



# Performance of the American College of Rheumatology 2016 criteria for fibromyalgia in a referral care setting

Sakir Ahmed<sup>1</sup> · Amita Aggarwal<sup>2</sup> · Able Lawrence<sup>2</sup>

Received: 20 March 2019 / Accepted: 6 May 2019 / Published online: 17 May 2019  
© Springer-Verlag GmbH Germany, part of Springer Nature 2019

## Abstract

The American College of Rheumatology (ACR) 2016 criteria for fibromyalgia (FM) is recommended for use in primary and referral setting. However, neither the ACR 2016 nor its predecessor ACR 2010 criteria have been validated in a referral setting. We hypothesized that the presence of higher comorbidities in the referral care setting may affect the performance of the ACR 2016. All patients referred to a tertiary care hospital with widespread pain for more than 3 months were screened using (1) the ACR 2016 criteria and (2) by a blinded expert physician (using ACR 1990 criteria). Using the ACR 1990 as reference standard, the sensitivity and specificity were calculated. Also, concomitant depression (BPHQ: Brief Patient Health Questionnaire), anxiety disorder (GAD7: Generalized Anxiety Disorder-7) and alexithymia (TAS-20: Toronto Alexithymia Scale-20) were screened for using standardized instruments. Other central sensitization syndromes were also screened clinically. Of 147 patients (132 females; median age 36 [30–45] years, median symptom duration 4 [1–6] years), 112 met the ACR 1990 criteria while 93 met the ACR 2016 criteria. There was disagreement between the two criteria in 47 patients. The sensitivity and specificity of ACR 2016 were 71% and 60%, respectively. Patients diagnosed by ACR 2016 criteria alone, had higher GAD7 scores than those diagnosed by the ACR 1990 alone. However, BPHQ and TAS-20 did not differ between the groups. Patients diagnosed by the ACR 2016 criteria had a greater odds (OR 5.2 CI 1.3–21.7,  $p = 0.022$ ) of having concomitant restless leg syndrome or post-traumatic stress disorder or chronic fatigue syndrome. The sensitivity/specificity of the ACR 2016 in tertiary settings matched those found in previous primary care-based studies. Thus, the ACR 2016 criteria are valid for use in the tertiary setting. However, patients diagnosed by only the ACR 2016 criteria (and not by the ACR 1990) have high probability of having another concomitant comorbidity.

**Keywords** Fibromyalgia · Diagnosis · Stress disorders, posttraumatic

## Introduction

Fibromyalgia (FM) is characterized by widespread pain, fatigue, distress and various degrees of other related symptoms [1]. The first two objective evidences of FM being a distinct entity were the sleep EEG changes and the presence of tender points. Sleep disturbances were demonstrated in FM in 1975 [2]. Then tender points were established in the 1990 ACR (American College of Rheumatology) criteria for FM [3]. These led to the acceptance of FM as a distinct disease entity [4] and made clinical trials, and medical and insurance reimbursements easier [5].

The tender point assessment required training and expertise making the diagnosis operator dependent and unsuitable for use by non-experts in primary care [6]. Then there were patients, especially male patients, with insufficient number of tender points who had pure widespread pain.

✉ Able Lawrence  
abledoc@gmail.com

Sakir Ahmed  
sakir005@gmail.com; sakir.ahmed@kims.ac.in

Amita Aggarwal  
aa.amita@gmail.com

<sup>1</sup> Department of Clinical Immunology and Rheumatology, Kalinga Institute of Medical Sciences (KIMS), KIIT University, Bhubaneswar 751024, India

<sup>2</sup> Department of Clinical Immunology & Rheumatology, Sanjay Gandhi Postgraduate Institute of Medical Sciences (SGPGIMS), Lucknow 226014, India

As mentioned by the authors of the ACR 1990 criteria, they had proposed tender points as an objective measure to characterize FM. They had not wanted to dichotomize it into two watertight compartments based only on tender point counts. A patient with FM may have only eight or ten tender points. But the 1990 criteria seemed to enforce the minimum requirement of 11 tender points that was in essence arbitrary [6, 7]. It has been shown that patients with widespread pain and lesser number of tender points (< 11) also behave similarly as those meeting the 1990 criteria [8]. Also, the 1990 criteria focused only on pain and neglected the other associated symptoms [9].

The 2010 proposed criteria for FM replaced the tender points entirely with a questionnaire and therefore made it patient centric and suitable for use in primary care and survey settings [6]. The 2010 ACR criteria have been extensively validated in the primary setting and translations to other languages have also been validated [10–15]. The entry criterion was simple without need for widespread pain. This led to inclusion of regional pain syndromes [16, 17] and possibly various psychiatric conditions associated with non-persistent pain being diagnosed as FM. Secondly, the 2010 criteria required the exclusion of other conditions causing pain which presented problems in patients with other comorbidities. The 2010 criteria were originally proposed as diagnostic criteria in primary care only. However, they became increasingly popular and are used in clinical practice and research in both primary and referral settings.

The 2016 modification of the 2010 criteria tried to correct the aforementioned shortcomings by specifying a minimum duration of 3 months of pain and also re-introducing widespread pain [16]. While the original 1990 criteria defined widespread pain as pain above and below the diaphragm, right and left and central and peripheral pain, the 2016 modification simplified it as pain in any four out of the five regions (the four quadrants and axial). It removed the physician assessment of the extent of somatic symptoms and replaced it by a summary score of three self-reported symptoms [18]. The 2016 modification removed the requirement for exclusion of other diseases and validated its use for both diagnosis (when administered by a physician) and classification when used as a survey form. Despite its widespread adoption, the 2016 modification has never been validated in a tertiary referral setting. Thus, we sought to evaluate the performance of the 2016 criteria in the referral care setting.

We hypothesized that comorbidities such as depression, anxiety disorder and alexithymia would be more in the referral setting, leading to higher probability of misdiagnosis by the newer criteria as they do not have objective criterion of tender points. Depression can present with somatic pain [19]. Similarly, anxiety accentuates pain inference and catastrophizing [20]. Alexithymia is the inability to identify and describe emotions. Subjects with alexithymia have higher

risk of developing chronic pain. This may in itself predispose them to FM.

Our primary objective was to compare the performance of the 2016 criteria of FM in a tertiary care setting and our secondary objective was to compare depression, anxiety disorder and alexithymia in patients fulfilling the ACR 2016 criteria as compared to the ACR 1990 criteria.

## Methods

The study was carried out at a tertiary care referral hospital in central India. All patients were enrolled after written informed consent. The institutional ethics committee, SGPGIMS, Lucknow, approved the project (IEC Code 2016-40-DM-EXP). This was a cross-sectional study carried out over a period of around 18 months.

The inclusion criterion was presence of widespread pain for at least 3 months without a prior diagnosis of FM. The exclusion criteria included the presence of inflammatory rheumatic diseases, osteomalacia, chronic kidney or liver disease, uncontrolled diabetes mellitus or malignancies. Though exclusion of other conditions is not required by the 2016 criteria, we did it to prevent confounding.

## Data collection

All data were collected using a predesigned questionnaire that captured demographic data, clinical features including characteristics of pain, presence of comorbidities, height and weight. Pain characteristics included duration of pain, episodic or persistent, intensity of pain on visual analogue scale (0–10) and early morning stiffness. Widespread Pain Index (WPI) and Symptom Severity (SS) Score were obtained from the standard questionnaire for the 2016 criteria. Manual tender point counts were performed independently by SA and AL to assess the interrater variability of tender point count and the ACR 1990 diagnosis of FMS. The tender point count by AL was considered for the ACR 1990 classification for the purpose of the study.

The ACR 2016 modified diagnostic criteria for FM was administered by a physician on the subjects. Then the validated Hindi language versions of Brief Patient Health Questionnaire (BPHQ) [21], Generalized Anxiety Disorder-7 (GAD7) [22] and Toronto Alexithymia Scale-20 (TAS20) [23] were self-administered by the subjects. The BPHQ has nine questions with a score of 0–3 for each question (range 0–27). A score of 5–9 indicates mild depression, 10–14 moderate depression and > 15 severe depression. The GAD-7 has seven questions with scores of 0–3 per question. A score of more than seven implies probable anxiety disorder. The TAS-20 has 20 questions each with a score 0–3. The authors do not advocate any

dichotomization, but higher scores imply higher levels of alexithymia.

Obstructive sleep apnoea syndrome (OSA), restless legs syndrome (RLS), posttraumatic stress disorder (PTSD), chronic fatigue syndrome (CFS) and temporo-mandibular joint syndrome (TMJ) are associated with somatic pains of central origin [24] and patients were screened for these disorders by an expert physician (AL). PTSD was diagnosed when the patient reported a traumatic event prior to the onset of symptoms and experienced reliving/flashbacks and showed avoidance behaviour fulfilling DSM-IV criteria [25]. RLS and CFS were diagnosed through detailed history if they fulfilled their respective criteria [26, 27]. Definitive diagnosis of OSA requires polysomnography that was not possible for all patients.

### Clinical examination

All patients underwent a detailed musculoskeletal examination to exclude any inflammatory arthritis. In addition, 18-point-based tender point assessment was done. Investigations included erythrocyte sedimentation rate, C-reactive protein, serum calcium, albumin and alkaline phosphatase. Additional investigations were carried out as needed to exclude other disease.

Final clinical diagnosis of FM based on ACR 1990 criteria was made by an experienced physician (AL) with more than 10 years of experience in tender point assessment as well as the diagnosis and management of FM. Tender point assessments were done independently both by the primary assessor (SA) and the expert (AL). Patients were assessed by both SA and AL on the same day. The need for two assessors (with different levels of experience) was felt to explore the variability in implementation of the ACR 1990 criteria.

### Data analysis

Data analysis was done using STATA version 14. The normality of variables was assessed using skewness, kurtosis and Shapiro–Wilk W statistics. Intergroup comparison of medians between the subgroups was done using Kruskal–Wallis test, the non-parametric option for one-way analysis of variance. Fischer’s exact test was used for contingency tables. Linear regression was used to analyse the predictors of pain. Interobserver reliability was evaluated using Cohen’s kappa for categorical data and intraclass correlation coefficient for continuous variables as applicable [28].

### Results

159 consecutive patients with widespread pain of more than 3 months were screened. However, 12 had inflammatory rheumatic disease and were thus excluded. Among the 147

patients, 132 were females. The median age of the patients was 36 (IQR 30–45) years and the median duration of symptoms was 4 (1–6) years. The median intensity of WPI was 12 (9–16), the number of tender points was 15 (11–17), symptom severity was 6 (4–7) and the pain intensity was 7.5 (5–9).

Of the 147 patients included in the study, 112 were diagnosed with FM by the expert using the ACR 1990 (reference standard), while 93 were classified as having FM by the ACR 2016 criteria (Table 1). While there was agreement between the two assessors in 100 patients (79 FM and 21 non-FM), there was disagreement in 47 patients with 33 patients being classified as having FM by an expert (ACR 1990) and another 14 by ACR 2016 alone. The Cohen’s kappa coefficient between ACR 1990 and ACR 2016 was only 0.26 ( $P=0.0005$ ), suggesting poor agreement in the diagnosis by the two criteria.

The tender point counts were lower (mean difference  $0.87 \pm 3.42$ ) for the primary assessor compared to the expert. The tender point scores had an intraclass coefficient (ICC, 2 way mixed effects, consistency of agreement, individual measure) of 0.80 (0.73–0.85,  $P < 0.001$ ).

The sensitivity of ACR 2016 was 71% (Table 2), while the specificity was 60% when the ACR 1990 was taken as the reference standard. Although the performance of the ACR 2016 did not differ between males and females, it performed poorly among females compared to ACR 1990 (Table 1).

The patients’ FMS by ACR 1990 alone, ACR 2016 alone or both did not differ from those without FMS in age, duration of symptoms or body mass index. While pain, Widespread Pain Index, Symptom Severity Score, Polysymptomatic Distress Score and anxiety (GAD7) differed between the four groups, there was no difference in depression (BPHQ) or alexithymia (TAS20) (Table 3).

**Table 1** Agreement and concordance of the diagnosis of fibromyalgia (FM) by the ACR2016 criteria versus the ACR1990 criteria, stratified by gender and overall

Sex	ACR 2016	ACR1990		Total	P value*
		FM	No FM		
Female	FM	74	11	85	0.006
	No FM	31	16	47	
	Total	105	27	132	
Male	FM	5	3	8	0.315
	No FM	2	5	7	
	Total	7	8	15	
Combined male and female	FM	79	14	93	0.002
	No FM	33	21	54	
	Total	112	35	147	

\*Fisher’s exact test

**Table 2** Sensitivity and specificity of the ACR2016 criteria as compared to the ACR1990 criteria stratified by gender and overall

	Female	Male	Combined
Sensitivity	71% (74/105)	71% (5/7)	71% (79/112)
Specificity	59% (16/27)	63% (5/8)	60% (21/35)
Positive predictive value	87% (74/85)	63% (5/8)	85% (79/93)
Negative predictive value	34% (16/47)	71% (5/7)	39% (21/54)

However, on univariate analysis, pain, tender points, WPI score, SS score, BPHQ and GAD7 scores were significantly different among patients in the four groups: non-FM, FM by only ACR 1990, FM by both and FM by only ACR 2016 (Table 3). Only TAS20 was not different between the groups. The same variables (except TAS20) were significant by multivariate analysis (data not shown).

The predictors of pain were analysed using linear regression (Table 4). The tender point count was the single most important predictor of pain, followed by GAD7. While there were 15 patients with irritable bowel syndrome, there was no difference between the subgroups (Table 3). There were five patients with restless legs

**Table 4** Predictors of pain

Variable	Coefficient	Standard error	Significance
Tender points	0.129	0.034	< 0.001
Widespread Pain Index	0.049	0.043	0.259
SS Score	0.069	0.087	0.429
TAS20 (alexithymia)	0.040	0.013	0.003
BPHQ (depression)	0.059	0.046	0.206
GAD7 (anxiety)	0.098	0.045	0.030

syndrome (RLS), nine with posttraumatic stress disorder (PTSD) and three with chronic fatigue syndrome (CFS). The presence of RLS, PTSD or CFS (Table 3) was associated with the diagnosis of FM by ACR 2016 criteria (Odds Ratio 5.2 CI 1.3–21.7,  $P=0.022$ ), while the presence of tender points was negatively associated (odds ratio 0.83 CI 0.76–0.92  $P<0.001$ ). Seven (7/14) patients classified as having FM by ACR 2016 alone, had comorbid RLS/PTSD/CFS against none (0/33) classified as having FM by ACR 1990 alone, and only 6 (6/79) of those classified as having FM by both ACR 2016 and ACR 1990 had RLS/PTSD/CFS (Table 3).

**Table 3** Clinical parameters and various comorbidities in patients (1) not having FM, and those diagnosed (2) exclusively by the ACR1990, (3) exclusively by the ACR2016 and (4) both by ACR1990 and ACR2016 criteria

	No FMS (21)	ACR1990 Only (33)	By Both (79)	ACR2016 only (14)	<i>P</i> value*
Age (years)	36 (25–58)	39 (18–60)	36 (17–62)	32 (19–53)	NS
Duration (month)	18 (0–120)	48 (2–360)	48 (2–240)	37 (2–120)	NS
BMI	24.5 (22.3–36.2)	26.7 (19.0–31.8)	26.3 (17.4–38.2)	24.0 (17.8–29.1)	NS
Pain	5.5 (1–9)	7.25 (3–10)	8 (1–10)	7 (5–10)	<b>0.011</b>
Tender points	2 (0–9)	14 (13–17)	17 (14–18)	4.5 (2–10)	<b>&lt; 0.001</b>
WP Index	6 (0–16)	11 (0–18)	14 (7–19)	11.5 (4–17)	<b>&lt; 0.001</b>
SS Score	4 (0–7)	4 (1–8)	7 (4–12)	6.5 (5–11)	<b>&lt; 0.001</b>
PSD Score	10 (2–19)	14 (6–22)	21 (12–29)	18 (12–23)	<b>&lt; 0.001</b>
TAS20	58 (34–71)	62 (36–77)	61 (0–90)	59.5 (44–75)	NS
BPHQ	12 (0–20)	14 (0–21)	15 (2–27)	15 (9–20)	NS
GAD7	9 (0–15)	11 (0–21)	13 (0–21)	13 (4–20)	<b>&lt; 0.001</b>
RLS (5)	1	0	2	2	NS
PTSD (9)	2	0	3	4	<b>&lt; 0.01</b>
CFS (3)	1	0	1	1	NS
RLS/PTSD/CFS	4	0	6	7	<b><i>P</i> &lt; 0.001</b>
Not RLS/PTSD/CFS	17	33	73	7	

Data represent median (range)

Significant *P* values are in bold

FM fibromyalgia, ACR American College of Rheumatology criteria, WPI Widespread Pain Index, SS Symptoms Severity Score, TAS-20 Toronto Alexithymia Score-20, BPHQ Brief Physical Health Questionnaire, GAD7 Generalized Anxiety Disorder-7, RLS restless legs syndrome, PTSD posttraumatic stress disorder, CFS chronic fatigue syndrome

\*Comparison using Kruskal–Wallis test and Fisher's exact test

## Discussion

ACR 2016 classification criteria for FM in a tertiary referral setting had a sensitivity of 60% and specificity of 71% when using ACR 1990 as reference standard. In addition, anxiety and depression scores were more in those diagnosed by only ACR 2016 as compared to those diagnosed by only ACR 1990. This suggests that the two criteria possibly pick up different subsets of FM patients. However, there is no gold standard to tell us which criteria are “better”.

The development of the new classification criteria was necessitated by the lack of sensitivity of the 1990 criteria among male subjects and its dependence on tender point assessment which is operator dependent. Expectedly, the ACR 2016 criteria had similar sensitivity among both males and females. The low apparent specificity of the ACR 2016 criteria in this study could also be explained by the ability of the criteria to classify subjects with central pain, but with fewer or no tender points. The original validation of the 2010 criteria had shown a sensitivity of 88% [6]. Other validation studies (of the 2010 criteria on which the 2016 criteria were based) have shown sensitivities of 60%–96% (Table 5). Specificity in these studies has varied from 65% to 90%. Our sensitivity lies between these ranges, while specificity is slightly lower, and this seems to imply that the ACR 2016 does not behave much differently in referral settings.

The lower sensitivity of ACR 2016 in this study is mainly seen among female patients (Table 1). These patients who were classified as having FM by only ACR 1990 had lower WPI as well as SS scores and lower levels suggesting that they may be having milder diseases with lower levels of overall distress and anxiety. This illustrates the point that the two classification systems define the disease differently, with ACR 1990 giving emphasis to peripheral allodynia (tender points), while ACR 2016 criteria emphasize the central pain perception and distress. Although it may be argued that the patients classified as having FM by only ACR 1990 had milder disease, there

was no difference between the groups in pain. Indeed, tender points were the single most important predictor of pain (Table 4) followed by anxiety (GAD7), while there was no association between pain and Widespread Pain Index, SS Scale or depression (BPHQ).

FM is a heterogeneous entity with different aetiologies converging to a common widespread pain. Although FM is considered as disease of central pain augmentation, augmentation of pain transmission at the periphery and spinal cord is also likely involved in many patients [29]. Recent studies have demonstrated small fibre neuropathy demonstrated by functional and structural (electron microscopy and immunohistochemistry) abnormalities in a significant proportion of patients otherwise classified as having fibromyalgia [30]. It is unclear whether these changes in patients with FM are primary or secondary to neurogenic neuro-inflammation from chronic pain [31]. In contrast to the above studies, Albrecht et al. demonstrated increased vasodilatory innervation in the cutaneous arteriovenous shunts of fibromyalgia patients [32]. Maybe the ACR 1990 criteria picks patients who have more of such peripheral pain generators (and hence more of tender points).

In contrast, the ACR 2016 has been designed to capture more of the central and subjective components of fibromyalgia. As shown in Table 3, 7/14 patients diagnosed only by the ACR 2016 criteria had more comorbid diagnoses (RLS/PTSD/CFS) as compared to none (0/33) diagnosed by the ACR 1990 only. Also, anxiety and depression scores were more in those diagnosed by only ACR 2016 as compared to those diagnosed by only ACR 1990. Our results reporting a higher presence of comorbidities such as RLS, CFS and PTSD among patients classified by only ACR 2016 criteria support the notion that the ACR 2016 is more inclined towards central pain sensitization [33]. A recent study has shown that almost a fifth of FM patients also fulfil criteria for “partial PTSD” [34] and this strengthens our findings. This has led us to the above hypothesis that just like the pathophysiologies leading to the clinical spectrum of fibromyalgia are varied, the different “diagnostic” criteria for FM may be picking up different subsets of patients.

**Table 5** Comparison with other studies validating ACR2010 criteria in different populations

Population	United states [10]	Japanese [13]	Spanish [9]	Iranian [11]	Spanish [12]	Present study
Criteria	2011 modification of ACR 2010	Japanese version of ACR2010	ACR 2010	ACR 2010	Spanish version of ACR 2010	2016 modification of ACR 2010
Gold standard	Expert opinion	ACR1990	Expert	Expert	ACR1990	ACR1990
Sample size	321	462	579 (294 controls)	168 (100 controls)	803 (366 controls)	147
Sensitivity	83	96	88.3	58.9	85.6%	71
Specificity	67	64	91.8	92.8	73.2	60

This study had two assessors (for the ACR 1990) to examine the consistency of the ACR 1990 criteria. There was good agreement between the primary assessor and the expert in tender point count with the intraclass correlation coefficient of 0.80 which showed excellent consistency. Interobserver variations in tender points can arise due to different reasons. While it can come from differences in the application of pressure (which can be minimized by practice using weighing scales), it can also arise from miscommunication and misunderstanding. While standardized instructions may improve reliability, cognitive difficulties in fibromyalgia patients such as fibro fog might also impair administration of both tender points and questionnaires.

The major limitation of this type of study is the lack of a true gold standard. Most previous studies (Table 5) have used expert opinion, while some have used the ACR 1990. Though we have used the ACR 1990 criteria, it was felt that it was not adequate. If the 1990 criteria were more physician centric with emphasis on peripheral pain (tender points), the newer criteria were more patient centric with greater emphasis on the central component of pain. Thus, possibly the very concept of the disease has been altered, and it may be incorrect to measure the performance on the ACR 2016 based purely on the ACR 1990 criteria. Disagreement between physician and criteria diagnosis of FM [35] is well described. So until the criteria are perfected and physician biases removed, there will always be overdiagnosis or underdiagnosis of FM [36].

To the best of our knowledge, this is the first evaluation of the 2016 criteria in a referral care setting. Though referral bias might have a role in our results, we look forward to other studies in referral settings to validate ours.

ACR 2016 has similar performance in referral settings as the ACR 2010 had in the peripheral setting. This study demonstrated the heterogenous nature of fibromyalgia. The current individual criteria may not be sufficient to capture all patients of fibromyalgia. This emphasizes the need to concurrently use the ACR 1990 and ACR 2016 criteria in further fibromyalgia studies. Moreover, even in a referral setting, combining the objectivity of the ACR 1990 with the subjectivity of the ACR 2016 may be more desirable. This study also underlines the importance of seeking out concurrent comorbidities such as RLS, CFS and PTSD in patients with fibromyalgia, especially in those not meeting the ACR 1990 criteria.

**Author contributions** The conception and design of the study, acquisition of data, analysis and interpretation of data—SA, AA, AL. Drafting the article—SA. Revising it critically for important intellectual content—AA, AL. Final approval of the version to be submitted—SA, AA, AL. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved—SA, AA, AL.

**Funding** No funding was received for this study.

## Compliance with ethical standards

**Conflict of interest** Sakir Ahmed declares that he has no conflict of interest, including no relationship with pharmaceutical companies. Amita Aggarwal declares that she has no conflict of interest, including no relationship with pharmaceutical companies. Able Lawrence declares that he has no conflict of interest, including no relationship with pharmaceutical companies.

**Ethical approval** Ethical approval was obtained from the Institutional Ethics Committee, SGPGIMS, Lucknow. All patients gave written informed consent before inclusion into the study.

## References

1. Sumpton JE, Moulin DE (2014) Fibromyalgia. *Handb Clin Neurol* 119:513–527. <https://doi.org/10.1016/B978-0-7020-4086-3.00033-3>
2. Moldofsky H, Scarisbrick P, England R, Smythe H (1975) Musculoskeletal symptoms and non-REM sleep disturbance in patients with “fibrositis syndrome” and healthy subjects. *Psychosom Med* 37:341–351
3. Wolfe F, Smythe HA, Yunus MB et al (1990) The American College of Rheumatology 1990 criteria for the classification of fibromyalgia. Report of the multicenter criteria committee. *Arthritis Rheum* 33:160–172
4. Mahan MA (2015) Is fibromyalgia a real pathology? *World Neurosurg* 83:717–718. <https://doi.org/10.1016/j.wneu.2015.03.002>
5. Smythe HA (2004) Fibromyalgia among friends. *J Rheumatol* 31:627–630
6. Wolfe F, Clauw DJ, Fitzcharles M-A et al (2010) The American College of Rheumatology preliminary diagnostic criteria for fibromyalgia and measurement of symptom severity. *Arthritis Care Res* 62:600–610. <https://doi.org/10.1002/acr.20140>
7. Wolfe F (2015) Editorial: the status of fibromyalgia criteria. *Arthritis Rheumatol* 67:330–333. <https://doi.org/10.1002/art.38908>
8. Pamuk ON, Yeşil Y, Cakir N (2006) Factors that affect the number of tender points in fibromyalgia and chronic widespread pain patients who did not meet the ACR 1990 criteria for fibromyalgia: are tender points a reflection of neuropathic pain? *Semin Arthritis Rheum* 36:130–134. <https://doi.org/10.1016/j.semarthrit.2006.05.002>
9. McBeth J, Mulvey MR (2012) Fibromyalgia: mechanisms and potential impact of the ACR 2010 classification criteria. *Nat Rev Rheumatol* 8:108–116. <https://doi.org/10.1038/nrrheum.2011.216>
10. Jones GT, Atzeni F, Beasley M et al (2015) The prevalence of fibromyalgia in the general population: a comparison of the American College of Rheumatology 1990, 2010, and modified 2010 classification criteria. *Arthritis Rheumatol* Hoboken NJ 67:568–575. <https://doi.org/10.1002/art.38905>
11. Segura-Jiménez V, Aparicio VA, Álvarez-Gallardo IC et al (2014) Validation of the modified 2010 American College of Rheumatology diagnostic criteria for fibromyalgia in a Spanish population. *Rheumatol Oxf Engl* 53:1803–1811. <https://doi.org/10.1093/rheumatology/keu169>
12. Bennett RM, Friend R, Marcus D et al (2014) Criteria for the diagnosis of fibromyalgia: validation of the modified 2010 preliminary American College of Rheumatology criteria and the development

- of alternative criteria. *Arthritis Care res* 66:1364–1373. <https://doi.org/10.1002/acr.22301>
13. Bidari A, Hassanzadeh M, Ghavidel Parsa B et al (2013) Validation of the 2010 American College of Rheumatology preliminary diagnostic criteria for fibromyalgia in an Iranian population. *Rheumatol Int* 33:2999–3007. <https://doi.org/10.1007/s00296-013-2829-6>
  14. Casanueva B, García-Fructuoso F, Belenguer R et al (2016) The Spanish version of the 2010 American College of Rheumatology preliminary diagnostic criteria for fibromyalgia: reliability and validity assessment. *Clin Exp Rheumatol* 34:S55–S58
  15. Usui C, Hatta K, Aratani S et al (2013) The Japanese version of the modified ACR preliminary diagnostic criteria for fibromyalgia and the fibromyalgia symptom scale: reliability and validity. *Mod Rheumatol* 23:846–850. <https://doi.org/10.1007/s10165-012-0759-x>
  16. Wolfe F, Clauw DJ, Fitzcharles M-A et al (2016) 2016 revisions to the 2010/2011 fibromyalgia diagnostic criteria. *Semin Arthritis Rheum* 46:319–329. <https://doi.org/10.1016/j.semarthrit.2016.08.012>
  17. Eglolf N, von Känel R, Müller V et al (2015) Implications of proposed fibromyalgia criteria across other functional pain syndromes. *Scand J Rheumatol* 44:416–424. <https://doi.org/10.3109/03009742.2015.1010103>
  18. Sarzi-Puttini P, Atzeni F, Masala IF et al (2018) Are the ACR 2010 diagnostic criteria for fibromyalgia better than the 1990 criteria? *Autoimmun Rev* 17:33–35. <https://doi.org/10.1016/j.autrev.2017.11.007>
  19. Kawamura A, Shimodera S, Furukawa TA et al (2013) Effect of depression-related somatic pain on treatment satisfaction and daily living functions. *Int J Psychiatry Med* 46:27–38. <https://doi.org/10.2190/PM.46.1.c>
  20. Curtin KB, Norris D (2017) The relationship between chronic musculoskeletal pain, anxiety and mindfulness: adjustments to the fear-avoidance model of chronic pain. *Scand J Pain* 17:156–166. <https://doi.org/10.1016/j.sjpain.2017.08.006>
  21. Kroenke K, Spitzer RL, Williams JB (2001) The PHQ-9: validity of a brief depression severity measure. *J Gen Intern Med* 16:606–613
  22. Spitzer RL, Kroenke K, Williams JBW, Löwe B (2006) A brief measure for assessing generalized anxiety disorder: the GAD-7. *Arch Intern Med* 166:1092–1097. <https://doi.org/10.1001/archinte.166.10.1092>
  23. Lumley MA, Neely LC, Burger AJ (2007) The assessment of alexithymia in medical settings: implications for understanding and treating health problems. *J Pers Assess* 89:230–246. <https://doi.org/10.1080/00223890701629698>
  24. Bourke JH, Langford RM, White PD (2015) The common link between functional somatic syndromes may be central sensitisation. *J Psychosom Res* 78:228–236. <https://doi.org/10.1016/j.jpsychores.2015.01.003>
  25. Treatment C for SA (2009) Appendix E: DSM-IV-TR criteria for posttraumatic stress disorder. Substance abuse and mental health services administration (US)
  26. Wijemanne S, Ondo W (2017) Restless Legs Syndrome: clinical features, diagnosis and a practical approach to management. *Pract Neurol* 17:444–452. <https://doi.org/10.1136/practneurol-2017-001762>
  27. Yancey JR, Thomas SM (2012) Chronic fatigue syndrome: diagnosis and treatment. *Am Fam Physician* 86:741–746
  28. Koo TK, Li MY (2016) A guideline of selecting and reporting intraclass correlation coefficients for reliability research. *J Chiropr Med* 15:155–163. <https://doi.org/10.1016/j.jcm.2016.02.012>
  29. Yunus MB (2012) The prevalence of fibromyalgia in other chronic pain conditions. *Pain Res Treat* 2012:584573. <https://doi.org/10.1155/2012/584573>
  30. Lawson VH, Grewal J, Hackshaw KV et al (2018) Fibromyalgia syndrome and small fiber, early or mild sensory polyneuropathy. *Muscle Nerve*. <https://doi.org/10.1002/mus.26131>
  31. Littlejohn G (2015) Neurogenic neuroinflammation in fibromyalgia and complex regional pain syndrome. *Nat Rev Rheumatol* 11:639–648. <https://doi.org/10.1038/nrrheum.2015.100>
  32. Albrecht PJ, Hou Q, Argoff CE et al (2013) Excessive peptidergic sensory innervation of cutaneous arteriole-venule shunts (AVS) in the palmar glabrous skin of fibromyalgia patients: implications for widespread deep tissue pain and fatigue. *Pain Med Malden Mass* 14:895–915. <https://doi.org/10.1111/pme.12139>
  33. Yunus MB (2007) Fibromyalgia and overlapping disorders: the unifying concept of central sensitivity syndromes. *Semin Arthritis Rheum* 36:339–356. <https://doi.org/10.1016/j.semarthrit.2006.12.009>
  34. Conversano C, Carmassi C, Bertelloni CA et al (2019) Potentially traumatic events, post-traumatic stress disorder and post-traumatic stress spectrum in patients with fibromyalgia. *Clin Exp Rheumatol* 37(Suppl 116):39–43
  35. Wolfe F, Schmukler J, Jamal S et al (2019) Diagnosis of fibromyalgia: disagreement between fibromyalgia criteria and clinician-based fibromyalgia diagnosis in a University Clinic. *Arthritis Care Res* 71:343–351. <https://doi.org/10.1002/acr.23731>
  36. Häuser W, Sarzi-Puttini P, Fitzcharles M-A (2019) Fibromyalgia syndrome: under-, over- and misdiagnosis. *Clin Exp Rheumatol* 37(Suppl 116):90–97

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.