EXTENDED REPORT

Pressure pain thresholds and tender point counts as predictors of new chronic widespread pain in somatising subjects

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Background : Tender points are a general measure of distress both in the community and in clinic subjects. It has been suggested that multiple tender points should be regarded as the early stages of somatisation of distress. Similarly, recent evidence suggests that chronic widespread pain (CWP) is one manifestation of the somatisation of distress.

Objective: Given that a high tender point count and CWP are clinical hallmarks of the fibromyalgia syndrome, it was hypothesised that in somatising subjects, a high tender point count or a low pain threshold would predict the development of CWP in the future.

Methods: In this population-based prospective study, 245 adults aged 25–65 years, free of CWP, were identified on the basis of a detailed questionnaire on pain and a psychosocial questionnaire comprising the Somatic Symptom Checklist and the Illness Behaviour subscale of the Illness Attitude Scales. These subjects took part in a pain threshold examination with a Fischer pressure algometer. Tender point counts were computed by including all areas with a pain threshold <4 kg/cm². Individuals were followed up at 15 months, at which time 231 (93% of subjects still living at their baseline address) provided data on pain status, using the same instruments.

Results: At follow-up, 26 (11%) subjects developed new CWP. Although subjects with a low baseline pain threshold were not at increased risk of developing symptoms, a high tender point count, adjusted for age, sex, baseline pain status and other confounding factors, predicted the development of new CWP.

Conclusion: Subjects free of CWP are at an increased risk of its development if they have a high tender point count. However, a low-pressure pain threshold does not predict the onset of symptoms. Data from this population-based prospective study suggest that a low pain threshold in subjects with CWP is likely to be a secondary phenomenon as a result of pain or associated distress rather than the antecedent of symptoms.

Tender points are an integral part of the fibromyalgia syndrome, with a high tender point count being included in the classification criteria for the condition.¹ It is interesting to speculate on the origins or genesis of tender points and the presumed associated low pressure pain thresholds. Are tender points merely a consequence of pain, in so far that they would be expected to vary directly with the extent of pain, but would be absent in those with no pain? Certainly, subjects with chronic widespread pain (CWP) in the community, unselected by diagnostic bias, have higher tender point counts^{2–3} and lower pressure pain thresholds⁴ than those with no pain or regional pain.

However, tender points are not just a correlate of pain, and occur independently. In a community-based study we found that as many as three quarters of subjects with no pain had at least one tender point, and a quarter had >5 .² Further, tender points are associated with the same psychological factors as CWP and fibromyalgia in cross-sectional studies. Thus, they are a measure of general distress both in the community and in clinic subjects,^{2–5–6} with high counts associated with increased levels of psychological distress, fatigue and sleep problems. On the basis of these results, it has been suggested that multiple tender points should be regarded as the early stages of somatisation of distress.^{6–7}

We have recently shown that psychological distress, including high levels of somatisation, is a risk factor for the development of CWP.⁸ However, even in the most distressed group, only 22% of subjects went on to develop CWP.⁸ Given the association of tender points with both distress and CWP, it is logical to hypothesise whether in somatising subjects without

CWP, the presence of a high tender point count could be a preclinical marker for the development of subsequent pain.

Tender points and pressure pain thresholds are considered to represent a similar underlying phenomenon in both population and clinical studies.^{4–9} Tender points represent pressure pain thresholds below an arbitrary level at specific site; ¹ thus a tender point count informs one on how widespread a low pain threshold is. A more quantitative approach would be to measure actual pressure pain thresholds at the given sites. We therefore conducted a study to test, for the first time, the hypothesis that high tender point count or low pain threshold among somatising subjects, free of CWP, predict its future onset.

SUBJECTS AND METHODS

This was a population-based prospective study that was conducted in three stages. A baseline population survey was carried out to identify subjects free of CWP but who showed evidence of somatising behaviour. A sample of these subjects was then assessed for pressure pain thresholds and tender point counts. A follow-up survey was carried out at 15 months to determine whether subjects with low pain threshold or high tender point count at baseline had a higher prevalence of new CWP compared with those who did not.

Abbreviations: CWP, chronic widespread pain; IAS, Illness Attitude Scales

Figure 1 Flow chart showing participation of subjects from baseline to follow-up phase.

Population screening Selection of patients

A random sample of subjects aged 25–65 years was selected from three population-based primary care registers covering two sociodemographically mixed suburban areas.

Pain questionnaire

Subjects were sent a questionnaire by mail, which enquired on whether they had experienced any pain that had persisted for at least 24 h during the past month, and, if so, whether the pain had been present for >3 months. Four manikin drawings of the body were included (front, back and sides), on which subjects were asked to indicate the sites of pain. This approach has been used before to determine the location and duration of pain.^{10 11} On the basis of this information, subjects were categorised according to the presence or absence of CWP. Subjects with CWP were defined using the definition of the American College of Rheumatology criteria for fibromyalgia.¹ To satisfy these criteria, subjects must have pain that is present both in two contralateral quadrants of the body and in the axial skeleton, and this pain must have been present for at least 3 months. On the basis of these criteria, 5 190 subjects free of CWP were identified.

Study cohort

The baseline questionnaire on pain included sections to assess aspects of somatisation and health-seeking behaviour, as measured by the Somatic Symptom Checklist and the Illness Behaviour subscale of the Illness Attitude Scales (IAS), respectively. These two scales were chosen because they predicted the onset of new CWP in a previous population-based prospective study.⁸ For this study, a score of ≥ 4 on the Illness Behaviour subscale of the IAS, in combination with a score of ≥ 1 on the Somatic Symptom Checklist (see below)

constituted the criteria for characterising subjects as “at risk” of developing CWP. Of the 5 190 subjects identified as being free of CWP, 768 fulfilled the “at risk” criteria.

The Somatic Symptom Checklist

The Somatic Symptom Checklist was originally validated as a screening test for somatisation disorder.¹² The scale includes six symptoms: breathing trouble, frequent vomiting (when not pregnant), loss of voice for >30 min, being unable to remember what you have been doing for hours or days (without the influence of alcohol or drugs), difficulty swallowing and frequent pain in the fingers or toes. A seventh item, frequent trouble with menstrual cramps, is included for female respondents. These symptoms are included in the American Psychiatric Association’s criteria for somatisation disorder.¹³ In the study from which these criteria were derived, a threshold between 3 and 4 resulted in a sensitivity of 73% and a specificity of 94% for identifying cases of somatisation disorder. To avoid spurious associations with new cases of CWP, only the “non-pain” somatic symptoms were examined (ie, frequent trouble with menstrual cramps and frequent pain in the fingers or toes were excluded). The total score was therefore between 0 and 5 for both men and women.

Illness Attitude Scales

The nine IAS¹⁴ assess attitudes and concerns about illness and health. Each scale includes three items, each scored from 0 to 4, providing a total score between 0 and 12. Individual scales assess worry about health, concern about pain, health habits, hypochondriacal beliefs, thanatophobia (fear of death), disease phobia, bodily preoccupation, treatment experience and effect of symptoms. A study based on a principal components analysis showed that of the 27 items that make up the IAS, 17 measure two dimensions reflecting “health anxiety” and “illness behaviour”.¹⁵ The “health anxiety” subscale consists of 11 items (such as “Are you worried that you may get a serious illness in the future?”) and has a total score between 0 and 44. The “illness behaviour” subscale consists of six items (such as “Do your bodily symptoms stop you from working?”) and has a total score between 0 and 24. For this study, we chose to use only the illness behaviour subscale, as the health anxiety subscale did not predict new CWP in our previous study.⁸

Pressure pain thresholds and tender point counts

Of the subjects free but “at risk” of CWP identified at baseline, a random sample was selected and invited to have the pressure pain thresholds measured with the Fischer pressure algometer (pressure threshold meter; Pain Diagnostics) and

Table 1 Baseline characteristics of the follow-up cohort

Attribute*	n (%)
Age band years	
25–39	66 (28.6)
40–49	54 (23.4)
50–65	111 (48)
Sex	
Female	160 (69.3)
Male	71 (30.7)
Somatic symptom score	1 (1–2)
Illness behaviour score	6 (5–9)
Total pain threshold	83 (58–109)
Tender points	3 (0–11)

IQR, inter-quartile range.

*Values for age and sex are n (%), and those for the psychological scales, total pain threshold and tender point count are the median (IQR).

Thermography, New York, USA). A known force (pressure) can be applied on the body through the rubber disc at the end of the algometer. The gauge is calibrated in kg/cm², with a range of 20 kg in divisions of 100 g. The instrument has been shown to be reliable and gives reproducible results.^{16,17} We measured pain threshold at the following eight paired points in the body: anterior border of the tibia, medial fat pad of knee, lateral gluteal area, medial supraspinatus, deltoids, lateral epicondyle of elbow, dorsum of forearm and mid-trapezius. We added the scores at the 16 points to compute a total pressure pain threshold score. We then identified the number of areas that had a pain threshold <4 kg/cm² to calculate the tender point count, as defined by the American College of Rheumatology.¹

Potential confounding factors

A number of factors may confound the relationship between pressure pain thresholds/tender point counts and new onset CWP. To assess the role of these factors, the questionnaire also asked about marital (married, single, separated, divorced, widowed) and occupational (employed full time, employed part time, unemployed, retired, student) status. In addition, we used subjects' area of residence as a proxy measure for socioeconomic status.

Follow-up to determine new CWP

Subjects attending the pain threshold examination at baseline were mailed a further questionnaire after 15 months that ascertained their current pain status. The method for categorising pain was the same as that used in the baseline survey. The observer categorising pain status was blinded to subjects' baseline psychological scores, pressure pain threshold or tender point scores, and all other information included in the baseline questionnaire.

Statistical analysis

Those subjects who provided complete data at baseline and follow-up were included in the analysis. The distribution of baseline pressure pain thresholds and tender point counts was not Gaussian. We were interested in examining the rate of new CWP in those subjects who were at the lowest end of the pain threshold distribution with those at the highest end to determine the association with symptom onset. To do so, subjects' total pain threshold scores were divided by thirds to produce three approximately equal-sized groups. The association between new CWP and the total pain threshold of subjects who scored in the middle and lowest thirds were compared with those in the highest third by logistic regression analyses, and adjusted for age, sex, baseline pain status (no pain vs regional pain), marital status, occupational status and socioeconomic status. When examining tender point scores, the lowest third of tender point counts was designated as the

referent, and the risk of new CWP was compared with the middle and upper thirds, after adjusting for age, sex, baseline pain status, marital status, occupational status and socioeconomic status. Results are presented as odds ratios (95% confidence intervals), which under the rare disease assumption, provide a valid estimate of the relative risk. We also conducted a "receiver operating characteristic" (ROC) "area under the curve" analysis to examine the ability of baseline total pain threshold and tender point count to discriminate between subjects with and without new CWP at follow-up. All analysis was conducted using the STATA statistical software package.¹⁸

RESULTS

Response rates and study subjects

Figure 1 shows a flow chart of participants from baseline to follow-up phase. Of those subjects who completed the baseline questionnaire, a total of 768 subjects were identified as being free of CWP but "at risk" of developing symptoms. Of those, 463 were invited to take part in the study and 267 (58%) agreed, of whom 254 (54%) provided full data. Analysis of baseline data from those subjects invited to participate and who did so, compared with those who refused, showed no significant differences in age, sex or any of the other questionnaire measures (data not shown).

At the 15-month follow-up, 245 subjects took part, of whom pain status could be determined in 231 (71 men, 160 women). After adjustment for the subjects who had moved to another address and therefore did not receive a questionnaire (n = 6), the response rate was 98.8%. Table 1 shows the baseline characteristics of subjects who participated at follow-up.

Point prevalence of chronic widespread pain at follow-up

Of the 231 subjects at baseline free of CWP, 26 reported new CWP at follow-up (prevalence 11.3%), with older subjects being at higher risk, although there was no effect of sex (table 2).

Total pain threshold as a predictor of new CWP

Table 3 shows the association of total pain threshold at baseline with new CWP at follow-up. Pain threshold at baseline showed a small, non-significant effect on new pain.

After adjusting for the effects of marital, occupational and socioeconomic status, these relationships were slightly attenuated and did not significantly predict the onset of CWP (middle third: OR = 1.6, 95% CI 0.5 to 5.0); highest third: OR = 1.5, 95% CI 0.4 to 5.2). However, as the two categories with higher pain threshold were at a slightly higher risk of the outcome than the referent, we pooled them and repeated the analysis. Pain threshold in the combined group still did not predict the development of new CWP (OR 1.1, 95% CI 0.4 to 3.3, p = 0.417). The ROC "area under the curve" for pain threshold as a discriminator of new CWP was 0.6175, indicating that low pain threshold was a "less accurate" predictor of new CWP.¹⁹

Tender point count as a predictor of new CWP

Table 4 shows the association of baseline tender point count with new CWP at follow-up. Subjects with higher tender points were at a greater risk of new CWP, but the CIs spanned unity. These relationships persisted after adjusting for marital, occupational and socioeconomic status (middle third: OR = 4.4, 95% CI 1.1 to 18.3); highest third: OR = 3.8, 95% CI 0.9 to 16.4). We again pooled the two upper thirds and repeated the analysis. The effect was significant (OR 4.1, 95% CI 1.1 to 15.5, p = 0.152). However, the area under the curve for tender point count as a discriminator of new CWP was 0.6876,

Table 2 Prevalence of new chronic widespread pain by age and sex

	Total subjects	Number with new CWP	Prevalence, % (95% CI)
Overall	231	26	11.3 (7.1 to 15.4)
Male	71	9	12.7 (4.7 to 20.6)
Female	160	17	10.6 (5.8 to 15.5)
Age (years)			
25-39	66	4	6.1 (1.5 to 12)
40-49	54	6	11.1 (2.5 to 19.8)
50-65	111	16	14.4 (7.8 to 21.1)

CWP, chronic widespread pain.

Table 3 Influence of baseline total pain threshold on new chronic widespread pain

Total pain threshold	Total subjects	New CWP n (%)	Odds ratio* (95% CI)	p Value
High	93	9 (9.7)	Referent	
Mid	70	9 (12.9)	1.66 (0.56 to 4.99)	0.362
Low	65	7 (10.8)	1.47 (0.42 to 5.18)	0.552

CWP, chronic widespread pain.

*Adjusted for age, sex and baseline pain status.

indicating that high tender point count, adjusted for distress, was a "less accurate" predictor of new CWP¹⁹.

DISCUSSION

The fibromyalgia syndrome is characterised by a high tender point count and associated, low pressure pain thresholds. In the community, there is a clear gradient for tender points, with an increase in count from those without any pain to those with regional pain, to those with CWP. As subjects progress from being pain free, to having some pain, to finally having widespread pain, their tender point count increases. However, whether tender points predate the development of pain or merely reflect the increased sensitivity to pressure, once pain has developed, is not clear. If they indeed precede the development of pain, they, and the associated low-pressure pain thresholds, would constitute useful markers for the future development of CWP. We already know that high tender point counts are a marker of distress in the community and also that distress itself predicts new CWP. Therefore, it was logical to enquire whether in psychologically distressed subjects, presumably already at a high risk of future pain, a high tender point count or low pain threshold would independently predict the development of future CWP. We examined this hypothesis for the first time in a population-based prospective study. We found that a high tender point count predicted the development of new CWP at 15 months, although on formal examination this was a poor discriminator of developing symptoms. Conversely, a low pain threshold did not considerably predict the onset of symptoms.

In interpreting these results, several methodological issues must be considered. Firstly, tender points are difficult to record reliably. The classical method of examining tender points is through digital palpation, and it can be difficult to standardise the pressure applied. We tried to overcome this difficulty by using an algometer to classify tender points. We believed that this would have the effect of reducing intra-observer variations in measurement.

Second, we may have missed some subjects who had new CWP in the intervening months, but which had resolved between the baseline and follow-up surveys. In this study, prevalent cases of CWP were identified at two time points, and the baseline tender point count and total pain threshold were examined to determine their ability to predict prevalent cases at follow-up. We did not investigate what happened during the intervening months. Nevertheless, both clinic and population studies have indicated that a large proportion of cases of CWP persist for years. It is unlikely that we missed many cases of CWP that developed and then resolved during the 15-month study period. It would be of interest to determine whether, over a longer period of follow-up, the associations observed in this study remain constant.

¹⁹Predictive value of ROC area under the curve (AUC); non-informative test (AUC = 0.5); less accurate test (0.5 < AUC ≤ 0.7); moderately accurate test (0.7 < AUC ≤ 0.9); highly accurate test (0.9 < AUC < 1); perfect test (AUC = 1).¹⁹

Table 4 Influence of baseline tender point count on new chronic widespread pain

Total pain threshold	Total subjects	New CWP n (%)	Odds ratio* (95% CI)	p Value
Low	87	7 (8.1)	Referent	
Mid	76	9 (11.8)	1.99 (0.65 to 6.17)	0.231
High	65	9 (13.9)	2.74 (0.78 to 9.65)	0.117

*Adjusted for age, sex and baseline pain status.

Third, we have not assessed physical comorbidities in this study that may be associated with both having a high tender point count and developing CWP. However, previous research has shown that among patients with fibromyalgia, only a very small proportion have underlying organic causes to which their pain can be attributed, and it is likely that physical comorbidities at baseline would only explain a relatively small proportion of new cases of CWP at follow-up. In addition, the sample was restricted to people aged 65 years, and it is unlikely that a large number of subjects in our study cohort would have an underlying organic illness that would be associated with symptoms. More importantly, underlying physical pathology is likely to be reflected by age and we have adjusted for the effects of age in all our analyses. Nevertheless, it does remain a possibility that the high tender point count we have observed at baseline may be associated with an underlying organic disease.

Finally, owing to the relaxed entry criteria for this study the prevalence of new CWP was around half that reported in our previous prospective study. On the basis of our original study, a total of 174 subjects would be needed to test the hypothesis, assuming that 22% of all distressed subjects would develop new CWP. However, the prevalence of new CWP in our study was 11.3%. Using a background risk of 11% for the above power calculation, we would have needed 423 subjects to test our hypothesis. Our study was therefore rendered underpowered by the unexpectedly low prevalence of new CWP, although we did find that a high tender point count was a significant predictor.

Our study has several strengths. It was prospective, and therefore allows us to draw conclusions on temporality. It was population based, and therefore more generalisable than a clinic-based study. Our ascertainment of psychological status was based on instruments that have been extensively used in the past and that have been shown to predict pain. The use of an algometer allowed us to standardise the force applied during tender point examination, as opposed to digital palpation.

What do these results mean? Ours was a psychologically distressed cohort, and it is possible that subjects with higher tender point counts or lower pain threshold may have coincidentally had less distress, which negated their effect on the outcome. However, we looked at the distribution of Illness Behaviour and Somatic Symptoms across the tender point and pain threshold categories and found no statistically significant differences. If anything, the Illness Behaviour scores were greater among those with higher tender points and lower pressure pain thresholds. Therefore, it is likely that a low pain threshold does not predict CWP.

Further evidence that a low threshold for pain is not constitutive, but acquired, possibly as a result of life events, comes from family studies. In a study of 609 healthy female-female twin pairs (269 monozygotic and 340 dizygotic), pain threshold levels were strongly associated within members of both monozygotic and dizygotic twin pairs, with only a small excess (10%) in correlation observed in monozygotic when compared with dizygotic pairs.²⁰ The results suggest that environmental factors have the most important aetiological

contribution to pain threshold. The influence of genetic factors seems to be substantially less important.

In summary, the present population-based prospective study has shown that while a high tender point count is associated with the onset of new CWP, a low pain threshold at baseline is not. An increased sensitivity to pressure pain in subjects with chronic widespread pain is therefore likely to be a secondary phenomenon rather than the antecedent of pain.

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