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Clinical Characterization of Juvenile Fibromyalgia in a Multicenter Cohort of Adolescents Enrolled in a Randomized Clinical Trial

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Abstract

Objective.—Juvenile fibromyalgia (JFM) is a complex chronic pain condition that remains poorly understood. The study aimed to expand the clinical characterization of JFM in a large representative sample of adolescents with JFM and identify psychological factors that predict pain interference.

Methods.—Participants were 203 adolescents (ages 12–17 years) who completed baseline assessments for the multisite Fibromyalgia Integrative Training for Teens (FIT Teens) randomized control trial. Participants completed the Pain and Symptom Assessment Tool, which includes a Widespread Pain Index (WPI; 0–18 pain locations) and Symptom Severity checklist of associated

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AUTHOR CONTRIBUTIONS

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somatic symptoms (SS; 0–12) based on the 2010 American College of Rheumatology criteria for fibromyalgia. Participants also completed self-report measures of pain intensity, functional impairment, and psychological functioning.

Results.—Participants endorsed a median of 11 painful body sites (WPI score) and had a median SS score of 9. Fatigue and nonrestorative sleep were prominent features and rated as moderate to severe by 85% of participants. Additionally, neurologic, autonomic, gastroenterologic, and psychological symptoms were frequently endorsed. The WPI score was significantly correlated with pain intensity and catastrophizing, while SS scores were associated with pain intensity and all domains of physical and psychological functioning. Depressive symptoms, fatigue, and pain catastrophizing predicted severity of pain impairment.

Conclusion.—JFM is characterized by chronic widespread pain with fatigue, nonrestorative sleep, and other somatic symptoms. However, how diffusely pain is distributed appears less important to clinical outcomes and impairment than other somatic and psychological factors, highlighting the need for a broader approach to the assessment and treatment of JFM.

INTRODUCTION

Fibromyalgia (FM) is a chronic musculoskeletal pain condition that affects mostly adult women (1) but can first manifest in childhood or adolescence. The cause of FM is not fully understood but is believed to be a result of alterations in pain processing within the central nervous system, with potential peripheral mechanisms (2). Familial aggregation of FM symptoms is also observed, suggesting that genetic factors are involved (3). Importantly, patients with FM describe experiencing widespread pain, as well as fatigue, sleep disturbance, and associated physical symptoms.

Juvenile FM (JFM) affects approximately 2–6% of children and adolescents, primarily females (4). However, the true prevalence remains unknown because of the inconsistency in the conceptualization and classification of JFM, limiting advances in understanding this disabling condition (5). In 1985, Yunus and Masi (6) first described JFM based on an observational study of 33 adolescents seen in a rheumatology clinic and suggested the following criteria: pain in ≥3 body sites for ≥3 months, the absence of an underlying medical condition, the presence of at least 5 soft tissue tender points, and at least 3 of 10 additional symptoms (e.g., chronic anxiety, fatigue, and poor sleep). In the absence of alternative criteria, the Yunus and Masi criteria have continued to guide the diagnosis of JFM despite the study’s small sample and unknown generalizability.

The classification of adult FM is based on American College of Rheumatology (ACR 2010, 2015) criteria that include 2 specific indices: the Widespread Pain Index (WPI) and the Symptom Severity (SS) scale (7), without a requirement for a tender point examination (8). The WPI is assessed via a checklist or diagram of 19 painful sites in the body, representing the spatial distribution of pain. The SS scale includes a rating of the severity of cardinal symptoms of FM (fatigue, cognitive problems, and sleep disturbance) and a checklist of other somatic symptoms. However, these criteria have not been validated for use in pediatric populations. In 2016, Ting et al (9) evaluated the utility of the 2010 ACR adult FM criteria in a sample of adolescent females and found that the WPI and SS scales were highly

sensitive and specific for distinguishing adolescents diagnosed with JFM from those with localized pain. The authors recommended removal of some symptoms from the SS scale based on the observation that adolescents rarely endorsed them (e.g., hives, fevers). Instead, the authors recommended adding symptoms to the SS scale that were commonly reported by adolescents (e.g., sensitivity to lights/sounds, dizziness) while preserving the original scoring algorithm. Overall, JFM appears to have similar features to adult FM, with joint hypermobility and dysautonomia more commonly observed in JFM (4).

There has been little effort to comprehensively phenotype JFM symptom characteristics in a representative pediatric population. Two published studies (Connelly et al [10] and Weiss et al [11]) described the clinical characteristics of JFM in a relatively large sample of youth with JFM using data from the Childhood Arthritis and Rheumatology Research Alliance (CARRA) registry of North American Rheumatology clinics (12). JFM patients in the registry were found to have several comorbid symptoms along with the highest levels of pain and pain-related disability compared to youth with rheumatic diseases (e.g., juvenile arthritis, childhood-onset lupus, etc.). Interestingly, the relationship between pain and disability was stronger in those with rheumatic diseases than in JFM, suggesting that there are other drivers of disability in JFM that were not measured in that study. However, due to CARRA registry measures being chosen primarily for relevance to pediatric rheumatic and autoimmune conditions, comprehensive assessment of pain characteristics and the range of associated symptoms unique to JFM was not possible in this study (11).

The aim of the current study was to comprehensively describe pain characteristics (pain intensity, pain locations) and associated symptoms (fatigue, sleep disturbance, cognitive difficulties, and somatic symptoms) in a large multicenter JFM cohort from an ongoing clinical trial. The study also examined how pain characteristics and associated symptoms (e.g., fatigue) were related to pain interference, pain catastrophizing, and depressive symptoms. Finally, it evaluated the extent to which clinical characteristics (pain, fatigue, and psychological factors) predicted pain interference. We hypothesized that in addition to pain symptoms, associated somatic symptoms of JFM and psychological variables would contribute to impaired functioning in JFM.

MATERIALS AND METHODS

Participants.

Data for this study were collected as part of baseline/screening assessments for an ongoing large multicenter randomized controlled trial, the Fibromyalgia Integrative Training for Teens (FIT Teens). Participants were adolescents with JFM who completed baseline assessments to determine eligibility for the FIT Teens trial (13) between January 2018 and April 2021. Inclusion criteria for the trial were: 1) ages 12–17 years, 2) a diagnosis of JFM by a pediatric rheumatologist or pain physician and confirmed using the 2010 ACR adult FM criteria (7,9,14), 3) moderate levels of functional disability (Functional Disability Inventory [FDI] ≥13) (15), 4) average pain intensity during the past week of ≥4 on a 0–10-cm visual analog scale, and 5) stable medications for 2–4 weeks before enrollment (13). Exclusion criteria included underlying rheumatic disease (e.g., arthritis, lupus), untreated psychiatric illness, and not meeting the 2010 ACR adult JFM criteria as measured by the

Pain and Symptom Assessment Tool (PSAT). Full details of the FIT Teens study protocol have been previously published (13).

Assessment of pain and symptom severity.

Participants reported their age, gender identity, and racial and ethnic identity. To assess fibromyalgia pain and symptom severity, participants completed the PSAT, a self-report measure containing the WPI and SS scale, which has been validated as a self-report measure in adult FM and found to be applicable to JFM with slight modification of the SS scale (9,14,16). For the WPI, participants were asked to identify in which of 18 body areas they felt pain over the past week (range 0–18). The nineteenth site ("abdomen") was removed from the original WPI to focus exclusively on musculoskeletal pain, as abdominal discomfort is already included on the SS scale

The SS scale is composed of 2 sections. The first section measures symptom severity based on a 4-point Likert scale (0 = no problem to 3 = severe, pervasive, continuous, life-disturbing problem) for fatigue, sleep disturbance, and cognitive problems (e.g., concentration problems) (range 0–9). The second SS section is a checklist of 24 additional somatic symptoms (e.g., numbness, nausea, dizziness) (9,14). To classify the magnitude of somatic symptoms, the number of somatic symptoms is grouped as either: 0 = no symptoms, 1 = few symptoms (range 1–5), 2 = moderate symptoms (range 6–9), or 3 = many symptoms (≥10). A total SS score (range 0–12) is created by summing the severity score (0–9) and the magnitude of somatic symptoms (0–3). Scale reliability in this sample was $\alpha = 0.79$ (WPI) and $\alpha = 0.78$ (SS scale).

Participants provided a rating of average pain intensity on an electronic daily pain diary for 1 week using a 0–10-cm visual analog scale (17,18) anchored by "no pain" and "pain as bad as it can be." An average pain intensity rating across the 7 days was calculated.

The Patient Reported Outcome Measurement Information System (PROMIS; www.nihpromis.org) Pediatric Fatigue scale was administered to assess self-reported fatigue (Short Form10a, version 2.0) (19). The scale contains 10 items and uses a 5-point Likert scale response format (never = 0 to almost always = 4). The raw score total is converted to a T score using reference tables (mean ± SD 50 ± 10). Research has suggested that a T score ≥ 55 can be considered a clinically significant threshold (20). Scale reliability in this sample was $\alpha = 0.93$.

A Beighton score (21) was calculated to evaluate generalized joint hypermobility. The Beighton score is assigned following a standard joint mobility protocol measuring a sample of body joints (e.g., bilateral fifth digit, elbow, knee). Beighton scores range from 0 to 9, with ≥6 indicating hypermobility among prepubertal children and adolescents (22).

Assessment of impact of pain on functioning.

To characterize the degree to which pain interferes with daily activities, participants completed the PROMIS Pediatric Pain Interference (PPI) scale (23). The PPI is an 8-item, self-report measure (Short Form 8a, version 2.0; www.nihpromis.org) using a 5-point Likert scale response format (never = 0 to almost always = 4). The raw score total is converted

to a T score using reference tables. Research has suggested that a T score of ≥55 can be considered a clinically significant threshold (20). Scale reliability in this sample was α = 0.79.

The FDI–Child Report (24) is a 15-item scale assessing difficulty in physical functioning due to pain across multiple domains. Response choices (no trouble = 0 to impossible = 4) are summed to create a total score (range 0–60) indicative of the overall level of disability. Clinical cutoffs are identified as minimal/mild (range 0–12), moderate (range 13–29), and severe (≥30) (15). Scale reliability in this sample was α = 0.86.

Assessment of depressive symptoms.

The Children's Depression Inventory–2 (CDI-2) (25) was used to assess depressive symptoms commonly reported as a comorbidity in FM and throughout other pediatric pain research (26,27). It is a 28-item self-report questionnaire validated for youth up to age 17 years. Participants were asked to rate the presence of symptoms on a 3-point Likert scale, with higher scores indicating greater severity of depressive symptoms (range 0–56). Scale reliability in this sample was α = 0.86.

Assessment of pain-related anxiety.

The Pain Catastrophizing Scale, Child version is a self-report questionnaire developed to assess rumination and worry about pain (28). Participants rated 13 items on a 5-point Likert scale (not at all = 0 to extremely = 4). Items are summed to create a total score, with higher scores indicating increased pain-related worry. The following clinical reference points are suggested: low (range 0–14), moderate (range 15–25), and high (≥26) (29). Scale reliability in this sample was α = 0.90.

Procedure.

Participants were recruited from rheumatology and pain management clinics at 7 participating sites (6 large pediatric medical centers in the Midwest and Northeast US and 1 in Canada) from 2018 to 2021. All participants were assessed for participation in the ongoing clinical trial (13). Medical providers presented the study to potentially eligible patients who, if interested, were provided more information by trained research coordinators. Parents and adolescents provided written consent/assent for the study. The study was conducted under the centralized Umbrella Institutional Review Board (IRB) protocol at the primary study site, with IRB reliance agreements obtained at the participating sites in the US. At the Canadian site, the study was approved by their institutional Research Ethics Board. Participants were scheduled for a study visit during which they completed paper-pencil self-report measures, and site coordinators entered data directly into a centralized electronic database (Medidata Rave, an FDA-compliant data management platform) maintained by a data coordinating center at the lead study site (13).

Statistical analysis.

Data were analyzed using SPSS software, version 27 (30). Adolescents not meeting the threshold for JFM diagnosis based on the 2010 ACR criteria measured by the PSAT were excluded from the study and no further data were collected (n = 24). Additionally,

1 case was excluded due to missing data on outcome measures; analyses were based on the remaining 203 participants. Descriptive statistics (frequency counts, estimates of central tendency, and variability) were calculated for the demographic and questionnaire data. Pearson's correlations were calculated to investigate the relationships between pain and symptom characteristics (PSAT total score, WPI and SS scale, average pain intensity, and fatigue) with demographic variables (e.g., age), pain-related disability/interference and depressive symptoms. Due to multiple correlations, a Bonferroni correction was applied with a *P* value less than 0.006 (2-sided) as the criterion for statistical significance. Participants were divided into 2 groups based on joint hypermobility (Beighton score <6 = JFM-hypermobility and Beighton score ≥6 = JFM + hypermobility). A 1-way analysis of variance was calculated for clinical outcome measures (pain interference, functional disability, fatigue, and depression). A hierarchical multiple regression was calculated using pain interference as the dependent variable, with age entered in the first step of the model and patient-reported outcomes (WPI, SS scale, depression, fatigue, pain intensity, and pain catastrophizing) entered in the second step.

RESULTS

Participant background and characteristics.

Of the 228 enrolled patients, 203 participants met inclusion criteria and constituted the final sample for analysis. The mean ± SD age was 15.7 ± 1.6 years. Participants were primarily White (n = 172, 84.7%) and cis-gender females (n = 177, 87.2%). There were 18 cis-gender males, and 8 participants identified as gender diverse (Table 1).

Widespread pain characteristics.

Participants reported a moderate level of pain on average (mean ± SD 5.9 ± 1.3). On the WPI from the PSAT, participants endorsed a median 11 of 18 pain locations (range 3–18). Axial locations of pain were the most frequently endorsed: low back (89.7%), neck (87.7%), and upper back (79.8%), as well as right (77.8%) and left (73.9%) shoulder pain (Figure 1).

Symptom severity and somatic complaints.

Participants scored a median 9 of 12 on the SS scale (range 4–12), which is a combination of the intensity of cardinal symptoms (fatigue, sleep disturbance, and cognitive problems) and the frequency of comorbid somatic symptoms. Most of the sample (86.7%) described fatigue as a moderate or severe problem, with 41.4% rating it as severe (Table 2). Consistent with the single PSAT item assessing fatigue, participants reported significant fatigue on the more comprehensive PROMIS Pediatric Fatigue measure (T = 68.9 ± SD 9.2). Additionally, most participants (84.7%) indicated that awakening from sleep feeling unrefreshed was a moderate to severe problem. Concentration difficulties were also reported but were mostly mild to moderate (62.6%), with a smaller proportion of the sample reporting severe problems (26.6%).

As for associated somatic symptoms, participants endorsed a median 12 of 24 symptoms (range 5–24) on the checklist. The most frequently reported symptoms were neurologic/autonomic: headaches (87.2%), muscle weakness (81.3%), dizziness/balance problems

(79.8%) and multisensory sensitivity (74.4%) (Figure 2). Approximately 70% of participants reported co-occurring headaches and muscle weakness, while 57% endorsed having headaches, weakness, and dizziness. Nearly half of the sample reported all 4 symptoms, suggesting that neurologic and dysautonomia symptoms appear to co-occur frequently in JFM.

Using a Beighton score of ≥6 positive joints, 34 participants (18.9%) were rated as having generalized joint hypermobility. Most participants had fewer than 6 hypermobile joints (81.1%), and of those, 41 had no hypermobile joints. There were no significant differences between JFM groups with or without hypermobility on pain interference, functional disability, or psychosocial functioning.

Pain-related disability, pain catastrophizing, and depressive symptoms.

Participants reported moderate functional disability (mean ± SD 25.1 ± 9.1) and pain interference (PROMIS PPIT = 63.5 ± SD 5.8). Moderately elevated depressive symptoms were reported (mean ± SD 19.8 ± 7.9). "Very elevated" scores (CDI total ≥24) were found in one-third of participants (n = 64), with suicidal ideation (item 8, CDI-2) endorsed by approximately 28% of participants. A high level of pain catastrophizing was reported (mean ± SD 28.0 ± 9.8) (Table 3) (29).

Correlations were calculated between the overall severity of JFM symptoms, widespread pain, symptom severity, fatigue, pain-related disability and interference, pain catastrophizing, and depressive symptoms (Table 3). The PSAT total score was significantly associated with greater pain intensity, depressive symptoms, pain-related functional impairment, pain catastrophizing, and fatigue (r = 0.26–0.42, $P < 0.0001$ for all). The WPI scale was modestly correlated with the SS scale (r = 0.22, $P < 0.002$).

Correlations were calculated for each PSAT subscale and clinical outcome measure to better understand the unique relationship between spatial aspects of pain (WPI) and the relevance of the associated symptoms (SS scale). Age was significantly correlated with symptom severity, pain interference, and fatigue. Older age was related to greater comorbidity and higher levels of impairment. For the WPI, higher average pain intensity (r = 0.20, $P < 0.005$) and greater catastrophizing (r = 0.23, $P < 0.001$) were associated with having a greater number of pain sites. The SS scale was significantly correlated with all clinical outcomes (r = 0.23–0.64, $P < 0.002$ for all).

To examine the effects of age and physical and psychological factors on pain interference, a hierarchical multiple regression was conducted. Age was entered at step 1, explaining 6% of the variance in pain interference. After entry of clinical outcomes (WPI, SS scale, depression, fatigue, pain intensity, and catastrophizing), 56% of the total variance in pain interference was explained by the full model ($F[7, 186] = 34.1$, $P < 0.001$). In the full model, 3 variables were significant: fatigue, pain catastrophizing, and depressive symptoms (Table 4).

DISCUSSION

Comprehensive characterization of JFM is a necessary first step to enhance clinical care and research for this under-recognized syndrome and to develop best practices for diagnosis and treatment. This multicenter study leveraged the infrastructure of a large clinical trial to advance the pediatric literature on JFM by quantifying clinical characteristics in a sample of over 200 adolescents from 7 pediatric rheumatology and pain clinics in North America. Unlike much of the prior research on pediatric chronic widespread pain, a clear and consistent standard based on the 2010 ACR adult FM criteria was used in this study to confirm the diagnosis of JFM using the PSAT. Validated pediatric measures of pain intensity, fatigue, pain-related disability/impairment, pain catastrophizing, and mood symptoms were also included and uniformly implemented in the baseline assessment for the clinical trial.

In a contemporary large-scale study of JFM (10), results showed that youth with JFM had some of the highest reports of pain and functional disability compared to their peers with other autoimmune conditions. Nevertheless, the correlation between pain intensity and disability for youth with JFM was moderate, while relationships between these 2 variables were significantly stronger within the autoimmune conditions, suggesting that JFM comorbidities likely make important contributions to functional disability. In the current study, the comparatively large JFM sample combined with a comprehensive assessment of pain, psychological symptoms, and functioning allowed for a robust characterization of JFM in adolescents and identification of the predictive factors of pain interference (fatigue, pain catastrophizing, and depression), which has not been previously feasible.

Based on our results, JFM appears to closely parallel the adult presentation of FM, with widespread chronic pain, fatigue, and sleep difficulties being prominent features. Concerning the widespread nature or the spatial spread of pain, participants with JFM endorsed a median of 11 of 18 painful sites, especially in the trunk, neck, and shoulders, which is comparable to the adult FM literature (31). Most of the JFM sample in this study described fatigue and unrefreshing sleep as a moderate to severe problem (≥85%), consistent with findings in adults with FM (endorsed 70–90% of the time), who reported significant problems with sleep duration, delayed sleep onset, and nighttime wakefulness (31). The crucial role of sleep for physical and mental health in adolescence has been amply documented in the developmental literature (32). Insufficient sleep even in healthy adolescents has been associated with greater frequency and severity of somatic complaints (33), underscoring the importance of considering the contribution of poor sleep in the development or maintenance of JFM symptoms.

Fatigue, which is linked to poor sleep, was frequently endorsed by adolescents with JFM and corroborated by an average pediatric PROMIS Fatigue scale score of nearly 2 SDs above the mean. Fatigue is a hallmark characteristic of adult FM and has been correlated with negative affect, mood, and dimensions of pain (31). Fatigue, together with pain catastrophizing and depressive symptoms, was found in the current study to predict the severity of pain interference. These findings highlight the significance of psychological and physical factors beyond pain intensity and diffuseness that limit functioning and promote disability. The

role of fatigue and its impact on daily functioning in adolescents with JFM have been understudied and deserve greater attention in future research

Cognitive complaints were endorsed less often in our sample than in samples of adults with FM (31), although over half the sample (61.1%) still reported moderate to severe problems with concentration or memory. These findings are consistent with a prior study on executive functioning deficits in adolescents with chronic pain, in which approximately 50% of the sample had clinically elevated scores in working memory and inhibition on the Behavior Rating Inventory of Executive Function 2 (34). Although objective assessment data in FM also show support for deficits in cognitive functioning (35,36), comorbid pain, fatigue, depression, and anxiety are thought to potentially amplify perceived cognitive deficits (31,35). Studies using objective tests of cognitive functioning in JFM have not been performed, highlighting a need for more empirical studies to clarify and quantify this domain.

On the PSAT somatic symptoms checklist, adolescents with JFM reported multiple comorbid symptoms. More than 80% of the sample endorsed neurologic/autonomic symptoms, suggesting possible underlying autonomic nervous system (ANS) dysregulation. The association between dysautonomia and joint hypermobility frequently seen in patients with JFM is also well documented in the literature (37,38). A recent review of studies on ANS functioning in pediatric chronic pain concluded that there was insufficient evidence to demonstrate ANS dysregulation at rest or in response to experimental stress (39). However, most studies were on youth with functional abdominal pain or mixed diagnoses of chronic pain conditions. Only 1 study focused specifically on adolescents with JFM, and results were consistent with autonomic dysfunction as suggested by chronotropic incompetence (inability to increase heart rate during exercise to match cardiac output to metabolic demands) and delayed heart rate recovery following exercise (40). ANS dysregulation may underlie some of the multisystem comorbid symptoms (dizziness/syncope, exercise intolerance) in JFM and likely play a role in physical impairment beyond the impact of pain. Considering how these symptoms may impact JFM patients' adherence to exercise recommendations, modifications to exercise programs may be warranted.

Correlations between PSAT subscales and measures of pain and physical and emotional functioning showed that the spatial spread of pain across body sites (WPI) was only significantly associated with pain intensity and pain catastrophizing. In contrast, significant correlations were found between the SS scale and all domains of functioning, pain interference, and mood. Older adolescents with JFM were more likely to report greater severity of symptoms than younger participants. However, the association between age and pain interference was reduced and no longer statistically significant once considering other somatic and psychological variables. The SS scale on the PSAT appears to represent the collective intensity and frequency of comorbid somatic symptoms in JFM and should be viewed as an important indicator of JFM severity.

Findings with respect to physical and psychological functioning were consistent with prior studies in JFM (10,14,41), with participants reporting moderate levels of pain-related functional disability, pain interference, and depressive symptoms based on validated patient-

reported outcome measures. A high level of pain catastrophizing was endorsed. In addition, one-third of adolescents reported depressive symptoms in the elevated range, and nearly 25% of adolescents reported suicidal ideation, a concerning finding recently described in another JFM study by Gmuca et al (42). Psychological functioning is an important contributor to long-term outcomes in JFM. A longitudinal study of JFM from adolescence through young adulthood found that a subset of JFM patients (15–20%) experienced worsening depressive symptoms as they entered young adulthood (19–21 years), and these individuals were at the highest risk for disability (43). Based on this finding, the authors recommended that close monitoring of mood symptoms and attention to proper mental health support should be routinely incorporated into clinical care for adolescents with JFM.

Our study results should be considered in the context of the following limitations. Consistent with the higher prevalence of FM in women, the sample was primarily female, with a minority of males and gender-diverse adolescents. Whether results would be replicated if a larger sample of either subgroup was available is unknown. Additionally, all measures were self-report, and whether participants' self-perceptions of symptoms would match objective measures (e.g., cognitive functioning, physical abilities) or parent/caregiver reports (e.g., mood, pain interference) is unclear. Nevertheless, the close similarities between adolescents' symptom reports within this large cohort paint a relatively consistent characterization of JFM syndrome.

Based on the current study, JFM syndrome seems closely aligned with the adult manifestation of FM, with widespread pain, fatigue, sleep difficulties, and autonomic dysregulation being hallmark characteristics of JFM in adolescence. With further validation, the PSAT measure could be a valuable JFM screening tool to quantify widespread pain and symptom severity, thereby advancing the field's ability to systematically identify, track, and describe the natural course of JFM, and evaluate response to treatment. This study used the PSAT and other measures to provide a clinical characterization of this multifaceted syndrome and to predict the factors contributing to pain interference. Based on our findings, we recommend that JFM management be done in a comprehensive manner with standard multidisciplinary pain management approaches (medications, cognitive-behavioral, and exercise-based interventions) while also directly addressing sleep, fatigue, somatic symptoms (dysautonomia), and emotional concerns. In addition to optimizing treatments, a critical need exists for more basic and translational studies of neurobiologic, immunologic, and genetic factors underlying the pathophysiology of JFM. Such studies are required to provide insights beyond what is currently known to guide more effective treatment to help prevent youth with JFM from becoming adults with FM.

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SIGNIFICANCE & INNOVATIONS

- Characterization of pain, functional disability, and psychosocial functioning in a large representative sample of adolescents with juvenile fibromyalgia (JFM) from an ongoing clinical trial.
- Use of evidence-based measures for pediatric chronic pain to characterize this large cohort.
- Use of the Pain and Symptom Assessment Tool to confirm JFM diagnosis based on the 2010 American College of Rheumatology criteria for adult fibromyalgia.
- Identification of the important multiple somatic and psychological factors that influence daily functioning of adolescents with JFM beyond pain symptoms.

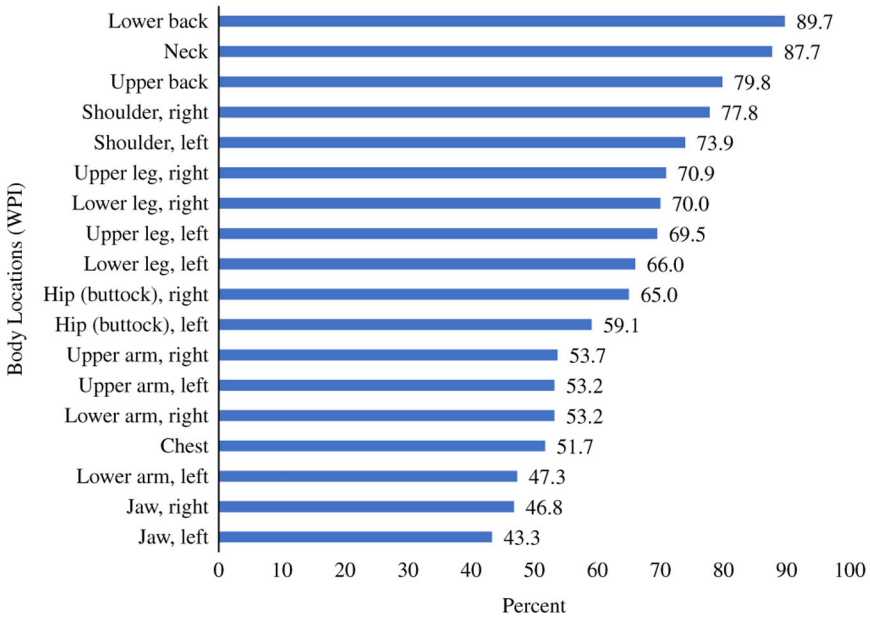

Figure 1.

Percentage of participants who endorsed each of 18 pain locations on the Widespread Pain Index (WPI). “Abdomen” was removed as a pain location to focus on musculoskeletal symptoms; abdominal pain is listed in the somatic symptom checklist.

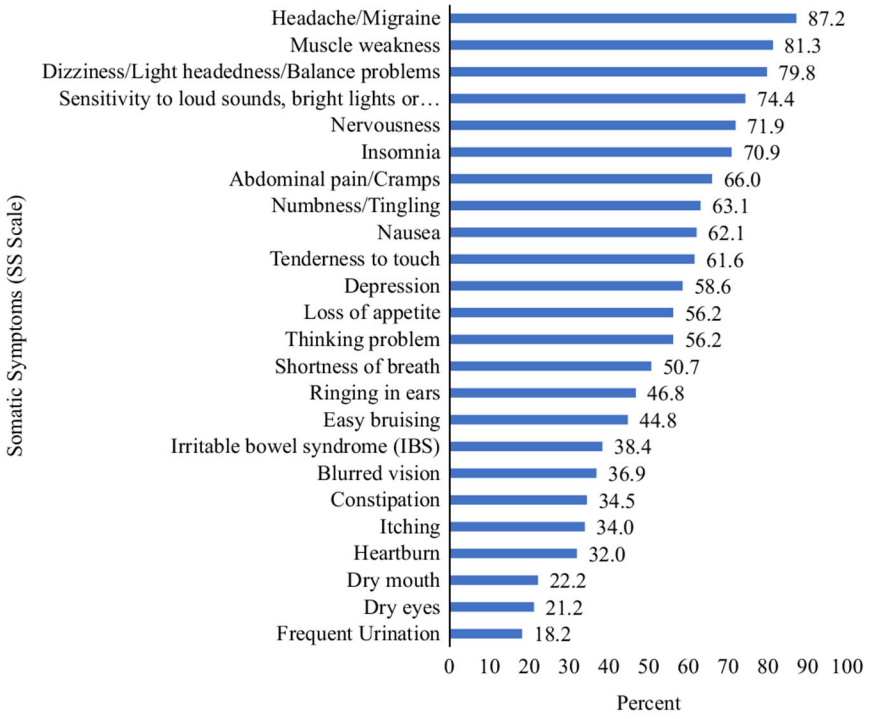

Figure 2.

Percentage of participants who endorsed each of 24 somatic complaints on the Symptom Severity scale. Color figure can be viewed in the online issue, which is available at http://onlinelibrary.wiley.com/doi/10.1002/acr.25077/abstract.

Table 1.

Participant demographic and background characteristics *

Characteristic	Value
Gender	
Female	177 (87.2)
Male	18 (8.9)
Transgender (female:male)	5 (2.4)
Nonbinary	1 (0.5)
Gender fluid	1 (0.5)
Agender	1 (0.5)
Race	
American Indian/Native Alaskan	2 (1.0)
Asian	3 (1.5)
Black/African American	11 (5.4)
Native Hawaiian/Other Pacific Islander	1 (0.5)
White/European American	172 (84.7)
More than 1 race	14 (6.9)
Ethnicity	
Hispanic	12 (5.9)
Non-Hispanic	191 (94.1)
Age, mean ± SD	15.7 ± 1.6
Beighton Score, mean ± SD †	3.0 ± 2.6

* Values are the number (%) unless indicated otherwise.

† Beighton score is a measure of joint hypermobility out of 9 joints; the median and SD number of joints were reported.

Table 2.

Frequency of cardinal symptoms of fatigue, sleep disturbance, and cognitive problems among adolescents diagnosed with JFM*

	No problem	Slight/mild	Moderate	Severe
Fatigue	2 (1.0)	25 (12.3)	92 (45.3)	84 (41.4)
Waking still feeling tired	3 (1.5)	28 (13.8)	84 (41.4)	88 (43.3)
Concentration or memory problems	22 (10.8)	57 (28.1)	70 (34.5)	54 (26.6)

* Values are the number (%). Cardinal symptoms are from the Symptom Severity scale of the Pain and Symptom Assessment Tool. Full item response options are: “no problem,” “slight/mild problem, generally mild or intermittent,” “moderate, considerate problem, often present,” and “severe, pervasive, continuous, life-disturbing problem.” JFM = juvenile fibromyalgia.

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Table 3.

Correlations between PSAT scores and measures of pain, functioning, distress, and fatigue among adolescents with JFM[*]

		Pearson's r								
Measures[†]	**Values**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1. PSAT total	20.0 (4.8)	–	0.91[‡]	0.61[‡]	0.26[‡]	0.29[‡]	0.34[‡]	0.30[‡]	0.42[‡]	0.36[‡]
2. WPI	11.0 (3.9)	–	–	0.22[‡]	0.20[‡]	0.10	0.16	0.10	0.18	0.23[‡]
3. SS scale	9.0 (2.1)	–	–	–	0.23[‡]	0.48[‡]	0.48[‡]	0.50[‡]	0.64[‡]	0.40[‡]
4. Average pain	5.9 ± 1.3	–	–	–	–	0.32[‡]	0.46[‡]	0.24[‡]	0.26[‡]	0.34[‡]
5. PROMIS PPI	63.5 ± 5.8	–	–	–	–	–	0.51[‡]	0.42[‡]	0.67[‡]	0.56[‡]
6. FDI	25.1 ± 9.1	–	–	–	–	–	–	0.51[‡]	0.55[‡]	0.45[‡]
7. CDI-2	19.8 ± 7.9	–	–	–	–	–	–	–	0.60[‡]	0.55[‡]
8. Fatigue[§]	68.9 ± 9.2	–	–	–	–	–	–	–	–	0.44[‡]
9. PCS-C	28.0 ± 9.8	–	–	–	–	–	–	–	–	–

[*] CDI-2 = Children's Depression Inventory-2; FDI = Functional Disability Inventory; JFM =juvenile fibromyalgia; PCS-C = Pain Catastrophizing Scale–Child version; PROMIS PPI = Patient Reported Outcome Measurement Information System Pediatric Pain Interference, T score; PSAT = Pain and Symptom Assessment Tool; SS = Symptom Severity; WPI = Widespread Pain Index.

[†] 1–3: median (SD); 4–9: mean ± SD.

[‡] $P < 0.006$ by Pearson's correlations.

[§] PROMIS Pediatric Fatigue, T score.

Table 4.

Hierarchical regression model predicting PROMIS pain interference in adolescents with JFM *

Step and predictor	B	SE	Beta	t	r^2	$r^2\Delta$	F	*P*
1.00	–	–	–	–	0.06	0.06	11.86	<0.001
Age	0.89	0.26	0.24	3.44	–	–	–	<0.001
2.00	–	–	–	–	0.56	0.50	34.14	<0.001
Age	0.10	0.19	0.03	0.52	–	–	–	0.60
WPI	−0.14	0.08	−0.09	−1.81	–	–	–	0.07
SS scale	0.15	0.18	0.05	0.81	–	–	–	0.42
Average pain	0.39	0.23	0.09	1.69	–	–	–	0.09
CDI-2	−0.11	0.05	−0.15	−2.24	–	–	–	0.03
Fatigue †	0.35	0.05	0.55	7.66	–	–	–	<0.001
PCS-C	0.22	0.04	0.36	5.91	–	–	–	<0.001

* CDI-2 = Children's Depression Inventory-2; JFM = juvenile fibromyalgia; PCS-C = Pain Catastrophizing Scale–Child version; PROMIS = Patient Reported Outcome Measurement Information System; SS = Symptom Severity; WPI = Widespread Pain Index.

† PROMIS Pediatric Fatigue.

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