

RUNNING HEAD: VALIDATING THE PMS

Validating the Philadelphia Mindfulness Scale (PMS) for Those with Fibromyalgia

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Abstract

Objectives: Dispositional Mindfulness (DM) has become an important construct in understanding and treating Fibromyalgia. However, few DM measures exist that have been validated in those with fibromyalgia. The Philadelphia Mindfulness Scale (PMS) is a self-report of DM. In the current study we validate the PMS within a sample of individuals with fibromyalgia.

Design: This was a cross-sectional online study. This enabled the recruitment of a larger sample of individuals with experiences of fibromyalgia than may have been achieved through face-to-face assessment. A cross-sectional approach was adopted to minimise resource demands.

Method: The PMS alongside measures of fibromyalgia severity (The Revised Fibromyalgia Impact Questionnaire), affect (Positive and Negative Affect Scale), and decentring (Experiences Questionnaire) were completed online by a sample of $N = 936$ individuals with fibromyalgia.

Results: Confirmatory factor analysis supported a revised three-factor structure for the PMS. This factor structure excluded items which could overlap with hypervigilance within fibromyalgia. The three supported factors were Awareness, Non-judging /Control and Non-suppression/reactivity. Concurrent validity of the subscales was partially supported via correlations with positive and negative affect and decentring.

Conclusions: The results support the use of the PMS in individuals with fibromyalgia, and in particular the use of this measure to compare those with and without experience of meditation. The PMS may be a useful tool in evaluating mindfulness based interventions within this population.

Limitations: The online design prevented more in-depth assessment of fibromyalgia. As the study was cross-sectional test re-test reliability could not be assessed.

Key words: Mindfulness; Fibromyalgia; Psychometrics, Confirmatory Factor Analysis,
Validity

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Validating the Philadelphia Mindfulness Scale for Those with Fibromyalgia

Fibromyalgia is a specific chronic pain condition of unknown aetiology characterised by ongoing pain in the soft tissues of the body.¹ Fibromyalgia is associated with considerable psychological distress and disorder, with greater levels in this group than the general population and those with other chronic pain conditions.^{2,3} In the context of traditional medical approaches showing little benefit,⁴⁻⁶ Mindfulness-Based Interventions (MBIs) are continuing to demonstrate their efficacy in improving the well-being of individuals with fibromyalgia.^{8,9} Within a clinical context, MBIs are interventions which focus on mindfulness as a trainable skill through regular meditation practice. Mindfulness may also be considered a dispositional trait (Dispositional Mindfulness; DM).¹⁰ That is, mindfulness may be described as the ability to maintain moment to moment awareness in both an open and accepting way,¹¹ and individuals seem to differ in their natural tendency to respond to their experiences in this way. Evidence suggests that levels of mindfulness without training remain stable over time.¹² The measurement of DM and its key underlying dimensions in those experiencing fibromyalgia is therefore important for both research evaluating MBIs and clinicians working within those with fibromyalgia who use a mindfulness-based framework. The current study focuses on the psychometric evaluation of a DM measure, the Philadelphia Mindfulness Scale (PMS)¹³ in a fibromyalgia population.

Bishop and colleagues¹⁴ propose that mindfulness consists of two broad facets: the ability to sustain attention to the present moment, and the ability to adopt a stance of acceptance characterised by being non-judgemental, open and curious. These qualities of acceptance and awareness may be beneficial to those with fibromyalgia, because they run counter to maladaptive emphasis on controlling the pain, such as through avoidance of activity, which ultimately further maintain both pain and distress.^{15,16} Likewise, a focus on the present moment is incompatible with worry or rumination, which again is common in chronic pain.¹⁶

Cardaciotto and colleagues¹³ developed the PMS specifically based on Bishop and colleagues' definition of mindfulness. It is a 20-item measure consisting of two orthogonal dimensions measuring awareness and acceptance.

Other widely used measures of DM exist. The Mindfulness Attention and Awareness Scale (MAAS)¹⁰ is a 15-item self-report measure of DM. The validity of the MAAS as a measure of DM has been supported¹⁰ but this measure has also been criticised because items do not fully capture the “acceptance” facet of mindfulness (i.e., being able to accept negative states without trying to avoid or push these away) proposed by Bishop and colleagues.¹⁴ The Five Facet Mindfulness Questionnaire (FFMQ)¹² is another measure of DM that was developed to specifically assess change in mindfulness skills within the context of interventions. It encompasses a broader definition of mindfulness which includes: Non-Reactivity to Inner Experience; Observing/Noticing; Acting with Awareness; Describing; and Non-Judging of Experience.¹² However, the scale has also been criticised, with the suggestion that the “Non-reactivity” subscale might be better conceptualised as an outcome of DM.¹⁴

The PMS benefits from an *a priori* definition of mindfulness and is also short enough not to be too demanding to complete by fibromyalgia populations.¹³ Whilst the above DM measures have been used in samples experiencing chronic pain, the underlying factor structure has not been confirmed amongst such samples, at least with English-language versions of these measures (although see other-language validation studies)¹⁷⁻²⁰. Establishing the factor structure of DM measures within chronic pain samples is necessary to ensure subscale scores map onto meaningful underlying factors. In the current study we therefore subject the PMS to a CFA within a chronic pain sample, those with fibromyalgia.

The hypothesised two-factor structure of the PMS was supported both by Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) in a sample of students,¹³ but not those with chronic pain. The CFA did not account for the ordinal nature of the items

in the PMS, which may have biased fit indices to some extent (Kline, 2011). Cardaciotto and colleagues¹³ suggest a number of residual correlations ($k = 6$) that improved the fit of their two factor model. In the current paper we test both models (i.e., two factors and two factors with correlated errors) as part of our CFA. An alternative factor structure can be suggested by reviewing the item content of the PMS. Notably, within the acceptance subscale, there appear to be two types of question. The first relate specifically to active attempts to suppress or avoid unwanted thoughts and feelings (e.g., “I try to distract myself when I feel unpleasant emotions”) whilst the second refer to a feeling that one should be able to control or should not experience certain thoughts or emotions (e.g., “I tell myself that I shouldn’t have certain thoughts”). The former represents an active, emotion-focussed, coping process (e.g., thought suppression and distraction). Alternatively, the latter reflects a judgement on whether certain thoughts and feelings are appropriate or should be suppressed or controlled. These can be likened to the concept of meta-beliefs concerning internal states.²¹ These two dimensions have similarities with the non-reactivity and non-judging subscales of the FFMQ.¹² Hence an *a priori* three factor structure for the PMS could be hypothesised with Awareness, Non-suppression/reactivity, and Non-judging/control as factors.

A question pertinent to the current paper is the extent to which those dimensions of DM established in other populations would apply to a sample of individuals experiencing chronic pain, specifically fibromyalgia. A notable psychological feature of those experiencing fibromyalgia is hypervigilance to internal states, possibly including both physical sensation and negative thoughts and feelings.^{22,23} A number of items in the PMS awareness subscale may inadvertently capture this hypervigilance, particularly those items that refer to shifts in physical (“I notice changes inside my body, like my heart beating faster or my muscles getting tense”) and emotional (“I am aware of thoughts I’m having when my mood changes”) states. Therefore we also consider a revised three-factor structure for the PMS where we

exclude those items from the Awareness subscale which focus on internal states. This leaves an Awareness factor focused on awareness of external events (“When talking with other people, I am aware of their facial and body expressions”) and sensory experience (e.g., “When I shower, I am aware of how the water is running over my body”).

It is also important that the PMS can be used to make meaningful comparisons across relevant subgroups of those with fibromyalgia. For example, comparisons between those with greater or lesser experience of meditation are important in determining whether mindfulness meditation based interventions are effective. Moreover, there is evidence that the structure of DM measures may vary as a function of meditation experience²⁴ limiting the extent to which such comparisons can be made. Whether the factor structure remains the same across subgroups is a matter of factor invariance²⁵ and this will be tested in the current paper for meditators and non-meditators.

In addition we assessed concurrent validity by testing theorised relationships with decentering, positive (PA) and negative affect (NA). It has been consistently demonstrated that mindfulness positively correlates with PA and negatively correlates with NA.²⁶ It has been proposed that mindfulness through intervention leads to improvements in well-being via increased decentering,²⁷⁻²⁹ which is a fundamental metacognitive shift in the ability to recognise one’s thoughts as thoughts, rather than necessarily true facts.²⁷ Fresco and colleagues explicitly state that they do not see their definition (and associated Experiences Questionnaire)²⁷ as synonymous with mindfulness as defined by Bishop and colleagues¹⁴; rather, they feel it is complimentary to it. They also note that Bishop and colleagues¹⁴ themselves consider mindfulness and decentering are not redundant concepts. To clarify, mindfulness enables an individual to focus on experiences in the present moment with acceptance and curiosity, but it is the process of decentering that is hypothesised to specifically facilitate an individual to recognise the thoughts they are noticing are just thoughts, as opposed to definite truths about

the self. It is predicted, therefore, that the PMS would be positively correlated with decentering in that individuals with higher levels of DM will also reported an increased ability to decentre.

The current study aimed to validate the PMS within a sample of those with fibromyalgia. We initially undertake a CFA comparing five alternative factor models: i) a single factor model; ii) the two-factor (Awareness, Acceptance) model initially theorised and supported by Cardaciotto and colleagues¹³; iii) Cardaciotto and colleagues two-factor model with correlated error terms; iv) a three factor model outlined in this paper (Awareness, Non-suppression/reactivity, Non-judging/control); and v) a revised four-factor model whereby those items concerning awareness of internal states and state shift are excluded. Identifying the optimal factor structure within this population is essential in order to derive meaningful and informative subscale totals from such measures, and also provides valuable theoretical insights into the psychological architecture of these constructs. We also test concurrent validity via associations between the PMS, NA, PA and decentering. Specifically, we hypothesise that awareness would positively, moderately correlated with Awareness, and that Non-suppression/reactivity and Non-judging/control would have positive moderate relationships with PA and negative moderate relationships with NA. An online survey was used to recruit a large sample of individuals with self-reported fibromyalgia, with decentering assessed via the Experiences Questionnaire²⁷, Fibromyalgia severity via the Revised Fibromyalgia Impact Questionnaire³⁰ and affect with the widely used Positive and Negative Affect Scale.³¹

Method

Participants & Procedures

A community sample comprising 936 individuals with self-reported fibromyalgia participated in the study. The sample consisted of 873 women and 63 men, with a mean age of 47.97 years ($SD = 10.82$, range 19-82 years). Inclusion criteria required that participants (i) reported confirmation of a clinical diagnosis of fibromyalgia, (ii) were aged 18 years or older

and (iii) were a resident of the United Kingdom (UK). Fibromyalgia-related difficulties assessed on the Revised Fibromyalgia Impact Questionnaire (FIQR)³⁰; were similar to levels reported in other studies for this population (Current sample = 68.54; sample from Bennett et al³⁰ = 59.7; see Table 1).

Eighty percent of the sample ($N = 753$) reported taking medication to manage their fibromyalgia symptoms, and 28% ($N = 260$) had previously completed some form of mindfulness-based intervention. Fifteen percent ($N = 144$) reported having practiced meditation for less than a year, 9% ($N = 81$) had practised for one to five years and 10% ($N = 90$) reported having practiced meditation for five or more years. However, most of the sample had not practiced any kind of meditation (66%; $N = 621$).

Following university ethical approval, the study was advertised via two national fibromyalgia charities in the UK. Participants took part by following a link placed on the advert that took them to the webpage containing the survey. The internet based online study required approximately 15 minutes to complete the questionnaires.

Measures

*The Revised Fibromyalgia Impact Questionnaire (FIQR)*³⁰ was used to assess fibromyalgia related difficulties. The FIQR is a 21-item measure which covers functional status, (e.g., “fibromyalgia made it difficult to [brush or comb your hair]”), overall impact (e.g., “Fibromyalgia prevented me from accomplishing goals for the week”), and presence of common FM symptoms (e.g., “Please rate your level of [pain]”). Participants are asked to think about how FM has impacted on their life over the last seven days. Items are rated on an 11-point Likert scale ranging from 0 to 10, with higher scores indicating that their FM has had a greater impact on their life. Total scores are scaled so that they range from 0 to 100. The FIQR has demonstrated good validity in distinguishing those with FM from healthy controls, individuals with rheumatoid arthritis and individuals with lupus (Bennett et al., 2009). In this present study, Cronbach’s alpha was .95.

Philadelphia Mindfulness Scale (PMS).¹³ The PMS is a 20-item scale designed to measure mindfulness based on Bishop and colleagues (Bishop et al., 2004) operationalized definition. Each item is rated on a Likert scale ranging from 1 (never) to 5 (very often). Reliabilities were acceptable for the awareness (.80) and acceptance subscales (.85). A full list of items is presented in Appendix I.

Positive and negative affect scale (PANAS).³¹ The PANAS is a well-established and validated measure of positive affect (PA) and negative affect (NA). The 20-item scale, comprises 10 PA (e.g., *active*) and 10 NA (e.g., *irritable*) items. Participants rated each item to the extent to which they have experienced each affect item during the past week on a Likert scale ranging from 1 (very slightly) to 5 (extremely). The construct validity, reliability and concurrent validity of these scales is well supported.³² In the present study Cronbach's alphas were .91 and .90 for PA and NA, respectively.

Experiences Questionnaire (EQ).²⁷ The decentering subscale of the EQ was used to assess decentering. This subscale comprises 11-items (e.g., *I can observe unpleasant feelings without being drawn into them*). Each item is rated on a Likert scale ranging from 1 (never) to 5 (all of the time). The subscale has evidenced concurrent and discriminant validity as demonstrated by positive correlations with cognitive re-appraisal and negative correlations with depressive rumination, experimental avoidance and emotional suppression (Fresco et al. 2007). Reliability in the present study was .87.

Statistical Analysis

Due to the ordinal nature of the items in the PMS the CFA were undertaken using Mean and Variance Weighted Least Squares (WLSMV) estimation with the polychoric correlation matrix between items used as the input. This approach has been shown to work well in the context of ordinal data.³³ Analyses were undertaken using Mplus Version 7.2.³⁴ Reverse items were reflected so that for all items higher scores suggested greater DM. Model

fit to the data was based upon a Confirmatory Fit Index (CFI; adequate fit $> .90$, good fit $> .95$), Tucker-Lewis Index (TLI; adequate fit $> .90$, good fit $> .95$) and Root Mean Squared Residual (RMSEA; adequate fit $< .08$, good fit $< .06$).³⁵⁻³⁷

Factor invariance was assessed at three hierarchical levels: dimensional & configural invariance; metric invariance and scalar invariance.²⁵ Dimensional & configural invariance was based upon estimating the best fitting model from the analyses of the full sample separately with each sub-sample. If the fit remained adequate for both groups and standardized factor loadings remained good (e.g., $> .4$)³⁸ then dimensional and configural invariance was present. Metric invariance was assessed by comparing a nested model whereby factor loadings were constrained to be equal across groups against a model where these are free to vary. Metric invariance is seen as present if the more restrictive model (factor loadings constrained) is not a significantly worse fit, as determined via the scaled X^2 difference test.³⁹ Scalar invariance follows metric invariance and involves comparing a model with both factor loadings and indicator thresholds held constant across groups against a model where thresholds (but not loadings) are free to vary.

Results

Descriptive Statistics

Mean descriptive statistics for the key study variables are reported in Table 1. Male and female participants did not significantly differ on any of these variables (all p 's $> .05$). Individuals who were taking medication reported significantly higher levels of NA, $t(934) = 3.47$, $p < .01$, $d = .23$, and fibromyalgia-related difficulties, $t(934) = 6.27$, $p = .04$, $d = .41$. There was no difference between participants who were taking medication and those who were not for the remaining study variables (all p 's $> .05$).

TABLE 1 ABOUT HERE

Factor Structure

The five competing factor structure models were estimated. Fit statistics for each model are reported in Table 2. The three factor model (Model 4) demonstrated a better fit than either the one or two factor models (Models 1 to 3), but the fit of this model still fell below our criteria for good fit. The revised three factor model (Model 5) in contrast met our criteria for adequate fit. Parameter estimates for this final model are reported in Table 3. All standardized factor loadings were above .40, meeting guidelines for minimum factor loadings within factor analysis.³⁸ Item 12, “There are things I try not to think about” introduced a degree of ambiguity around whether it was better placed with the Non-suppression/reactivity factor or Non-judging/control factor. We did test an alternative 3-factor model where item 12 loaded onto the former rather than latter factor, but found this was an even poorer fit to the data, $X^2(62) = 852.90$, CFI = .90, TFI = .87, RMSEA = .12.

Modification indices for Model 5 suggested this model could be further improved by allowing item two (“I try to distract myself when I feel unpleasant emotions”) to cross-load on to the awareness factor as well as the non-suppression/reactivity factor. Cross-loading items can create difficulties in using self-report measures, since the same items contribute to different subscales, which can limit the use of different subscales together within the same statistical model (e.g., predictors in a regression). For these practical reasons we did not allow this cross-loading. Additionally, where we allowed this cross-loading, the standardized loading of this item onto the awareness factor was small (< .3). We calculated generalised Cook’s distances for this final model using the FAOUTLIER⁴⁰ package for R, which accounts for the ordinal nature of the data. The largest Cook’s distance (.0002) fell below the recommended cut-off of $4/N = 0.004$ ⁴¹ and thus was not treated as an overly influential case.

In the final model both Non-judging/control and Non-suppression/reactivity factors were highly correlated. However, they demonstrated distinct correlations with the third Awareness factor, whereby the Non-judging/control factor had no relationship with this

factor but Non-suppression/reactivity was moderately negatively correlated with Awareness. Thus awareness was unrelated to the tendency to judge internal states, but was related to a greater tendency to try and suppress or avoid negative internal states.

TABLE 2 ABOUT HERE

TABLE 3 ABOUT HERE

Factor Invariance

First dimensional and configural invariance was assessed by estimating the final model (revised three factor model) across the two meditation sub-samples (meditators $N = 315$; non-meditators $N = 621$). Meditators were defined here on the basis of some experience of meditation irrespective of duration. The model fit adequately in both cases but better for meditators, scaled $X^2(62) = 248.48$, CFI = .97, TFI = .96, RMSEA = .07, than non-meditators, scaled $X^2(62) = 215.99$, CFI = .94, TFI = .92, RMSEA = .09. In both models all standardized factor loadings were good ($> .4$). Dimensional and configural invariance was therefore supported. Metric invariance was not, however, supported, as a model where factor loadings were constrained to be equal across groups was a significantly worse fit than one where these were free, scaled $\Delta X^2(10) = 15.02$, $P = .02$. The factor loading for item 16 varied more noticeably between groups (standardized loadings; meditators: .75, non-meditators: .87) and the wording (“If there is something I don’t want to think about, I’ll try many things to get it out of my mind”) was more ambiguous than others with regards to the specific strategies one might try to put thoughts out of their mind. We therefore tested a partial metric invariance, whereby all factor loadings were constrained to be equal except that associated with item 16. Notably, partial metric invariance was supported, $\Delta X^2(9) = 9.61$, $P = .10$. We then tested partial scalar invariance, comparing the metric invariance model to one where item thresholds were also constrained to be equal across groups (again with the

exception of item 16), $\Delta X^2(36) = 9.28, P = .73$. In summary partial scalar invariance was supported across the two groups.

Reliability & Validity

Total scores for the three subscales derived from the three factor model were calculated by summing the relevant items. Internal reliability for each subscale is reported in Table 4. Internal reliability exceeded $\alpha = .70$ for all subscales except for Awareness, likely due to the fewer items in this subscale ($k = 3$). Nonetheless reliability for this subscale was still adequate ($\alpha = .62$). Correlations with decentring and affect are also reported in Table 4. Multiple regressions were undertaken to explore the relationship between the three subscales and decentring, positive affect and negative affect. The results of these analyses are in Table 5. Residuals were homoscedastic and normally distributed within all regression analyses with the exception of the regression of negative affect onto the PMS subscales, where mild heteroscedasticity was present. Testing for significance using bootstrapped confidence intervals⁴² with 5000 resamples led to equivalent results. Multicollinearity was not identified (Tolerance $> .2$).⁴³ There were no influential outliers identified in any of the regression analyses. All models were significant. Both Awareness and Non-judging/control predicted greater decentring, positive affect and less negative affect. In contrast, Non-suppression/reactivity predicted less decentring (e.g., those who make less use of avoidance and suppression also report less decentring) and less positive affect decentring (e.g., those who make less use of avoidance and suppression also report less positive affect) but was unrelated to negative affect.

TABLE 4 ABOUT HERE

TABLE 5 ABOUT HERE

Discussion

Considering the high levels of distress often associated with fibromyalgia, and the potential for mindfulness as a therapeutic tools, valid measure of DM in this population are needed, yet no DM measures exist that we are aware of that have been fully validated in a fibromyalgia population. Here we aimed to validate the PMS within a sample of individuals with fibromyalgia, using CFA to compare five alternative factor models to determine the best fitting structure. The results supported a revised 3-factor structure for the PMS when used in this population. This revised structure extends on the originally hypothesised structure of the PMS¹³ in two important ways. First, the idea of separate Non-judging/control and Non-suppression/reactivity factors was supported over a single acceptance factor. This distinction captures the idea that the actual use of avoidance and suppression as a means of managing negative internal states may be separate to an individual's judgment of such states as problematic and the desire to control such states. The latter Non-judging/control factor could be understood as a set of meta-beliefs concerning internal states,²¹ whilst the former Non-suppression/reactivity factor concerns a specific coping strategy. The Non-judging/control factor may also be similar to the idea of an intolerance of certain emotional or cognitive states.⁴⁴ The Non-judging/control and Non-suppression/reactivity factors were correlated as would be expected, since a wish to control certain internal states is naturally liable to lead to specific attempts to suppress or avoid these. The Non-judging/control factor is probably closer than the Non-suppression/reactivity factor to the underlying idea of acceptance within the DM literature. Second, the revised PMS excludes those items of the Awareness subscale that could potentially overlap with a hypervigilance of internal states. A hypervigilance to internal states has been reported in chronic pain conditions including fibromyalgia, and may contribute to the emergence of the disorder.^{22,23} With this in mind, an Awareness factor which focuses on the awareness of sensory and external experiences is one way of assessing the awareness component of DM whilst avoiding this overlap.

The factor inter-correlations further support the distinction between Non-judging/control and Non-suppression/reactivity, since these showed different relationships with Awareness. In particular, greater reported Awareness was associated with a greater tendency to attempt to suppress or avoid internal states. This is not unexpected, since the ability to suppress or avoid an internal state necessitates a certain level of awareness of these experiences. Moreover, as this is a sample who are struggling with a chronic pain condition, for whom avoidant coping may be a common way of managing distress, such a relationship is understandable. It will be important to test if similar factor structures and relationships emerge within other samples, including mixed chronic pain samples.

The results support the partial scalar invariance of the PMS across meditators and non-meditators. Scalar invariance is necessary for group comparisons on factor means to be meaningful²⁵ and as such these findings support the use of this measure in chronic pain populations to compare those with and without experience of meditation. However, as this invariance was only partial an uncertainty around the use of item 16 of the PMS remains. This is problematic only for the Non-suppression/reactivity factor, where this item loads and so it may be that clinicians and researchers using the PMS within this population consider dropping this item from this subscale or make comparisons on this subscale cautiously. Notably, the reactivity embodied in the Non-suppression/reactivity factor may be better conceptualised as an outcome of DM¹⁴ rather than a core facet of DM, and so it may also be that this subscale is dropped leaving just the Awareness and Non-judging/control subscales. This conceptualisation is also in-line with Bishop and colleagues¹⁴ definition.

The relationships the revised PMS factors had with decentring, negative affect and positive affect partially supported hypotheses. As predicted decentring, which involves an awareness and recognition of thoughts and feelings, was highly correlated with the Awareness factor. Decentring was also correlated with the Non-judging/control factor, which

would be expected since decentring is to a certain extent incompatible with a desire to control thoughts and feelings.²⁷ Reporting more mindful awareness of one's environment and a lesser tendency to judge or wish to control negative internal states was linked to greater positive affect, which is consistent with the wider mindfulness literature.²⁶ Notably, the Non-judging/control factor was also strongly related to negative affect. This relationship is consistent with meta-cognitive models of distress which suggest it is the negative meta-beliefs concerning internal states and processes that underlie the emergence of distress.^{21, 45} The Non-suppression/reactivity factor, once overlapping variance with other PMS subscales was accounted for, was negatively related to positive affect (contrary to hypotheses), so that those who reported more of a tendency to use avoidance and suppression also tended to report more positive affect, although this effect was small. This finding suggests a more nuanced understanding of avoidance and suppression techniques, which suggests these coping strategies may have benefits for those with chronic pain conditions, leading to more positive emotions. Thus the current study suggests it is an individual's beliefs about aversive internal states and their wish to control these that may be more problematic than the actual tendency to adopt avoidance and suppression as a coping strategy. Further confirmation of these findings is needed, however.

A few key methodological issues deserve comment. It should be noted that the study did not look at measurement invariance between the FM group and other samples. The current findings do suggest an alternative factor structure to the original development study (which took place in students) and so a test of measurement invariance between a student and FM population would be of interest. This was not however the goal of the current study. The study used a cross-sectional design. Therefore, it is possible, that severity of pain and/or mood states at the time of completing the measures may have influenced reports. Future research would benefit from testing on more than one occasion to assess test-retest reliability

of the measures within this population. While we tested the revised 3-factor model across two meditation sub-samples (meditators vs. non-meditators), it should be acknowledged that the meditator group varied considerably on the duration of meditative practice, nor where specific types of meditative practices reported.

It could be argued that the revised Awareness factor by not capturing mindful awareness of emotions and thoughts may not capture the full content of the construct of mindful awareness. However, we would argue this issue of the breadth of the factor needs to be weighed up against the dangers of confounding mindful awareness with hypervigilance in those with fibromyalgia. Notably, the results do not rule out the possibility of alternative, carefully worded items being introduced in the PMS that better capture this aspect of mindfulness. Further work in this area would be valuable. The small number of items remaining ($k = 3$) when the potentially confounding items are removed from this subscale means that it should be used with caution, and it may be that additional items more suited to a chronic pain population could be added. The presence of fibromyalgia was based on self-reported diagnosis, and not confirmed by a clinician or diagnostic tests. This may have led to the current sample including individuals who would not meet formal diagnostic criteria for fibromyalgia taking part, although levels of reported symptomology were similar to clinical groups. Moreover, checks of diagnosis would have added extra burden and limited the attainable sample size, which would have been problematic for large-sample size techniques like CFA.

The online methodology facilitated the recruitment of a large sample of participants, which may have been more challenging if face-to-face assessments had been used. This approach may have other advantages, such as supporting more honest and open responding due to the anonymous nature of online surveys. However, this online design meant that more in depth interview-based assessments, which could have been used to confirm the presence of

fibromyalgia, were not possible. A cross-sectional design was adopted as it places fewer demands on participants' time and the resources of the research team but this meant some psychometric properties requiring a prospective design (e.g., test re-test reliability). The sample were recruited via adverts placed in Fibromyalgia charities. It is unclear how representative such individuals are of the wider population of those with fibromyalgia but severity of fibromyalgia was similar to previous samples.

Despite these limitations, our study identified a more optimal revised 3-factor PMS structure in a fibromyalgia population. As such, it represents an important development on the originally hypothesized PMS structure (Cardaciotto et al., 2008), extends theoretical understanding of these psychological constructs and provides a validated clinical assessment tool for use within the fibromyalgia population. The PMS may therefore provide one tool for pain clinics and individual clinicians working with those with fibromyalgia to determine baseline levels of DM, which in turn is useful information for guiding interventions. Those particularly low in DM may, for example, benefit more from MBIs. The results also support the suggestion that practitioners should be wary of those items of the PMS that focus on awareness of internal states. Lastly, the current study supports the suggestion that low scores on the Non-judging /Control may be particularly informative in terms of understanding the distress patients experience, an observation consistent with psychological models of chronic pain.

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Declaration of Interest

None

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Table 1

Descriptive Statistics

Variable	Mean	Standard Deviation	Range
PA	23.35	8.45	10 – 48
NA	26.31	9.35	10 – 50
M'ful aware	36.48	5.94	13 – 50
M'ful accept	25.31	6.60	10 – 50
Decentering	33.02	6.96	14 – 55
FM	68.54	18.52	5 – 100

Note. PA = positive affect; NA = negative affect, M'ful aware = mindful awareness; M'ful accept = mindful acceptance; FM = fibromyalgia-related difficulties.

Table 2

Model	<u>Model fit</u>				
	Scaled χ^2	<i>df</i>	CFI	TLI	RMSEA (90% CI)
Model 1: 1 factor	4927.51	170	.55	.50	.17 (.17, .18)
Model 2: 2 factor	2283.02	169	.80	.78	.12 (.11, .12)
Model 3: 2 factor, correlated errors	2108.41	164	.82	.79	.11 (.11, .12)
Model 4: 3 factor	1831.03	167	.84	.82	.10 (.10, .11)
Model 5: revised 3 factor	406.72	62	.96	.94	.08 (.07, .08)

Fit Statistics for the Completing CFA Models

Table 3

Parameter Estimates for the Final Model

Parameter	Unstandardized estimate	Standardized estimate
<u>Factor loadings</u>		
Awareness (Aw)		
Item 3	1.00	.52
Item 5	1.28	.67
Item 9	1.41	.74
Non-suppression/reactivity (NR)		
Item 2	1.00	.47
Item 6	1.37	.65
Item 16	1.74	.83
Item 18	1.44	.68
Item 20	1.49	.71
Non-judging/control (NC)		
Item 4	1.00	.75
Item 8	0.81	.61
Item 10	1.05	.79
Item 12	1.15	.86
Item 14	0.87	.65
<u>Factor covariances & correlations</u>		
Aw – NR	-0.06	-.24
Aw – NC*	0.02	.04
NR - NC	0.25	.70

*All loadings and correlations significant ($p < .001$) with the exception of this one

Table 4

Descriptive statistics, Reliability, Correlations and Regression Results for PMS Subscales

^a Spearman's correlations; * $p < .05$; Aw = Awareness; NR = Non-suppression/reactivity; NC

Variable	<u>Descriptives</u>			Zero-order		
	Alpha	Mean	SD	Correlations ^a		
				Decentring	Positive Affect	Negative affect
Aw	.62	11.05	2.51	.43*	.26*	-.13*
NR	.77	12.76	3.48	-.01	.03	-.28*
NC	.82	12.54	4.04	.41*	.37*	-.62*

= Non-judging/control

Table 5

Results of Regression of Outcome Variables onto PMS Subscales

Predictor	<u>Decentring</u>			<u>PA</u>			<u>NA</u>		
	R^2	B	r_{sp}	R^2	B	r_{sp}	R^2	B	r_{sp}
Aw	.41*	1.06*	.37	.22*	0.76*	.22	.40*	-0.42*	-.11
NR		-0.47*	-.19		-0.39*	-.13		0.11 ^a	.03
NC		0.94*	.45		0.95*	.38		-1.48*	-.53

* $p < .001$; ^a $P = .19$; Aw = Awareness; NR = Non-suppression/reactivity; NC = Non-judging/control