be offered in primary care to patients with pain and moderate to severe insomnia symptoms. Thus, there is a need to investigate whether treating insomnia in patients with substantial regional or WSP will decrease the spreading of pain. So far, intervention studies about insomnia have only demonstrated modest acute effects on pain intensity (Tang et al., 2015). In addition, efforts to prevent the occurrence of MRP should be considered. Therefore, it is important to conduct studies on primary and secondary prevention to investigate whether the spreading of pain can be slowed or stopped. Future research should also follow new cases with LP to investigate the time span in which spreading of pain occurs. It is possible that the effect/risk of insomnia symptoms varies over time in terms of critical periods. Finally, the sparse longitudinal literature indicates that sleeping problems together with both modifiable and non-modifiable risk factors can predict spreading of pain.

CONFLICT OF INTEREST

None declared.

AUTHOR CONTRIBUTIONS

All authors contributed to the conception of the study. TW, BG and ED analysed the data. TW, BG and ED drafted the manuscript. All authors commented on different versions of the manuscript and all authors have approved the final version of the manuscript. All authors are aware and agree to the submission of the paper to the journal.

ETHICAL APPROVAL AND CONSENT TO PARTICIPATE

The study was conducted in accordance with the Helsinki Declaration and Good Clinical Practice and approved by the Ethical Review Board in Linköping (ref: 2011 72/31).

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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