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# BMJ Open Exploratory study into the relationship between the symptoms of chronic fatigue syndrome (CFS)/myalgic encephalomyelitis (ME) and fibromyalgia (FM) using a quasiexperimental design

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## ABSTRACT

**Objective** To explore the relationship between symptoms of chronic fatigue syndrome (CFS)/myalgic encephalomyelitis (ME) and fibromyalgia (FM). The hypothesis predicated that there would be no significant differences between the group's symptom experience.

**Design** A quasiexperimental design. Structural equation modelling (SEM) and invariance testing.

**Participants** Males (M) and females (F) >16 with a confirmed diagnosis of CFS/ME or FM by a general practitioner or specialist. CFS/ME (n=101, F: n=86, M: n=15, mean (M) age M=45.5 years). FM (n=107, F: n=95, M: n=12, M=47.2 years).

**Outcome measures** Diagnostic criteria: the American Centers for Disease Control and Prevention (CDC) for CFS/ME and the American College of Rheumatology (ACR) criteria for FM. Additional symptom questionnaires measuring: pain, sleep quality, fatigue, quality of life, anxiety and depression, locus of control and self-esteem.

**Results** Invariance was confirmed with the exception of the American CDC Symptom Inventory, Fibromyalgia Impact Questionnaire and Hospital Anxiety and Depression Scale ( $p<0.05$ ) based on five questions. Consequently, it was erroneous to conclude differences. Therefore, the Syndrome Model was created. SEM could not have tested the ACR previously, as it comprised a single data point. Thus, it was combined with these three questionnaires, increasing the data points, to create this new measurable model. Results confirmed no significant differences between groups ( $p=0.07$  ( $p<0.05$ )).

**Conclusion** Participants responded in a similar manner to the questionnaire, confirming the same symptom experience. It is important to consider this in context with differing criteria and management guidelines, as this may influence diagnosis and the trajectory of patient's management. With the biomedical cause currently unclear, it is the symptom experience and the impact on quality of life that is important. These findings are meaningful for patients, clinicians and policy development and support the requirement for future research.

## BACKGROUND

Chronic fatigue syndrome (CFS)/myalgic encephalomyelitis (ME) and fibromyalgia (FM) are both identified as debilitating

## Strengths and limitations of this study

- To our knowledge, this is the first study to assess the symptom experience of chronic fatigue syndrome (CFS)/myalgic encephalomyelitis (ME) and fibromyalgia (FM) using structural equation modelling.
- This study brings attention to an area of CFS/ME and FM that has not been researched for a number of years.
- Addresses the possible constraints to symptom management imposed by guidelines or a lack thereof for CFS/ME and FM and highlights the importance of symptom management to improve health-related quality of life, which is forefront in the lived experience of CFS/ME and FM.
- The constraints of the sample size prevented the testing of a model incorporating all the questionnaires.
- The use of generic questionnaires should be considered when assessing the symptoms of CFS/ME and FM, as their criteria-based questionnaires are biased towards the specific syndrome they were designed for.

syndromes, with unclear/unknown aetiologies and no specific diagnostic tests or cure at the present time.<sup>1</sup>

CFS/ME and FM patients experience extensive polysymptomatology that affects all aspects of daily life, such as educational, economic and social, which has a great impact on their quality of life.<sup>2-7</sup> Symptoms of CFS/ME include fatigue, headaches, muscle aches and pains, and/or joint pain.<sup>8</sup> FM is characterised by chronic widespread musculoskeletal pain, persisting for  $\geq 3$  months, with an exhaustive list of additional symptoms.<sup>4,5</sup> Ambiguity regarding the accuracy of diagnostic classification of CFS/ME or FM may have significant ramifications in terms of the management offered and the trajectory of patient care.<sup>6,9-11</sup> Understanding the relationship between CFS/ME and FM is



consequently vital in the delivery of effective, evidence-based and contextually appropriate clinical interventions.<sup>6 12–14</sup>

Thirty-eight criteria exist for diagnosing CFS/ME, with the American Centers for Disease Control and Prevention (CDC) Criteria being most frequently applied in research.<sup>15–17</sup> This includes the National Institute for Health and Care Excellence (NICE) (2007) guidelines for CFS/ME, which are currently under review. The American College of Rheumatology (ACR)<sup>4</sup> published the only diagnostic criteria for FM. This criterion was modified to focus on areas of pain and remove the controversial pain point assessment, which historically required patients to experience pain in 11 out of 18 highlighted points on the body when pressure was applied.<sup>5</sup> Fibromyalgia Action submitted a proposal to NICE in 2007 recommending the development of guidelines, but this was subsequently rejected. The reasons cited were management/treatment of FM may be hindered by guidelines, as no diagnostic test exists and clinicians are not in agreement on the optimal management for FM.<sup>18</sup> NICE stated that formal guidelines may create illness behaviour and hinder possible treatment options. This suggests that current guidelines may influence the restriction in management options offered to a patient with CFS/ME.

Research investigating whether CFS/ME and FM have the same underlying pathology is limited, and this may be an artefact of the traditional approach of diagnosing and managing these syndromes as two distinct entities.<sup>1 19</sup> The research available concludes that CFS/ME and FM share many symptoms, but they do not agree if these syndromes are equivalent.<sup>12 20–24</sup> Most of these studies were performed prior to the development and publishing of the accepted American CDC Criteria<sup>15</sup> for CFS/ME, and when the ACR<sup>4</sup> diagnostic criterion for FM was in its infancy, and although important in the context of this study, may now be considered obsolescent. Much of the literature available may discuss both together; however, little research actually investigates if the symptom experience is the same.<sup>1 24</sup> Although diagnosis and management of CFS/ME and FM is improving, it is clear from the literature that there remains at this time no definitive biomedical cause identified, nor has there been a diagnostic test developed or a formal management strategy implemented. Diagnosis is a long drawn out process hindered by the subtle differences in the presenting symptoms such as location of pain and fatigue, where management options may be suitable for both CFS/ME and FM.<sup>8 11 14</sup>

Considering there has been little improvement in the clinical management for these patients, it was important to perform a study into the symptoms of CFS/ME and FM to create a contemporary understanding of the relationship. This is pertinent due to the restrictions that the NICE guidelines impose and the argument that has been presented as to why there are no FM guidelines. By re-examining the symptoms to improve the understanding of the relationship between them, and the challenges faced

by patients, may provide evidence that CFS/ME and FM could be a single syndrome.

The purpose of this research was to assess the current relationship between the symptoms of CFS/ME and FM and to establish whether a relationship exists. In the absence of clear pathophysiology or diagnostic test, if the symptom experience is the same for both CFS/ME and FM, then this may have ramifications for the individual's management. This process may identify new areas for review and be informative for medical practitioners who come into contact with CFS/ME and FM patients and influence care.

## Aims and objectives

To perform structural equation modelling (SEM) and inform this study, preliminary work was undertaken by McKay *et al.*<sup>25</sup> to address and report the foundation objectives, which would form the basis of the research now reported. These aims were to identify and confirm the key occurring themes/symptoms of CFS/ME and FM, and the magnitude that these were experienced by the participants. Participants confirmed that they had received a formal diagnosis of CFS/ME and FM from a general practitioner (GP) or specialist and that they satisfied the requirements set out by their respective criteria. The demographic characteristics of the participants, such as age and gender, were established. In addition, the reliability and validity of the questionnaires used to measure symptoms in the current sample were confirmed and reported. A web-based questionnaire was designed to use for data collection.

The aim of the current research was to undertake an exploratory study into the symptoms of CFS/ME and FM. The hypothesis predicated that there would be no significant differences between the group's symptom experience. To address this hypothesis a number of objectives and strategies were undertaken to identify and assess the symptoms. These were to confirm if a relationship exists between the symptom experience of CFS/ME and FM patients.

## METHODS

### The sample

#### Inclusion

The sample included males and females from the general population who are >16 years of age and had a confirmed diagnosis of CFS/ME or FM by a GP or specialist. People self-selected to participate and were recruited through advertisements on the internet and through CFS/ME and FM self-help groups. In addition, people with CFS/ME were required to satisfy the American CDC Criteria for CFS/ME,<sup>15</sup> and people with FM were required to satisfy the ACR criteria for FM.<sup>4</sup>

#### Exclusion

Exclusions were as a result of self-diagnosis, additional chronic conditions, anxiety and/or depression or

**Table 1** Description of questionnaires used for data collection

Symptom	Questionnaire	Purpose	Reliability	Validity	Author
<b>Specific questionnaire/criteria</b>					
Diagnostic Criteria for CFS/ME	American Centers for Disease Control and Prevention Diagnostic Criteria (CDC) for CFS/ME. Symptom inventory.	Diagnostic criteria. In addition, measures, frequency, intensity and duration of eight symptoms.	Good. Cronbach's alpha ( $\alpha$ ) ranging from 0.82 to 0.91 $r > 0.77$ . <sup>33 52 53</sup>	Good. Significant correlations $r = 0.64-0.94$ ( $p < 0.001$ ). <sup>33 52</sup>	Fukuda <i>et al</i> <sup>15</sup> Wagner <i>et al</i> <sup>33</sup>
Diagnostic criteria for FM	American College of Rheumatology Diagnostic Criteria for FM	Diagnostic criteria for FM.	n/a	n/a	Wolfe <i>et al</i> <sup>4</sup>
Symptom experience of FM	The Fibromyalgia Impact Questionnaire	Comprises 20 items to assess the impact of symptoms of FM on patients' daily lives and their response to any management/treatment offered. Questions address patient's function, pain level, fatigue, sleep disturbance and psychological distress.	Good $\alpha = 0.72-0.93$ $r = 0.58-0.83$ . <sup>34 54</sup>	Good. Significant correlations with the Arthritis Impact Scale ( $p < 0.0001$ ). <sup>55</sup>	Burkhardt <i>et al</i> <sup>54</sup>
<b>Generic questionnaire</b>					
Pain	McGill Pain Questionnaire	Measures frequency and intensity of pain, namely: affective, evaluative, sensory and miscellaneous. There is a body diagram to indicate areas of pain, 72 descriptor words to assess pain and pain rating intensity scale. Each section is scored based on the guidelines.	Good. $\alpha > 0.9$ . $r \geq 0.89$ ( $p \leq 0.001$ ). <sup>26 56</sup>	Good. Coefficient ranging between 0.3 and 0.4. <sup>26</sup>	Melzack <sup>26</sup>
Fatigue	Multidimensional Fatigue Inventory	Measures 20 items on five dimensions: general, physical, mental, reduced motivation and reduced activity. Each dimension contains four items: two items relating to fatigue and two items that are contraindicative of fatigue.	Good. $\alpha > 0.80$ with average of 0.84. Stability $r \geq 0.72$ . <sup>28 57</sup>	Good. $p < 0.001$ High scores 0.77 general fatigue, 0.7 physical fatigue, 0.61 reduced activity, 0.56 reduced motivation mental fatigue 0.23 ( $p < 0.01$ ). <sup>28 57</sup>	Smets <i>et al</i> <sup>28</sup>
Sleep quality	The Pittsburgh Sleep Quality Index	Measures sleep over the period of 1 month. Comprising 19 items, generating seven component scores measuring: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, the use of sleeping medication and day-time dysfunction.	Good. $\alpha > 0.83$ . Mean component scores $r = 0.58$ . Individual items $\alpha > 0.83$ . $r \geq 0.85$ ( $p < 0.0001$ ). <sup>27 58 59</sup>	Good $r = 0.33$ ( $p < 0.001$ ). <sup>27 58</sup>	Buysse <i>et al</i> <sup>27</sup>
Quality of life	The SF-36 V2 Questionnaire (SF-36 V2)	Comprises 36 questions within eight domains of health namely: pain general health, vitality, physical functioning, social functioning, role limitations through physical problems, role limitations due to emotional problems and mental health including anxiety, depression, loss of behavioural/emotional control and physiological well-being. Results in two summary components of health physical and mental well-being of the patient. Aims to identify the positive and negative aspects of health that are most important to patients.	Good. $\alpha > 0.7$ in all aspects except emotional role $\alpha > 0.6$ . <sup>60-62</sup>	Good. Construct validity measuring $> 0.7$ . <sup>61</sup>	Ware and Sherbourne <sup>29</sup>
Anxiety and depression	Hospital Anxiety and Depression Scale (HADS)	Measures anxiety and depression in non-psychiatric populations. Comprises 14 questions. Seven questions for anxiety (HADS-A) and seven questions for depression (HADS-D).	Good. $\alpha = 0.93-0.98$ , $t = 0.93-0.97$ . <sup>30 63 64</sup>	Good. Range 0.6-0.8. <sup>30 63 64</sup>	Zigmond and Snaith <sup>30</sup>
Ability to approach illness	Multidimensional Health Locus of Control Form C	Measures self-related beliefs, comprised four scales namely: internal, chance, doctors and other people. Internal and chance scales comprise six questions, and doctors and other people comprise three questions. A total of 18 questions.	Good. $\alpha = 0.60-0.75$ . Internal consistency measures 0.71-0.87 $t > 0.80$ . <sup>31 65</sup>	Good. $r = 0.38-0.65$ ( $p < 0.001$ ). <sup>31 65</sup>	Wallston <i>et al</i> <sup>31</sup> Michielsen <i>et al</i> <sup>65</sup>
Self-esteem	The Rosenberg Self-Esteem Scale	Measures 10 items related to self-esteem. Includes feelings of self-worth and self-acceptance with five positive worded questions and five negatively worded questions. The negative items have their scores reversed prior to analysis.	Good. $\alpha = 0.78-0.89$ $t = 0.63-0.92$ . Internal consistence 0.77. <sup>66 67</sup>	Good. $r = 0.57-0.79$ ( $p < 0.01$ ). <sup>67 68</sup>	Rosenberg. <sup>32</sup>

Adapted from McKay *et al*.<sup>25</sup>  
CFS/ME, chronic fatigue syndrome/myalgic encephalomyelitis; FM, fibromyalgia; SF, Short Form.





incomplete data sets. Suitability for inclusion was based on screening answers posed by the questionnaire.

### Consent

Informed consent was confirmed electronically based on full written disclosure of the study. Consent could be retracted up to the point of data analysis.

### Measures

Table 1 details the nine self-assessment questionnaires that were subjected to validity and reliability checks and used to reflect and measure the symptoms that impact people with CFS/ME and FM and include: the McGill Pain Questionnaire (MPQ)<sup>26</sup>; the Pittsburgh Sleep Quality Index<sup>27</sup>; the Multidimensional Fatigue Inventory (MFI)<sup>28</sup>; the Health-Related Quality of Life (HRQoL) (SF-36 V2) Questionnaire<sup>29</sup>; the Hospital Anxiety and Depression Scale (HADS)<sup>30</sup>; the Multidimensional Health Locus of Control Scale (MHLOC Form C)<sup>31</sup> and the Rosenberg Self-Esteem Scale (RSES).<sup>32</sup> These questionnaires were selected as they were identified as being able to measure the most frequently reported symptoms of CFS/ME and FM.

The American CDC Symptom Inventory, the diagnostic criterion for CFS/ME<sup>15 33</sup> and the ACR diagnostic criterion for FM,<sup>4</sup> were selected as they are disease specific. The Fibromyalgia Impact Questionnaire (FIQ)<sup>34</sup> was used as it was designed specifically to measure the symptom experience of FM.<sup>34 35</sup> In addition, a questionnaire collecting sociodemographic information (eg, date of birth, sex, employment and educational level) and details relating to CFS/ME and FM (duration of illness, clinician who provided diagnosis and medical history) was used.

### Sample size

Addressing the sample required to perform SEM is challenging as no closed form expression exists; however, sample sizes between 100 and 300 are sufficient to generate meaningful data.<sup>35 36</sup> Prior to analysis, data were manually screened to confirm all sections of the questionnaire, and consent were fully completed and submitted. The final sample comprised 101 CFS/ME and 107 FM participants.

### Data analysis

Descriptive statistics were used to report the demographic details. Individual scoring methods for each of the questionnaires confirmed participants experienced a number of debilitating symptoms and confirmed that the participants fulfilled the requirements of the American CDC Criteria for CFS/ME<sup>15</sup> and the ACR criteria for FM<sup>4</sup> as reported by McKay *et al.*<sup>25</sup>

The preparatory work by McKay *et al.*<sup>25</sup> ascertained if it would be suitable to perform SEM on the symptoms of the CFS/ME and FM groups by identifying patterns that could be measured. The Mann-Whitney U test was used to test how likely any significant differences in the groups means are not due to chance.

In this study, SEM using Analysis of Moment Structures,<sup>35–43</sup> addressed the hypothesis that no significant differences exist between the symptom experience of the CFS/ME and FM groups. This technique uses a combination of statistical processes including, factor, regression and path analysis, to test causal relationships between measured variables and latent constructs. In addition, invariance testing was performed to confirm if participants were approaching the questionnaires in a similar manner, confirming that they have the same symptom experience.

There are no standardised goodness of fit indices (GFI) to confirm the degree to which the proposed model under study (eg, the HADS) fits the empirical data (CFS/ME and FM).<sup>35 37</sup> Therefore, the GFI selected and used for analysis are: the  $\chi^2$ , which measures how well the hypothesised model fits this sample of CFS/ME and FM, or how much the data deviate from this model.<sup>35</sup> Non-significant results ( $p>0.05$ ) will confirm that the groups are responding to the questionnaires in the same way.<sup>35</sup> The  $\chi^2$  divided by the df (CMIN/df) was used as it overcomes any issues with sample size and will confirm if the current models from the questionnaire fit the current CFS/ME and FM data.<sup>37 38</sup> The root mean square error of approximation<sup>39</sup> is a discrepancy test that is sensitive to the complexity of the model specified, the number of parameters and quality of the model under study.<sup>37</sup> The Comparative Fit Index assesses how superior the fit of the model proposed in the current study is compared with the null model, with the assumption that all latent variables are uncorrelated.<sup>40</sup> The fit indices selected were based on their appropriateness of use for assessing the selected hypothesised models of the nine questionnaires in the CFS/ME and FM groups. Table 2 highlights the GFI and their measurement parameters.

### The multigroup invariance test procedure

Following confirmation of good model fit for the nine individual questionnaires, multigroup invariance was used to test if the questionnaires held the same meaning for both groups, confirmed by the participants responding

**Table 2** Classification of selected goodness of fit indices

Fit index	Shorthand	Acceptable threshold levels
Absolute fit indices Chi-square	$\chi^2$	Low $\chi^2$ relative to df with an insignificant p level ( $p>0.05$ ).
CMIN/df	CMIN/df	Ratio of $\chi^2$ to df $\leq 2$ or 3, useful for nested models/model trimming $<3$ .
Comparative fit index	CFI	Greater or equal to 0.95 for acceptance. Norm range of 0–1.
Root mean square error of approximation	RMSEA	$<0.05$ – $0.08$ with CI of 90%. Values $<0.05$ are better.

to the questions in a similar manner. If the questionnaires are representative of the symptoms associated with CFS/ME and FM, and participant responses found to be invariant across the groups, it may be rational to say that CFS/ME and FM have the same underlying presentation. If the model is found to be significant ( $p < 0.05$ ), it is said to be non-invariant across the groups and does not support the theory that participants with CFS/ME and FM are responding in a similar way to the questionnaire. Non-invariance would suggest that the nine questionnaires hold a different meaning for each group and that participants fitting the criteria for CFS/ME are reporting different symptom experiences to those fitting the criteria for FM.<sup>41</sup> In this instance, the reason why the models are different needs to be investigated to identify which items are responsible for the differences between the two groups.<sup>42</sup>

Each item of the model was constrained individually to identify which factors/items are responsible for CFS/ME and FM groups approaching the questionnaires differently. A significant ( $p < 0.05$ ) result will identify the item/items responsible for these differences.<sup>35</sup>

### Patient and public involvement

Patients and the public were not involved in the design, conduct or reporting of this research.

### RESULTS

Data were screened prior to analysis to confirm that all participants met the requirements of the inclusion and exclusion criteria. The age range of participants was between 17 and 75 years. The CFS/ME group (n=101) had a mean (M) age of 45.52 years and the SD was 12.52 years, and for the FM group (n=107), M=47.20 years, SD=10.77 years. The CFS/ME sample comprised 85.2% (n=86) females and 14.8% (n=15) males. The

FM group comprised 88.9% (n=95) females and 11.2% (n=12) males. Participants with CFS/ME 45.5% (n=46) were more readily diagnosed by a GP. In the case of FM, a greater portion were diagnosed by a rheumatologist (57.9% (n=62)).

All participants with CFS/ME confirmed that they had experienced their symptoms for the required  $\geq 6$  months<sup>15</sup> and  $\geq 3$  months for a FM diagnosis.<sup>4</sup> The CFS/ME group experienced their symptoms for a mean of 10.69 years (SD=8.91 years), ranging from 1 year to 37 years, exceeding the minimum requirements of 6 months. Participants with FM experienced symptoms for a mean of 12.62 years (SD=9.85 years), ranging from 1 year to 28 years, exceeding the 3-month history required for a diagnosis of FM.

The American CDC Symptom Inventory was used to assess the additional symptoms associated for both CFS/ME and FM. Both the CFS/ME 7.9% (n=8) and FM 1.8% (n=2) groups experienced a minimum of five additional symptoms listed by the American CDC criteria, confirming that both groups fulfilled the CFS/ME criteria, as they experienced  $\geq 4$  symptoms required.<sup>15 33</sup> The maximum number of eight additional symptoms was experienced by the CFS/ME 49.0% (n=51) and FM 59.8% (n=61) groups (table 3). Table 3 highlights the number of participants who confirmed they had experienced a particular symptom in the past 6 months.

The CFS/ME group (n=101) had a median score of 8 and mode of 6 pain points selected, below the minimum requirement. The FM (n=107) group presented with a median of 14 and mode of 18 pain points, based on the ACR<sup>4</sup> diagnostic criteria for FM, exceeding the minimum required number of 11 pain points. In the FM group, the most frequently reported number of pain points were 18 (n=31). The total number of participants with  $\geq 11$  pain points were for CFS/ME: 29.7% (n=30) and FM: 76.6%

**Table 3** Mean scores for the diagnostic questionnaires for the CFS/ME and FM groups and the number of participants who confirmed that they experienced each symptom in the past 6 months on the American CDC Symptom Inventory

American CDC Symptom Inventory	CFS/ME					FM				
	Mean Score	Yes n	Yes %	No n	No %	Mean Score	Yes n	Yes %	No n	No %
Sore throat	3.79	77	76.2	24	23.8	3.59	82	76.6	25	23.4
Tender lymph nodes	4.60	81	80.2	20	19.8	4.25	83	77.6	24	22.4
Fatigue after exertion	12.43	101	100.0	0	0	12.99	106	99.1	1	0.9
Muscle aches and pains	9.51	95	94.1	6	5.9	13.79	107	100.0	0	0
Joint pain	7.78	85	84.2	16	15.8	11.48	105	98.1	2	1.9
Unrefreshing sleep	10.97	96	95.1	5	4.9	13.19	107	100.0	0	0
Headaches	6.27	93	92.1	8	7.9	9.96	95	88.8	12	11.2
Memory and concentration problems	9.37	96	95.1	5	4.9	9.62	104	97.2	3	2.8
Total degree of distress	64.72	-	-	-	-	75.87	-	-	-	-
Number of pain points	8.49	-	-	-	-	13.59	-	-	-	-

CDC, Centers for Disease Control and Prevention; CFS, chronic fatigue syndrome; FM, fibromyalgia; ME, myalgic encephalomyelitis.

(n=82). Both groups of participants reported pain in differing areas of their body, which did not necessarily correspond with the number of pain points recorded.<sup>25</sup>

### The Mann-Whitney U test results for the American CDC Symptom Inventory for CFS/ME and FM

The results from the Mann-Whitney U test for tender lymph nodes and/or swollen glands confirmed there were no significant differences between CFS/ME (median=2.5, n=101) and FM (median=5.0, n=107) groups ( $U=0.5$ ,  $z=-0.004$ ,  $p=0.9$ ,  $r=0.003$ ), where  $U$ =Mann-Whitney U,  $z$ =Kolmogorov-Smirnov test for evenly distributed groups,  $p$ =significance level and  $r$ =effect size. A significant difference between scores was identified for muscle aches and pains between the CFS/ME (median=10.0, n=101) and FM (median=16.0, n=107) ( $U=2611$ ,  $z=-6.7$ ,  $p=0.001$ ,  $r=0.3$ ), groups, with the FM confirming they experienced more muscle aches and pains than the CFS/ME group, and this difference was medium. These results confirmed that the FM group experienced more symptoms of unrefreshing sleep than participants with CFS/ME. A significant difference was identified between the CFS/ME (median=12.0, n=101) and FM (median=16.0, n=107) groups; however, the magnitude of this difference was small ( $U=4023.5$ ,  $z=-3.3$ ,  $p=0.001$ ,  $r=0.2$ ).

The results identified that there were statistically no significant differences between the CFS/ME and FM groups on the CDC Symptom Inventory, with the exception of the total score, joint pain, muscle aches and pains and unrefreshing sleep. However, the magnitude of the difference measured by the effect size was small, with the exception of muscle aches and pains, where the difference was medium, suggesting this difference was not significant. The effect size explains the magnitude of any significant differences detected between variables, confirming how important differences are. Calculating the level of significance, the power and the effect

size should increase the validity of the study. These results confirm that any differences between the CFS/ME and FM groups were not clinically significant, suggesting that both groups were similar at their baseline. These tests were carried out on all the questionnaires prior to SEM being performed.

### Confirming a relationship between CFS/ME and FM

SEM results confirmed that both groups were invariant on all the questionnaires with the exception of the American CDC Symptom Inventory, the FIQ and the HADS (table 4). The results also confirmed that the criteria for metric invariance have not been fulfilled, suggesting that CFS/ME and FM groups were responding differently to items on these questionnaires ( $p<0.05$ ) for each model. To identify which questions were responsible, each item was constrained individually. The results confirmed that, on the CDC Symptom Inventory, muscle aches and pains was the item of interest ( $\chi^2=55.44$ ,  $df=25$ ,  $\Delta\chi^2=10.69$ ,  $\Delta df=1$ ,  $p=0.01$  ( $p<0.05$ )). Two items on the FIQ were identified: the symptoms ( $\chi^2=104.16$ ,  $df=63$ ,  $\Delta\chi^2=9.92$ ,  $\Delta df=1$ ,  $p=0.02$  ( $p<0.05$ )) and *how tired have you been* ( $\chi^2=104.16$ ,  $df=63$ ,  $\Delta\chi^2=10.36$ ,  $\Delta df=1$ ,  $p=0.01$  ( $p<0.05$ )). On the HADS, the questions identified were: *I can laugh and see the funny side of things* ( $\chi^2=207.87$ ,  $df=149$ ,  $\Delta\chi^2=5.45$ ,  $\Delta df=1$ ,  $p=0.01$  ( $p<0.05$ )) and *I can enjoy a good book or radio programme* ( $\chi^2=208.05$ ,  $df=149$ ,  $\Delta\chi^2=5.63$ ,  $\Delta df=1$ ,  $p=0.01$  ( $p<0.05$ )).

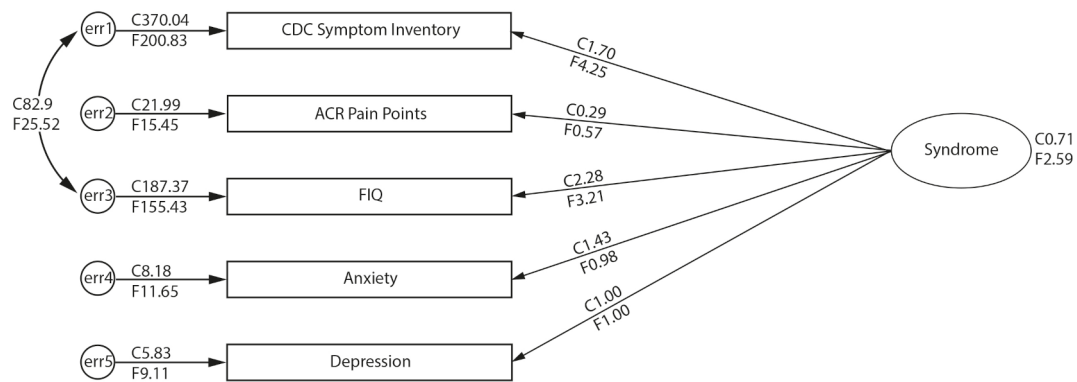
Due to the constraints of this research, it was not possible to perform a SEM on a model comprising all 400 questions from the questionnaires used. Instead, the Syndrome Model was created comprising the three questionnaires responsible for non-invariance, which now incorporated the ACR Criteria for FM pain points (figure 1). The ACR criteria could not have been previously tested using SEM, because an independent model could not be created and tested as it only comprised one data point. Incorporating the ACR with these three

**Table 4** Summary of the results from the invariance testing of the questionnaires used to measure the symptoms of CFS/ME and the FM groups

Questionnaire	$\chi^2$	df	$\Delta\chi^2$	$\Delta df$	P value	CFI	RMSEA	Invariance confirmed
American CDC Symptom Inventory	63.20	30	18.62	6	0.01	0.85	0.07	No
FIQ	1.74	71	29.49	9	0.01	0.92	0.06	No
MPQ	40.83	30	2.59	6	0.86	0.95	0.04	Yes
MFI	24.57	14	1.87	4	0.76	0.98	0.06	Yes
PSQI	40.83	30	2.59	6	0.86	0.95	0.04	Yes
SF-36 V2	116.26	43	13.14	9	0.09	0.89	0.09	Yes
HADS	223.81	160	21.39	12	0.04	0.94	0.04	No
MHLOC form C	420.89	366	14.01	14	0.45	0.84	0.05	Yes
RSES	122.12	79	4.88	9	0.85	0.95	0.05	Yes
Syndrome Model	27.69	12	10.49	4	0.07	0.91	0.08	Yes

CDC, Centers for Disease Control and Prevention; CFI, Comparative Fit Index; CFS, chronic fatigue syndrome; FIQ, Fibromyalgia Impact Questionnaire; FM, fibromyalgia; HADS, Hospital Anxiety and Depression Scale; ME, myalgic encephalomyelitis; MFI, Multidimensional Fatigue Inventory; MHLOC, Multidimensional Health Locus of Control Scale; MPQ, McGill Pain Questionnaire; PSQI, Pittsburgh Sleep Quality Index; RMSEA, root mean square error of approximation; RSES, Rosenberg Self-Esteem Scale.





**Figure 1** The Syndrome Model and note changes made. G=CFS/ME, F=FM. CDC, Centers for Disease Control and Prevention; err, errors; FIQ, Fibromyalgia Impact Questionnaire; Anxiety and Depression = HADS, Hospital Anxiety and Depression Scale.

questionnaires increased the data points to create a testable model, where the sample size was appropriate to generate meaningful data. Invariance testing confirmed no differences between groups ( $p < 0.05$ ) (table 4).

## DISCUSSION

The need for contemporary research in this area was evident from the literature, which identified that although CFS/ME and FM may be discussed together, there are a limited number of studies which link CFS/ME and FM.<sup>12 20-24</sup> This study is unique as it measured the symptoms of CFS/ME and FM using self-assessment questionnaires to identify if the symptom experience was similar. The results confirmed that the characteristics of the participants, such as age and gender, concur with previously reported characteristics of patients with CFS/ME and FM.<sup>11 25</sup>

Both groups satisfied the requirements of the CFS/ME criteria<sup>15 33</sup> and the FM criteria.<sup>4</sup> The CFS/ME group recorded lower than the required number of pain points to meet the 1990 FM<sup>4</sup> Criterion. However, with the publication of the reviewed criteria for FM,<sup>5</sup> which removed the highly restrictive pain point assessment, and instead focuses on areas of pain, it may be fair to say in this instance that this strengthens the argument that the CFS/ME group has satisfied the requirements of the revised 2010 FM criteria. Historically, pain in FM and fatigue in CFS/ME have been the defining symptoms of the criteria to determine the possible management pathway. Although reported in each as an associated symptom, it is confirmed here that these are as problematic for both groups.<sup>6 9-11 25</sup> This is supported as both groups reported that they had pain in differing areas of the body but not necessarily on a prescriptive pain point, which normally requires to be palpated with pressure to evoke an excruciating pain response. By testing for any differences in the mean scores between groups, it was confirmed that any differences were not clinically significant. Although these results suggest that both groups have similar mean scores, it did not confirm that a relationship existed. This is why the SEM was performed to give meaning to these results.

SEM confirmed good model fit for the nine individual questionnaires to facilitate the invariance testing to confirm if the CFS/ME and FM participants were responding in a similar manner to the questionnaires. Overall, the results presented confirmed invariance between the latent variables on the models measured, suggesting that the CFS/ME and FM groups were approaching the questionnaires in a similar manner as summarised in table 4. Invariance was confirmed for the symptoms measured by the MPQ, MFI and HRQoL measured by the SF-36 V2, MHLOC and the RSES. Following SEM, any differences in the mean scores identified and reported by McKay *et al*<sup>25</sup> were further confirmed as being clinically insignificant and support the findings of the invariance testing.

In contrast, non-invariance was confirmed on the American CDC Symptom Inventory, the FIQ and the HADS. Two of these criteria were designed as syndrome specific and may account for this result. These differences may be due to the level of detail included for measuring that particular symptom and the criteria-based questionnaires not being sufficiently detailed to accurately measure the complexity of these symptoms. For example, consideration should be given to these results in context with the findings from the symptom-specific questionnaires, such as the MPQ, which were confirmed as invariant, as this questionnaire provides a detailed account of pain and extensively measures the symptom experience.<sup>26</sup> However, considering our findings, it may have been erroneous to conclude that CFS/ME and FM were different based on the five questions (out of 400) identified as responsible for the non-invariance, taken from three of the questionnaires. Having considered all the results from the SEM's performed, and the constraints imposed by the current study, it was proposed that the Syndrome Model be created (figure 1). The results from the SEM of the Syndrome Model subsequently confirmed invariance between groups (table 4). These results are encouraging in presenting the explanation that both groups have responded to the questions in a similar manner.

Taking these findings in context with the results from the individual SEM performed for the symptom





questionnaires, it may be concluded that these participants with CFS/ME and FM are invariant across the symptoms and have the same overall syndrome experience impacting their quality of life.

However, our findings do not suggest that any single symptom, such as pain or fatigue, nor the magnitude of any similarities or differences between the individual symptoms are responsible for the cause, or any differences between CFS/ME and FM, but contribute to the whole symptom experience. This argument/conclusion is presented based on the evidence which highlights that to date, the aetiologies for both these groups have not been clearly identified, and therefore the symptoms of CFS/ME and FM manifest as a single reality based on their responses to the questionnaires.<sup>4 5 15 25</sup> Multiple possible contributing factors for CFS/ME have been discussed in the literature that include different viruses, infections and traumatic life events, with the WHO categorising CFS/ME as a neurological condition of unknown origin G93.3 (2013).<sup>23 44 45</sup> In contrast, the exact aetiology of FM is presently unknown, but studies previously performed have suggested patients may have experienced trauma to an area of the body resulting in chronic pain associated with the central nervous system, infections, genetics (affecting the neurotransmitters) or hypersensitivity to pain.<sup>46–49</sup> However, despite vigorous searching, the cause of CFS/ME and FM still remains to be identified.<sup>23 44 45</sup> In this instance, it is the experience of the complex constellation of debilitating symptoms that is important and should be considered and managed appropriately to enhance the patients' recovery and quality of life, despite the restrictions imposed by criteria or guidelines or lack thereof.

The findings presented complement research into the biomedical aspects of the syndromes and the management options that may be available for CFS/ME and FM.<sup>1 24</sup> Focus should be on enhancing quality of life by improving the symptom experience until definitive biomedical markers are identified for CFS/ME and FM. It is imperative that there is investment in biomedical research. In addition, with the CFS/ME NICE guidelines currently under review, and the proposal for a guideline for FM being rejected, these findings may be used to assist in any amendments and consideration for future guidelines.

Therefore, until the treatable cause is identified, both groups should be afforded whatever management options are available regardless of diagnostic criteria, classification of the syndrome, clinical experience, geographical location or cost to improve quality of life. There is evidence to suggest that some of the current management options for CFS/ME and FM may be counterproductive. Treatments such as cognitive-behavioural therapy, graded exercise therapy and pacing, yield mixed results in these patients, with some reporting that exercise may have a negative effect on their symptoms.<sup>24 50 51</sup> Instead it may be beneficial to manage the patient's symptoms individually to promote and support the patient's quality of life. For example, consideration could be given to good medicine

management of symptoms, involvement from specialist services such as nutritionists, chronic pain specialists, physiotherapists or occupational services and ensure the correct/appropriate delivery of care when required.

### Strengths and limitations of this study

To our knowledge, this is the first study to assess the symptom experience of CFS/ME and FM using the methods described. This study brings attention to an area of CFS/ME and FM that has not been researched in a number of years and addresses the possible constraints imposed by pertinent guidelines or a lack thereof for CFS/ME and FM. Attention should focus on symptom management for improved quality of life, which is at the forefront in the lived experience of CFS/ME and FM.

The constraints of the sample size prevented the testing of a model incorporating all the questionnaires. In future, a substantially larger sample would be recommended to test the model.

The groups were found to be non-invariant on the American CDC Symptom Inventory and the FIQ. Both were designed to specifically assess CFS/ME and FM respectively, concluding that these criteria/questionnaires may each be biased towards the diagnosis they were designed for, as these findings suggest that CFS/ME and FM may manifest as a single reality for patients. In future, with the unclear origins of the aetiology, it may be recommended that these be reviewed or omitted and only generic questionnaires used, until a time when physiological differences between CFS/ME and FM have been confirmed.

In future, it is recommended that the focus be on investment in education and training of clinicians responsible for diagnosing and managing patients with CFS/ME and FM. This is to enhance the management of the debilitating symptoms such as pain, fatigue, sleep disturbance and the additional debilitating symptoms of CFS/ME and FM. Optimal management may provide improvements in patients' symptoms.

### CONCLUSION

In conclusion from taking these results into context with the literature reviewed, this new approach confirms that both CFS/ME and FM symptom profiles and the daily challenges these patients are presented with are similar, making differentiation between the two symptom experiences questionable. CFS/ME and FM may manifest as a single reality, with the evidence presented supporting the proposal to review the diagnostic criteria, guidelines and management and challenge the clinical opinion that divides CFS/ME and FM, or even rejects these syndromes as a reality. Therefore, consideration should be given to offering both groups the same management opportunities to address their symptoms and improve their health-related quality of life until research into the biomedical causes identifies and confirms the source of CFS/ME and FM.

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