Tender Point Scores and Their Relations to Signs of Mobility, Symptoms, and Disability in Female Home Care Personnel and the Prevalence of Fibromyalgia Syndrome

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ABSTRACT. ***Objective.*** In this study of female home care personnel employed in a municipality (n = 643; participation rate 94%) we investigated (1) the prevalence of tender points and fibromyalgia (FM); (2) the relationships between tender point score and other signs and symptoms; (3) if subgroups based on the tender point score differed with respect to signs, symptoms, disability, and health related quality of life; and (4) signs that showed the strongest intercorrelations with disability and health.

Methods. The following variables were registered: (1) Signs: joint mobility, spinal posture and mobility, tender points, and segmental mobility and pain provocation at L4–S1 levels of the low back. (2) Symptoms: pain and pain intensity and other symptoms. (3) Disability (i.e., self-rated reduced capacity for everyday activities and employment) and health: 3 indices and sick leave.

Results. The tender point score correlated with the number of pain regions and the pain intensities, and the amount of other symptoms, sick leave, and disability. Tender point score was the strongest regressor of the investigated signs in regression of the 2 disability indices. Segmental pain showed the strongest correlation with tender point score. Three subgroups identified by tender point score showed significant differences in segmental pain, prevalence and intensity of different symptoms, disability, and health related quality of life. The prevalence of FM was 2.0%.

Conclusion. Tender point score together with different symptoms showed relatively strong correlations with disability. A relatively high prevalence of FM was found in occupationally active female home care personnel. (J Rheumatol 2002;29:603–13)

Key Indexing Terms:
FIBROMYALGIA HOME CARE MUSCULOSKELETAL
PAIN TENDER POINT WOMEN

Clinical signs related to the musculoskeletal system are regarded to have low correlation to pain and disability and little relevance when predicting the outcome of treatments and rehabilitation at the disability level[1-4]. A tender point is a localized area of tenderness in a muscle, muscle tendon junction, fat pad, or bursal region at digital palpation. Tender point palpation is frequently used as a clinical sign to estimate pain sensitivity of the musculoskeletal system.

Jacobs, *et al* concluded that there was no association between frequency of self-reported pain and tender point score for patients with fibromyalgia syndrome (FM) with shorter duration and only a weak association with longer duration of the disease[5]. Nicassio, *et al* found on the other hand that high pain and high pain behavior were independently related to the tender point score and did not independently reflect generalized psychological distress in FM[6]. McBeth, *et al* reported associations between tender points, psychological distress, and adverse childhood experiences[7]. Croft, *et al* asked if FM is just one end of a continuum with more pain and more tender points and concluded that the association between tender points and pain was not restricted to the subgroup with chronic widespread pain[8].

Most studies concerning tender points have been made in groups of patients with FM. Only a few studies have been population based. Such studies are advantageous from several points of view compared to studies based on patients known to the health care system. Population based studies of subjects with similar working conditions are also needed, since occupation and associated factors interact with pain and its consequences. Working in home-care is a common female occupation in Sweden and is generally considered to be heavy and demanding. It is associated with high incidences of work related accidents and diseases/illness[9-11]. This is the third study from a project concerning health factors related to the musculoskeletal system and working

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Supported by grants from Arbetsmarknadsförsäkringar (AMF).

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Submitted May 17, 2001; revision accepted August 28, 2001.

situation in a population of female home-care personnel in the municipality of Nyköping, Sweden. We recently reported, using the same subjects as in this study, that the total lumbar sagittal mobility, segmental mobility, and above all, segmental provocation pain correlated with disability (i.e., self-rated reduced capacity for everyday activities and gainful employment)[12,13]. The aims of the present study of female home-care personnel were to: (1) Investigate the prevalence of tender points and fibromyalgia; (2) investigate the relationships between tender point score and other signs and symptoms; (3) identify subgroups based on the tender point score and to what extent the identified subgroups differed with respect to signs, symptoms, disability, and health related quality of life; and (4) investigate signs (including tender point score) and symptoms that intercorrelated most strongly with disability and health related quality of life.

MATERIALS AND METHODS

Subjects. To take part in the study, the subjects had to fulfil the following criteria: employed in the municipality of Nyköping, working, on parental leave or on sick leave, with or without pain or other dysfunction, and having a permanent position or longterm substitute position that is at least 50% of fulltime as home-care personnel. Based on lists from the employer all employees meeting these criteria were invited to participate in the study. All subjects were informed about the study both individually via a letter and in groups at the workplace. Out of 643 subjects fulfilling the predefined criteria, 607 (94%) participated in this part of the study, of which 1.3% were on parental leave and 1.5% were on sick leave.

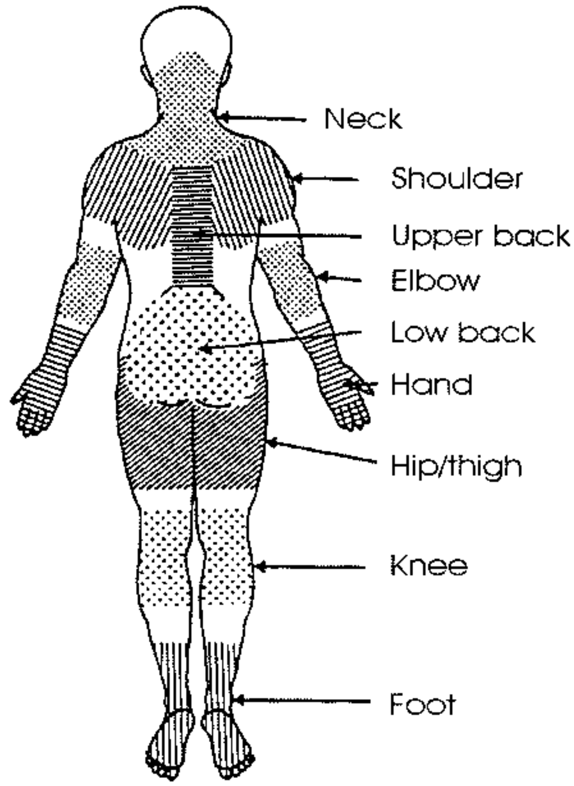

Figure 1. The 9 predefined anatomical regions — neck, shoulder, arm, hand, upper back, low back, hip, knee, and foot — according to the Nordic Council of Ministers questionnaire[14].

Methods. The study consisted of the following steps:

1. Questionnaires

Subjects filled in questionnaires individually after a brief instruction from a test leader and were able to get help from the test leader. The following data were collected.

Sociodemographic data: age, weight, stature, duration of employment, fraction of fulltime (40 h/week = 100%), and number of children (as reported[12,13]).

The 7 day prevalence of complaints from neck, shoulders, upper back, low back, elbows, hands, hips, knees, and feet was registered. The anatomical regions were shown on a drawing and were identical to the regions used in the questionnaire of the Nordic Council of Ministers[14] (Figure 1). An index that counted number of anatomical regions with complaints was calculated (the musculoskeletal index or MS index; possible range 0–9).

Average pain intensity was requested over the previous month for each of 9 anatomical regions (neck, shoulder, arm, hand, upper back, low back, hip, knee, and foot; Figure 1) using 100 mm visual analog scales (VAS) with the anchor points 0 = no pain and 100 = maximal pain.

Fourteen binary questions concerning common symptoms related to FM: (1) generalized pain (i.e., pain in 4 quadrants), (2) symptoms related to physical activity, (3) reduced muscular endurance, (4) symptoms influenced by weather, (5) symptoms influenced by anxiety and stress, (6) sleep disturbances, (7) general fatigue, (8) headache, (9) irritable bowel syndrome, (10) feeling or occurrence of swelling, (11) numbness, (12) anxiety or distress, (13) morning stiffness, (14) axial pain. When generalized pain and spinal pain from these questions were combined (determining those fulfilling both items), this construct was labelled widespread pain (WSP; i.e., the definition of widespread pain according to the FM criteria of the American College of Rheumatology, ACR).

Symptoms from a complementary questionnaire (as described by the Nordic Ministers Council questionnaire[14]). The answer alternatives of the 19 symptoms were on a graded scale (always, often, sometimes, seldom, never): (1) headache, (2) sleeping difficulties, (3) tachycardia, (4) abdominal/bowel problems, (5) gastritis, (6) fatigue, (7) head feeling heavy, (8) dizziness, (9) difficulties in concentrating, (10) eye problems (red, itching, tears), (11) nasal problems, (12) hoarse, (13) sore throat, (14) cough, (15) skin dryness, (16) blush, (17) itching face, (18) skin desquamation, and (19) itching hands.

The Disability Rating Index (DRI) was used to assess mainly physical aspects of disability[15]. The 12 items were divided into 3 sections as follows. Items 1–4: common basic activities of daily life; items 5–8: more demanding daily physical activities; items 9–12: work related or more vigorous activities. The questions are arranged in increasing order of physical demand, particularly with reference to low back pain. The DRI was calculated as the mean of the 12 items (i.e., the DRI is a continuous scale and can vary between 0 and 100; a high value denotes high disability). The items were: (1) dressing without help, (2) outdoor walks, (3) climbing stairs, (4) sitting a long time, (5) standing bent over a sink, (6) carrying a bag, (7) making a bed, (8) running, (9) light work, (10) heavy work, (11) lifting heavy objects, and (12) participating in exercise/sports.

With the same strategy as for the DRI, the subject also answered additional items concerning mainly activities of daily living (ADL) items with focus on the low back (described in detail[13]): (1) rise from sitting, (2) drive a car, (3) stand a long while, (4) bend forward, (5) rise from forward bending, (6) lie prone, (7) lie supine, (8) side lying in bed, (9) go up a hill, (10) go down a hill, (11) how much do you train, (12) how do you manage your physical training now, (13) how do you manage housework, and (14) how do you manage at work? The 8 questions that showed the strongest correlations with low back strain and pain intensity (questions 2 and 4 from the DRI scales and 3, 4, 5, 6, 13, 14 from the additional questions) are summarized as the lumbar index (abbreviated L index), which is the mean of these measurements. This index is not validated.

The Global Self-Rating Index (GSI) is a self-administered health related quality of life instrument that covers 3 parts considered to be important to patients with disorders of the locomotor system: physical condition, psychological condition, and sleep disturbances (Salén, *et al*, unpublished observations). The first and second questions are, "Is your bodily/psychological condition worse than usual?" If the subject answers "yes," there are 4 physical conditions (weakness/fatigue, low endurance, dizziness/unsteadiness, poor appetite) and 4 psychological conditions (psychological exhaustion, depression, poor memory/low concentration, irritation/impatience), where the subject answers in accordance to her perceived condition. Each "yes" answer yields one point. The third and fourth questions are "Do you have difficulty falling asleep because of pain?" and "Do you wake up from sleep because of pain?" If the subject answers "yes," there are 4 alternatives to specify the answer: rarely, sometimes, often, or always, yielding 0.25, 0.50, 0.75, and 1.0 points, respectively. The sum of the items results in a total 0–10 score, where 0 represents the highest measured degree of health related quality of life. Validity and reliability seem to be good for healthy persons and for patients with neck/shoulder/low back pain (Salén, *et al*, unpublished observations, personal communication).

2. A Clinical Examination

The clinical examination was made by 3 experienced physiotherapists according to a predetermined schedule focusing on the following 4 items: (1) Sagittal lumbar mobility and spinal sagittal configuration measured by Debrunner's kyphometer; (2) joint mobility using a modified Beighton score; (3) segmental mobility and segmental provocation pain tests at levels T10 to S1 of the spine by manual examination; and (4) tender point palpation.

Except for tender point palpation, the clinical examination has been described in detail (including references) in the 2 publications resulting from this project[12,13]. Only brief summaries are given below.

Sagittal lumbar mobility and spinal sagittal configuration. Debrunner's kyphometer was used for measurements of spinal sagittal configuration and spinal (thoracic and lumbar) sagittal mobility in the standing position. The kyphometer has a protractor with a 1° scale (80° to 0° to minus 70°) at the end of 2 double, parallel arms, which are connected to 2 blocks. The blocks are large enough to span 2 spinous processes. A total of 606 subjects participated in this part of the study; data were incomplete for one subject. The neutral zero starting position was defined as the configuration in the erect standing relaxed position, arms hanging down, barefoot, and heels 10 cm apart.

Spinal sagittal posture: The kyphosis was measured from a point between the spinous processes of T2 and T3 and from a second point between T11 and T12. The lordosis was measured between T11–T12 and S1–S2. The degrees of kyphosis and lordosis were read directly from the scale. A chart was used for the classification of body posture.

Sagittal lumbar mobility: The sagittal range of motion was determined separately in the lumbar and thoracic spine. Total backward and forward bending from neutral position was recorded, and the total sagittal range of movement was calculated.

Joint mobility. Joint mobility was assessed using a modified Beighton score (0–9 points) at 4 bilateral peripheral sites (yielding 0–2 points each) and forward bending of the trunk (yielding 0–1 point): (1) passive dorsiflexion of metacarpophalangeal joint 5 over 90°, (2) passive apposition of the thumb to the flexion (palmar) aspect of the forearm, (3) hyperextension of the elbow 10° or more, and (4) hyperextension of the knee 10° or more bilaterally, and (5) forward bending of the trunk with knees straight until the palms were put flat on the floor. Mild generalized joint hypermobility was defined as a score of 3–4 and prominent generalized hypermobility as 5 or greater.

Manual testing of segmental mobility and tenderness. With the patient lying on her side with hips and knees flexed and the examiner standing opposite the patient, mobility was tested through passive movements in forward and backward bending, rotation, and translational sagittal "gliding" for each segment from the lumbosacral segment up to T10–T11. The lumbosacral segment was defined as L5–S1. Segmental mobility was estimated by stepwise interspinal palpation from the neutral position. Any tenderness during each part of the testing was recorded.

From this examination, the examiner rated segmental mobility using a 5 grade scale: +2, +1, 0, –1, –2, where +2 = extreme hypermobility, +1 = moderate hypermobility, 0 = normal mobility, –1 = moderate hypomobility, and –2 = extreme hypomobility. The segmental provocation tenderness was categorized using a 2 grade scale: +1 = tenderness and 0 = no tenderness. We have reported good reliability of manual segmental mobility and segmental pain provocation tests in the lowest back segments (Kappa ≈ 0.7)[12]. The results of levels L4–S1 have been used in the different analyses of this study.

Tender point palpation. Digital palpation was performed at 60 predetermined sites (summarized in TP^{60} score), including the sites defined in the ACR criteria[16] (summarized in TP^{ACR} score). Registration was "painful" or "not painful." The 3 physiotherapists were trained to accurately palpate 4 kg with one finger using a weighing machine with 0.1 kg accuracy. Moreover, the physiotherapists worked together and had examined patients with regard to tender points in clinical practice during at least the previous 5 years. Each physiotherapist had participated in roughly 100 double examinations together with one of the authors (GL) with regard to tender points in order to reach consensus in the clinical work. Before the study, they had palpated tender points by training on each other and on subjects not participating in the study with feedback and on one of the authors (GL) with feedback in order to reach consensus of site and pressure technique, and for deciding whether the sign was present or not. Thus they were trained to use the same protocol. FM was defined according to the 1990 ACR criteria[16]. All subjects that had more than 8 tender points according to the 1990 ACR criteria were also palpated by one of the authors (GL) to check that no subject with FM was missed. No additional subject with FM was found using these checks.

Statistics. All analyses were performed using Statistics for Windows (v 5.1), SPSS for Windows (v 9.0), or SIMCA-P (v 7.01). Mean values ± one standard deviation (SD) have been reported for variables and indices; in some instances median values are also reported. To evaluate differences between groups, Kruskal-Wallis analysis of variance (ANOVA) and Mann-Whitney U tests were used. Spearman rank order correlation was used for univariate correlation analysis. A cluster analysis (based on the K-means algorithm) was performed to investigate whether subgroups existed with respect to number of tender points, and to compare any identified subgroups. The identified subgroups, based on the number of tender points, were compared with respect to different variables using ANOVA and post hoc tests (Bonferroni). Regression analysis was performed according to the partial least square technique (PLS) using SIMCA-P. The VIP variable (variable influence on projection) gives information about the relevance of each X-variable and each Y-variable pooled over all dimensions and VIP > 1.0 is significant. In different analyses we regressed the Y-variable (DRI, L index, sick leave and/or GSI) using different signs and symptoms as regressors (X-variables). Multiple linear regression could have been an alternative method for the prediction but it assumes that the regressors (X-variables) are mathematically independent. If such multicolinearity occurs among the regressors, the calculated regression coefficients become unstable and their interpretability breaks down. All statistical tests were performed at the 5% significance level ($p \leq 0.05$, 2 tailed).

RESULTS

This study focuses on the prevalence of tender points and their relationships with other signs, different symptoms, and disability. Results concerning sociodemographic and anthropometric data, pain, joint mobility, posture and sagittal and segmental mobility and pain provocation, and disability have been published[12,13]. The variables of these studies are summarized in Table 1.

Table 1. Pain prevalence, pain and strain intensities, 2 indices of disability, together with the following signs: sagittal mobility of the spine and posture groups according to the kyphyometry, joint mobility according to Beighton score (trichotomized), and segmental mobility and pain provocation tests at L4–S1 levels (summarized from references 12, 13).

Variables	N	Mean	SD
Age, (years)	607	40.5	11.9
Pain intensity, previous month			
Pain neck intensity, mm	604	26.0	27.0
Pain shoulders intensity, mm	604	25.8	25.7
Pain low back intensity, mm	604	34.2	27.9
Disability			
DR index	606	18	16
L index	607	15	15
Sagittal mobility			
Sagittal thoracic mobility (°)	605	35.3	10.6
Sagittal lumbar mobility (°)	605	71.0	13.4
Lumbar extension (°)	605	49.1	10.1
Lumbar flexion (°)	605	21.9	9.3

Variables	N	Percentage	Cumulative Percentage
Smoking			
Prevalence of pain (recent 7 days)			
Pain neck	237	39.2	
Pain shoulders	276	45.7	
Pain low back	287	47.5	
Posture			
Normal posture	507	83.53	83.53
Hyper curvature	28	4.61	88.14
Hypo curvature	22	3.62	91.76
Hyper kyphosis	35	5.77	97.53
Hyper lordosis	14	2.31	99.84
Missing	1	0.16	100.00
Beighton (trichotomized)			
Normal (0–2p)	437	71.99	71.99
Mild hyper (3–4p)	108	17.79	89.79
Prominent hyper (> 4p)	62	10.21	100.00
Segmental mobility			
L4–L5			
Hypo	75	12.4	12.4
Normal	444	73.3	85.6
Hyper	87	14.4	100.0
L5-S1			
Hypo	116	19.1	19.1
Normal	393	64.9	84.0
Hyper	97	16.0	100.0
Pain provocation			
L4-L5			
No	474	78.2	78.2
Yes	132	21.8	100.0
L5–S1			
No	472	77.9	77.9
Yes	134	22.1	100.0

Tender point prevalence. The TP^{ACR} mean value was 2.5 ± 2.8 (median 2) and the TP^{60} mean value was 5.1 ± 6.2 (median 3). The 2 tender point scores were highly intercorrelated (R = 0.921; p = 0.000). About one-third of the subjects (N = 209, 34.6 %) lacked tender points according to TP^{ACR} (Table 2). Corresponding figures for tender points according to TP^{60} were N = 168 (27.9%). Two percent (12 subjects) had a TP^{ACR} number > 10 and 85% had a TP^{60} score < 11 (Table 2).

The most frequent location of tender points in both TP^{ACR} and TP^{60} were the upper trapezius, the suboccipital muscles, and the outer quadrant of the buttocks, with no prominent side differences (Table 3). In most of the analyses reported below, TP^{ACR} and TP^{60} showed nearly identical results. Results related to TP^{60} presented below are only reported when they deviated markedly from the results related to TP^{ACR}. There were marginal, although significant, increases of the number of tender points with increasing age (R = 0.092, p = 0.023). No significant differences in tender point scores existed between smokers and nonsmokers.

Relationships between tender point score and other signs. There was a slight significant increase of TP^{60}, but not TP^{ACR}, in non-normal posture (median 5) in comparison to normal posture (median 3) (p = 0.016). No significant difference in TP^{60} existed between the 4 non-normal posture subgroups. There was no significant relation between joint mobility (Beighton score trichotomized) and TP^{60} or TP^{ACR}.

A significant negative relation existed between lumbar mobility (measured by kyphometry, trichotomized as hyper/normal/hypomobility) and the TP^{60} score (medians: 2, 3, 5, respectively; p = 0.0014). For TP^{ACR} no such significant pattern was seen.

For segmental mobility at the L4–L5 and L5–S1 levels, significantly higher TP^{ACR} scores were noted for the groups with hypo and hypermobility compared to normal mobility (Table 4). Significantly higher TP^{ACR} was noted when segmental pain was recorded at L4–S1 levels (Table 4); segmental pain was associated with 4 times higher TP^{ACR} scores than when it was not present. A principal component analysis (data not shown) confirmed that TP^{ACR} correlated more strongly with segmental pain than with the other symptoms investigated.

Table 2. Distribution of subjects with respect to number of tender points according to TP^{60} (N = 603) and TP^{ACR} (N = 604).

No. of Tender Points	TP^{60} Count	TP^{60} %	TP^{ACR} Count	TP^{ACR} %
0	169	28.03	209	34.60
1–5	223	36.98	315	52.15
6–10	119	19.73	68	11.26
11–15	51	8.46	10	1.66
15–20 (18)	26	4.31	2	0.33
21–25	5	0.83		
26–30	5	0.83		
31–35	4	0.66		
36–40	0	0.00		
41–45	1	0.17		

Table 3. Prevalence (%) of the individual tender points (left and right sides taken together) sorted in order of prevalence.

TP^{60} Rank	TP^{ACR} Rank	Area	N	%
1	1	Upper trapezius	279	46.3
2	2	Suboccipital muscles	171	28.4
3	3	Outer quadrant of buttock	125	20.7
4		Levator scapulae	118	19.6
5	4	Greater trochanter post. part	110	18.2
6		Biceps sulcus and proc. coracoideus	99	16.4
7		Costotranverse articulations	82	13.6
8		Paraspinal muscles	80	13.3
9		Piriformis	78	12.9
10	5	Low cervical (C5–C7)	76	12.6
11	6	Medial part of knee	66	10.9
12		Medial tibia (Sp6)	65	10.8
13		Epicondylus lat	61	10.1
14		C5	59	9.8
15		Margo medialis scapulae	58	9.6
16		Gastrocnemius-Achilles transition	57	9.5
17	7	2 cm dist to lat. Epicondyle	54	9.0
18		Rhomboidei	49	8.1
19		Rotator cuff	49	8.1
20		C6	49	8.1
21		C7	48	8.0
22	8	Second rib	46	7.6
23		Quadratus lumborum	45	7.5
24		M. interosseus 1	44	7.3
25		Scalenius	37	6.1
26		Pectoralis	31	5.1
27	9	Supraspinatus	24	4.0
28		Epicondylus medialis	23	3.8
29		Lateral coll lig of knee	18	3.0
30		Ankle joint	16	2.7
31		Serratus anterior	7	1.2

Relationships between tender point score and pain. Tender point score and generalized pain. The MS index correlated significantly with TP^{ACR} ($R = 0.545$; $p < 0.000$). Those with pain in 4 quadrants (prevalence 16.3%) had a significantly higher number of tender points than those without pain in 4 quadrants — 4.7 ± 3.9 vs 2.1 ± 2.3 ($p < 0.000$). Similar situations were found for axial pain (prevalence 55.8%) — 3.3 ± 2.8 vs 1.2 ± 1.9 ($p < 0.000$), and for those having both these constellations of symptoms labelled widespread pain (WSP) (14.4%): 4.3 ± 3.6 vs 2.1 ± 2.3 ($p < 0.000$).

Prevalence of FM. Twelve out of 607 subjects (2.0%) fulfilled the 1990 ACR criteria and were diagnosed as having fibromyalgia syndrome. The TP^{60} score was 27.9 ± 9.2 in the FM group, compared with 4.7 ± 5.2 for those not fulfilling the ACR criteria.

Relationships between tender point score and pain of certain anatomical regions. Those with neck pain had a significantly higher number of tender points than those without neck pain, 4.2 ± 3.1 vs 1.4 ± 1.8 ($p < 0.000$). Similar situations were found for the shoulders, 3.7 ± 3.2 vs 1.5 ± 1.9 ($p < 0.000$), and the low back, 3.4 ± 3.1 vs 1.7 ± 2.2 ($p < 0.000$).

Neck or shoulder pain was more frequently combined with pain in other regions than low back pain. Hence, there was isolated neck pain in 3.4% of the subjects, isolated shoulder pain in 6.2%, isolated upper back pain in 2.2%, isolated pain in neck plus shoulder in 8.3%, all in comparison to isolated low back pain in 13.4% of the subjects.

Relationships between tender point score and pain intensities. Positive significant correlations existed between TP^{ACR} and the pain intensities. The strongest correlations were towards neck pain and shoulder pain ($R > 0.34$) (Table 5).

Subgroups based on number of tender points. To investigate the distribution of tender points, a cluster analysis was performed based on TP^{ACR} (with the option of identifying 3 clusters/subgroups; Table 6). The 3 clusters differed significantly in TP^{ACR} ($p < 0.000$) as intended; the first cluster had a low number of tender points (0.9 ± 1.0 tender point, range 0–3), the second intermediary (5.2 ± 1.3, range 4–8), and the third the highest number (11.2 ± 2.2, range 9–16). These 3 groups are compared below with respect to other variables under investigation.

Prevalence of signs in the 3 subgroups. The cluster with lowest TP^{ACR} had significantly better lumbar sagittal mobility than the other 2 clusters (Table 6A). Segmental mobility at L5–S1 differed significantly between the clusters; the cluster with highest TP^{ACR} had the greatest prevalence of hypermobility at L5–S1. Significant differences also existed in segmental pain provocation at L4–L5 and

Table 4. Number of tender points (TP^{ACR}) versus segmental mobility and segmental pain at L4–L5 and L5–S1 levels.

Segmental Mobility	p	Post hoc	N	Median	p < 0.05	Segmental Pain	N	Median	p
L4–L5	0.0001	Hypo	75	3	*	No pain	472	1	0.000
		Normal	442	2	/	Pain	131	4	
		Hyper	86	3	*				
L5–S1	0.0000	Hypo	116	4	*	No pain	470	1	0.0000
		Normal	391	1	/	Pain	133	4	
		Hyper	96	2	*				

* Significant difference in post hoc test.

Table 5. Correlation coefficients (Spearman R) between number of tender points according to TP^{ACR} and pain intensities (VAS) in the 9 predefined anatomical regions.

TP^{ACR} vs Pain Intensity of	N	Spearman R	p
Neck	604	0.40	< 0.000
Shoulders	604	0.34	< 0.000
Upper back	604	0.27	< 0.000
Arms	604	0.26	< 0.000
Low back	604	0.26	< 0.000
Hands	604	0.24	< 0.000
Hips	604	0.24	< 0.000
Knees	604	0.20	< 0.000
Ankles and foot	604	0.21	< 0.000

L5–S1 levels. Thus the prevalences with positive signs increased from 13 to 14% in the first cluster (mean TP^{ACR} 0.92) to 34–35% in the second cluster (mean TP^{ACR} 5.15), and in the third cluster (mean TP^{ACR} 11.19) to 76% (Table 6A).

Prevalence of symptoms in the 3 subgroups. The prevalence of symptoms (in both the symptoms directly related to pain and most of the other symptoms) increased with number of tender points (Table 6A, 6B). No significant differences were found between the 3 subgroups for the majority of the symptoms related to the skin. For most of the symptoms, the differences in prevalences tended to be more prominent between the first and the second clusters than between the second and third clusters.

In the first cluster (lowest number of tender points), 25.4% had MS index of 0 (i.e., lacked pain). The corresponding figure for the second cluster was 4.6% and for the third cluster 0%. In the third cluster all subjects had pain from 2 or more of the predefined 9 anatomical regions.

Disability, sick leave, and Global Self-Rating Index in the 3 subgroups. Positive correlations existed between TP^{ACR} and the DRI ($R = 0.418$; $p < 0.000$) and the L index ($R = 0.405$; $p < 0.000$). This pattern was also recognized in the cluster analysis (Table 6C). Slight but significant increases of TP^{ACR} ($p = 0.01$) with increasing days of reported sick leave were noted. An overall significant difference existed

Table 6. Cluster analysis based on number of tender points according to TP^{ACR} (above the broken line). The 3 identified clusters have been compared with respect to age, signs, pain and other symptoms, GSI, and disability variables using ANOVA (below the broken line). Sick leave was categorized in 4 classes (≥ 30 days taken together). Note the table is divided in 3 parts (A–C).

Table 6A Variables	Group 1, n = 410 Mean	SD	Group 2, n = 173 Mean	SD	Group 3, n = 21 Mean	SD	ANOVA p	Posthoc Bonferroni Gr1 vs Gr2	Gr1 vs Gr3	Gr2 vs Gr3
TP^{ACR}	0.92	1.07	5.15	1.28	11.19	2.23	0.000	*	*	*
Age	39.4	11.7	43.0	12.1	41.2	9.9	0.004	*	NS	NS
Signs										
Lumbar sagittal mobility (°)	72.84	13.17	67.01	12.91	67.90	15.97	0.000	*	NS	NS
Beighton	1.55	1.85	1.35	1.83	2.10	1.97	0.167	NA	NA	NA
Segmental mobility† L4–L5	0.01	0.46	0.01	0.61	0.19	0.68	0.293	NA	NA	NA
Segmental mobility† L5–S1	0.00	0.53	–0.18	0.67	0.48	0.68	0.000	*	*	*
Pain provocation ** L4–L5	0.13	0.34	0.35	0.48	0.76	0.44	0.000	*	*	*
Pain provocation ** L5–S1	0.14	0.35	0.34	0.47	0.76	0.44	0.000	*	*	*
Symptoms–Pain										
Prevalence neck pain	0.24	0.43	0.70	0.46	0.95	0.22	0.000	*	*	*
Prevalence shoulder pain	0.33	0.47	0.72	0.45	0.90	0.30	0.000	*	*	NS
Prevalence low back pain	0.38	0.49	0.66	0.47	0.81	0.40	0.000	*	*	NS
Pain intensity neck	18.74	23.52	39.35	27.34	57.24	22.75	0.000	*	*	*
Pain intensity shoulders	19.79	22.86	37.50	26.69	47.48	25.71	0.000	*	*	*
Pain intensity low back	29.54	26.94	42.98	27.32	52.38	28.58	0.000	*	*	*
MS index	1.74	1.57	3.64	1.90	5.05	1.77	0.000	*	*	*
Widespread pain	0.09	0.29	0.21	0.41	0.67	0.49	0.000	*	*	*

* Significant difference between the 3 clusters; posthoc test (Bonferroni) was used to localize differences between the 3 clusters. NS: no difference; NA: not applicable. †3 graded scale (–1 = hypomobility, 0 = normal, 1 = hypermobility). **2 graded scale (0 = no pain/tenderness, 1 = pain/tenderness).

Table 6B Variables	Group 1, n = 410 Mean	SD	Group 2, n = 173 Mean	SD	Group 3, n = 21 Mean	SD	ANOVA p	Posthoc Bonferroni Gr1 vs Gr2	Gr1 vs Gr3	Gr2 vs Gr3
TP[ACR]	0.92	1.07	5.15	1.28	11.19	2.23	0.000	*	*	*
Other symptoms										
Fibromyalgia symptoms†										
Pain 4 quadrants	0.10	0.30	0.24	0.43	0.76	0.44	0.000	*	*	*
Symptoms related to physical activity	0.17	0.37	0.39	0.49	0.43	0.51	0.000	*	*	NS
Reduced muscular endurance	0.09	0.28	0.44	0.50	0.38	0.50	0.000	*	*	NS
Symptoms influenced by weather	0.14	0.35	0.28	0.45	0.29	0.46	0.000	*	NS	NS
Influence by anxiety and stress	0.30	0.46	0.49	0.50	0.67	0.48	0.000	*	*	NS
Sleep disturbances	0.13	0.34	0.35	0.48	0.55	0.51	0.000	*	*	NS
General fatigue	0.17	0.38	0.34	0.47	0.52	0.51	0.000	*	*	NS
Headache	0.09	0.28	0.22	0.42	0.38	0.50	0.000	*	*	NS
Irritable bowel syndrome	0.11	0.31	0.11	0.31	0.10	0.30	0.972	NA	NA	NA
Feeling or occurrence of swelling	0.14	0.35	0.33	0.47	0.32	0.48	0.000	*	NS	NS
Numbness	0.12	0.32	0.32	0.47	0.33	0.48	0.000	*	*	NS
Anxiety or distress	0.06	0.24	0.19	0.39	0.24	0.44	0.000	*	*	NS
Morning stiffness	0.30	0.46	0.59	0.49	0.86	0.36	0.000	*	*	*
Axial pain	0.44	0.50	0.82	0.38	0.89	0.32	0.000	*	*	NS
5 graded symptoms††										
Headache	2.55	0.81	2.85	0.85	3.05	0.89	0.000	*	*	NS
Sleeping difficulties	2.28	0.94	2.56	0.96	3.00	1.08	0.000	*	*	NS
Tachycardia	1.47	0.75	1.74	0.84	1.80	1.01	0.000	*	NS	NS
Bowel problems	2.02	1.03	2.23	1.01	2.10	0.79	0.089	NA	NA	NA
Gastritis	1.85	1.01	2.33	1.11	1.95	1.05	0.000	*	NS	NS
Fatigue	3.08	0.72	3.24	0.75	3.65	0.67	0.000	NS	*	NS
Head feeling heavy	2.53	0.83	2.81	0.88	3.30	0.66	0.000	*	*	*
Dizziness	1.68	0.79	1.89	0.83	2.05	0.94	0.007	*	NS	NS
Concentration problems	1.98	0.77	2.10	0.79	2.50	0.69	0.007	NS	*	NS
Eye problems	1.81	0.94	1.80	0.88	2.20	0.95	0.172	NA	NA	NA
Nasal problems	1.94	0.99	1.82	0.93	2.40	1.31	0.039	NS	NS	*
Hoarseness	1.76	0.87	1.90	0.88	2.00	0.92	0.150	NA	NA	NA
Sore throat	1.45	0.67	1.45	0.65	1.80	0.77	0.075	NA	NA	NA
Cough	1.64	0.67	1.80	0.86	1.80	0.89	0.045	*	NS	NS
Skin dryness	2.12	1.13	2.01	1.17	2.35	1.23	0.361	NA	NA	NA
Blush	1.54	0.80	1.55	0.78	1.80	1.06	0.374	NA	NA	NA
Itching face	1.40	0.72	1.45	0.73	1.70	0.98	0.181	NA	NA	NA
Skin desquamation	1.49	0.87	1.56	0.96	1.60	1.14	0.652	NA	NA	NA
Itching hands	2.27	1.18	2.35	1.27	2.55	1.28	0.523	NA	NA	NA

* Significant difference between the 3 clusters; posthoc test (Bonferroni) was used to localize differences between the 3 clusters. NS: no difference; NA: not applicable. † 2 graded scale (0 = no and 1 = yes). †† 5 graded scale (never = 0 to 5 = always).

Table 6C Variables	Group 1, n = 410 Mean	SD	Group 2, n = 173 Mean	SD	Group 3, n = 21 Mean	SD	ANOVA p	Posthoc Bonferroni Gr1 vs Gr2	Gr1 vs Gr3	Gr2 vs Gr3
TP[ARC]	0.92	1.07	5.15	1.28	11.19	2.23	0.000	*	*	*
Health										
GSI	0.86	1.36	1.77	1.67	2.29	1.68	0.000	*	*	NS
Disability										
Sick leave	1.05	1.16	1.28	1.44	1.76	1.58	0.012	NS	*	NS
DR index	13.78	12.89	25.81	16.41	35.86	20.69	0.000	*	*	*
L index	12.00	12.72	23.58	17.09	33.98	21.69	0.000	*	*	*

*Significant differences between the 3 clusters; posthoc test (Bonferroni) was used to localize differences between the 3 clusters. NS: no difference; NA: not applicable.

between the 3 clusters in sick leave (Table 6C). Significant correlations existed between tender point scores and GSI (R = 0.32; p < 0.000). This pattern was also seen in the cluster analysis (Table 6C).

Regression of disability, sick leave, and GSI. The DRI could be significantly regressed using the different signs (R^2 = 0.23). Tender point score was a stronger regressor than the other signs: TP^{ACR} (VIP 1.73), pain provocation L4–L5 (VIP 1.22), pain provocation L5–S1 (VIP 1.14), and lumbar total sagittal mobility (VIP 1.02) (the other signs were not significant, i.e., VIP < 1.0). A similar pattern was also found when the L index was regressed.

A PLS regression of the DRI and L index was carried out simultaneously (i.e., 2 Y-variables) (R^2 = 0.38) in order to understand the relative importance of the investigated signs versus different pain related symptoms. The 5 most important significant regressors were MS index (VIP 1.76), pain intensity of low back (VIP 1.66), presence of low back pain (VIP 1.43), TP^{ACR} (VIP 1.40), and pain intensity of neck (VIP 1.18). The only additional signs that were significant were pain provocation at L4–L5 (VIP 1.07) and pain provocation at L5–S1 (VIP 1.00). It was not possible to regress sick leave using the signs and symptoms.

When GSI was regressed (R^2 = 0.22), the 5 most important significant regressors were MS index (VIP 1.90), TP^{ACR} (VIP 1.42), pain intensity of shoulder pain (VIP 1.37), presence of shoulder pain (VIP 1.37), and pain intensity of low back (VIP 1.27). No sign other than TP^{ACR} had significant importance in this regression.

DISCUSSION

Our study focused upon a common Swedish female occupation associated with relatively low socioeconomic status. Studies focusing upon tender point occurrence have mainly been based on groups of patients with FM or patients at specialist centers[5,6,17,18] and relatively few studies of tender points and/or FM have been population based[19-23]. Musculoskeletal pain tends to be milder and less chronic in the community than in speciality clinics[17,24]. Population based samples are desirable from several points of view, but the effects of occupation or socioeconomic status might bias the results and conclusions; blue collar work or low socioeconomic status are associated with higher prevalences of pain, work related injuries/diseases, and greater consequences[9,22,25,26].

Our study had few dropouts (6%). As reported, there was a low prevalence of sick leave and it is likely that a healthy worker effect existed[13]. Unfortunately, no systematic data are available for the dropouts (6%), but as far as is known, this is a heterogeneous group.

Tender points. Interrater reliability of digital tender point examination has been reported[19,27]. Among patients with FM, the inter and intraobserver reliabilities of the digital tender point examination appear to be high[23]. The validity of our results can be challenged, in that 3 examiners were used and for economic and practical reasons we did not measure inter and intra reliability. However, the examiners had relatively long clinical experience and worked together for several years; they learned to palpate with 4 kg and practiced tender point palpation together in order to have a high degree of consensus at examination. Signs are considered as objective phenomena that are observed by an independent examiner. However, many of the signs in clinical practice — including signs associated with pain reports such as tender point palpation — include cooperation from the patient and have subjective elements. Only certain laboratory tests appear to be objective in a strict sense. Moreover, whether a test is judged as a sign or not at physical examination appears to some extent to be due to the medical speciality of the investigating physician and the kind of medical condition of the patient.

What is a tender point? Recently it was reported that a tender point in the trapezius of female cleaners with and without trapezius myalgia and healthy female teachers was associated with significantly higher prevalence of ragged red fibers than in subjects without a tender point in trapezius (subjects with FM were not studied)[28]. Ragged red fibers are mainly found among type I fibers and appear to be related to insufficient blood supply[29]. Tender points in subjects with few tender points might indicate lowered pain thresholds due to peripheral nociception in the muscle or other tissues, leading to pain evoked by digital palpation. Central sensitization cannot be excluded in more regional pain conditions[30], and thus the cause of the allodynia at the tender point could reasonably be either a peripheral or central sensitization, or both. The tender point concept has been discussed in the context of FM since it is a part of the criteria[16]. Allodynia in FM is generalized and is even present at sites with no pain (i.e., not only at tender point sites), which suggests central nervous system dysfunction in FM[31]. Signs of central sensitization in major subgroups of patients with FM[32-35], failure of descending pain inhibition systems[36,37], motor cortical dysfunction[38], and neuroendocrine deficiencies[39] have also been found, giving support to the hypothesis of aberrant central pain mechanisms. Peripheral muscle involvement in FM has also been reported[40-42]. Even though current opinion appears to be that peripheral or central factors have initiated a condition with aberrant central pain mechanisms, it must be pointed out that FM is a syndrome that might have a heterogeneous picture with regard to the amount of peripheral and central factors. Thus, even though tender points are found in both localized and widespread pain conditions, they might not be maintained by identical mechanisms. Our finding that a positive segmental pain provocation test at L4–S1 level was associated with a 4 times higher TP^{ACR} is reasonable because both these signs are elicited by pressure pain palpation. Thus possible explanations for this relationship could be that it reflects localized, regional, or generalized allodynia.

We found a positive weak significant correlation between tender point score and age. Increasing tender point scores in FM with increasing age have also been reported[43,44]. In a 5.5 year prospective study, the tender point score increased significantly both in the total sample of different kinds of pain conditions and in the 3 subgroups — the persisters, the deterioraters, and the improvers[45]. The authors concluded that an increasing number of tender points should not be interpreted as a poor prognostic sign if pain status does not deteriorate also. Tender point score was not a significant predictor for FM in a prospective study[46]. The risk of developing FM was considerably higher in women with extensive pain[46]. Limited pain also represented an increased risk for developing FM. Pain > 6 years duration, > 4 associated symptoms, not feeling refreshed in the morning, and paresthesia were found to be predictors.

Prevalence of FM in women. In this study a relatively high prevalence of FM (2.0%) was found in occupationally active women, despite the likely existence of a healthy worker effect. Using the Yunus criteria for FM, a prevalence of 1% in a town in Sweden was reported[47]. The overall prevalence of FM in an adult Finnish population was 0.75%[48]. The minimum prevalence was estimated to be 1.8% in a German population[49]. Recent studies from North America have reported prevalences of 3.2 to 4.9%[20,22,50].

Disease spectrum. The different measures of widespread pain (MS index and WSP) correlated with tender point score, consistent with earlier reports[19,51]. In FM, weak or nonexisting relations between self-reported pain and tender point scores have been reported[5,52,53]. On the other hand, Nicassio, *et al* reported that high pain, high pain behavior, and shorter illness duration were independently related to tender point scores in FM[6].

The majority of subjects belonging to the third cluster had widespread pain. Indeed, all subjects with ≥ 11 tender points according to the ACR criteria were also diagnosed as having FM. In contrast to our results, Croft and coworkers found that the majority of subjects with 11 or more tender points did not report chronic widespread pain[8,51]. It has been suggested that chronic musculoskeletal pain represents a continuum (without qualitative differences), with chronic WSP and FM as the most severe clinical manifestations[8,45,54].

A greater clinical similarity has been reported between individuals with between 0 and 6 tender points and between 7 and 10 tender points than between those with 7 to l0 tender points and those with 11 to 14 tender points[23]. These findings can be interpreted as if distinct subgroups exist. Obviously from the present study, it is possible to identify subgroups based upon tender point score, but this does not necessarily mean that the differences are qualitative.

In our study, 14.4% had widespread pain. We used a stricter definition of WSP than the ACR criteria (i.e., the definition according to the ACR criteria for FM). In a population based study from Oslo, Norway, a prevalence of 10% of generalized pain was found among women[55]. Using the Manchester definition of chronic widespread pain, Hunt, *et al* reported a prevalence of 4.7%[56]. Wolfe, *et al* reported in a community based study a prevalence of 10.6% (using the ACR[57] criteria for WSP)[20]. Croft, *et al* reported a prevalence of WSP of 16% in women[58]. Only 35% of the subjects with WSP had the condition when followed up 1–3 years later[17], but WSP was less favorable when it was accompanied by other symptoms. Retrospective studies show that in most cases FM is preceded by local/regional chronic pain[59]. Forseth, *et al* reported a 10% increase in chronic WSP and a 15% increase of FM throughout a 5.5 year perspective[45].

Tender points and other symptoms. Symptoms not directly pain related also correlated with tender point score. Similar results have been reported in several studies[18,19,43,51]. Croft, *et al* suggested that tender points are a measure of general distress[8,51]. Subjects with psychological distress and with ≥ 5 tender points had significantly lower levels of self-care, a greater number of somatic symptoms, high levels of fatigue, pattern of illness behavior, and adverse childhood experiences[7]. A significantly increased prevalence of mental disorders and different symptoms have been reported in chronic WSP in population based studies[56,60]. Tender point scores did not indicate psychological disturbance or distress in FM[6].

Disability and health related quality of life. Disability according to sick leave, the DRI, and the L index generally increased with tender point score (Table 6C). A group with generalized pain in a geographically defined population had higher numbers of tender points, more symptoms, and greater disability measured as sick leave[25]. A great proportion of those with WSP including FM in the present study were employed. Henriksson and Liedberg reported that 50% of female patients with FM referred to a university hospital were employed[61]. The Henriksson and Liedberg study and our study had different selections of subjects. WSP and especially FM were associated with higher prevalence of disability pension than in general controls (FM 26.0%, WSP 9.2%, and controls 3.0%)[21]. Several studies imply that the consequences at the disability level in FM are considerable[62]. However, the validity of self-reported disability in FM has been questioned[63].

The health related quality of life (GSI) differed significantly between the 3 clusters. These differences are not only due to differences between the first and third cluster. Indeed, significant differences between cluster 1 and 2 existed for GSI, the DRI, and the L index, and the differences between clusters 1 and 2 were similar or somewhat greater in these variables than the difference between clusters 2 and 3. In other words, a relatively moderate number of tender points will be associated with clinical consequences not only with respect to pain and other symptoms, but also with respect to aspects of disability and health related quality of life. Tender point score was the strongest regressor among the signs in the regressions of the DRI, the L index, and the GSI. It also remained significant in a multivariate context that included symptoms. It is known that FM is associated with prominent decreases in quality of life[64-66].

In summary, from our findings tender point score correlated with widespread pain, pain intensities, amount of symptoms not directly pain related, and disability. A relatively high prevalence of FM (2%) was found among female home-care personnel. In contrast to other studies, it was found that tender point score together with different symptoms showed relatively strong correlations with disability.

ACKNOWLEDGMENT

We are very grateful for valuable comments from Associate Professor K.G. Henriksson. We also thank the physiotherapists Annika Enquist-Blid, Cecilia Nordholm-Berg, Marie Levin, and Ulf Forsberg, nurse Birgitta Carlsson, secretary Lena Matsson, and all homecare personnel who participated in this study.

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