



The role of personality in patients with fibromyalgia

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Received: 25 May 2018 / Revised: 13 September 2018 / Accepted: 24 September 2018 / Published online: 1 October 2018
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Abstract

Previous studies suggest personality, the multifaceted characteristics underlying a person's affect, cognition, and behavior, may influence fibromyalgia. We examined associations among personality, fibromyalgia impact, and health-related outcomes in patients with fibromyalgia. We further tested whether anxiety and depression mediated the effect of personality on fibromyalgia impact. We performed a secondary analysis using baseline data from a randomized trial on fibromyalgia. Personality was assessed using the NEO-Five Factor Inventory 3. Fibromyalgia impact was evaluated using the revised Fibromyalgia Impact Questionnaire (FIQR). We also measured symptom severity, anxiety, depression, stress, quality of life, social support, self-efficacy, outcome expectations, and mindfulness. Multivariable linear regression was performed to evaluate each association. Mediation analysis assessed whether anxiety and depression mediated the relationship between personality and FIQR. There were 92 participants, 95% female, mean age 52 years, body mass index (BMI) 30 kg/m², 52% white, and mean duration of body pain 14 years. Higher neuroticism was significantly associated with higher FIQR ($P = 0.002$) and symptom severity ($P = 0.008$), as well as higher levels of anxiety, depression and stress, worse mental component quality of life, and lower self-efficacy, mindfulness, and social support. Higher conscientiousness and extraversion were associated with better psychological health and health-related outcomes. The effect of neuroticism on fibromyalgia impact was mediated by anxiety and depression. Personality was associated with fibromyalgia impact and a variety of health outcomes. Identifying the factors that influence fibromyalgia will help us better understand the condition and provide insight for more effective treatment.

Keywords Anxiety · Chronic pain · Depression · Fibromyalgia · Personality

Introduction

Fibromyalgia is a chronic widespread musculoskeletal pain syndrome characterized by muscle tenderness, fatigue, sleep disturbance, and physical and psychological impairment [1]. Current treatment typically involves symptom management through medication, cognitive behavioral therapy, and exercise, but the neuropathology of the

disorder remains unclear, and the condition currently has no known cure [2–4]. In order to better understand the complex nature of fibromyalgia, further investigation of the various factors that influence the syndrome is necessary.

Personality is the multifaceted set of characteristics that underlie a person's affect, cognition, and behavior. It has a large influence on an individual's ability to cope with adversity and distress [5]. The Big Five personality theory, also known as the Five Factor Model, is a widely recognized model describing five personality traits that are considered stable throughout adult life: agreeableness, conscientiousness, extraversion, neuroticism, and openness. The effect of personality on fibromyalgia has recently garnered increasing interest. Research has found that inadequate coping to stress is common among fibromyalgia patients [6, 7], and it is suggested that personality may facilitate the conversion of these stressors to physiological responses that ultimately exacerbate the symptoms of fibromyalgia [8]. Since 2001, at least seven studies have used the Big Five inventory and NEO-Five Factor Inventory (NEO-FFI) to investigate these personality traits

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among fibromyalgia patients [9–15]. However, these studies have been limited by either the number of measures and outcome they examined and/or by their sample size. Furthermore, these studies have produced mixed results. One study found that personality did not distinguish people with fibromyalgia [15]. Several other studies, however, have demonstrated that personality dimensions are associated with certain health outcomes related to fibromyalgia. Of these studies, four revealed significant associations between neuroticism and pain [9–12]. Two studies showed significant associations between neuroticism and fatigue, stress, sleep, and anxiety [9, 10]. One study found neuroticism and conscientiousness are significant predictors of pain catastrophizing, while neuroticism, openness, and agreeableness are significant predictors of pain anxiety [14].

Prior literature has shown that certain personality traits are significantly associated with anxiety and depression [16, 17], and the prevalence of these comorbid disorders in fibromyalgia patients is well documented [18, 19]. However, whether personality directly affects an individual's fibromyalgia condition or if its effects are mediated through other psychosocial variables is unknown. Past studies have revealed that anxiety and depression are independently associated with the severity of fibromyalgia symptoms, with higher levels of each correlating with more severe pain and fatigue [20, 21]. Therefore, the effect of personality on one's fibromyalgia condition may potentially act through either anxiety and/or depression.

Overall, there is limited evidence examining the association between personality and other psychosocial and related health outcomes. Elucidating the role of personality in fibromyalgia will further expand our knowledge of the disorder and its complex nature. This may have implications in improving patient outcomes by providing insight for designing more individualized and effective treatment plans that account for the diverse components contributing to the clinical symptoms of fibromyalgia. Therefore, this study had two primary objectives: (1) to evaluate the association between personality dimensions and the clinical symptoms of fibromyalgia and other health-related outcomes; this is the first study to examine the individual associations between personality and quality of life, self-efficacy, social support, outcome expectations for exercise, and mindfulness in adult patients with fibromyalgia; (2) to evaluate whether the association between personality dimensions and overall fibromyalgia impact is mediated by either anxiety or depression. We hypothesize neuroticism will associate with higher overall fibromyalgia impact and poor health outcomes compared to other dimensions of personality. We also predict that the effect of personality on fibromyalgia impact will be mediated by both anxiety and depression.

Methods

Study design

We performed a secondary cross-sectional analysis of baseline data from a randomized controlled comparative effectiveness trial between Tai Chi and aerobic exercise for fibromyalgia. All data were collected at Tufts Medical Center, a tertiary hospital located in downtown Boston. This study was approved by Tufts Medical Center and Tufts University Human Institutional Review Board and was granted by the National Center for Complementary and Integrative Health of the National Institutes of Health (Trial Registration: NCT01420640). Signed informed consent was obtained from each study participant. A detailed protocol has been published [22].

Recruitment procedures

We used multiple advertising strategies to recruit a diverse study population. Flyers were posted throughout Tufts Medical Center, and advertisements were placed in local newspapers, magazines, and electronic media outlets. Additionally, we collaborated with rheumatologists to identify patients who might be eligible. All interested respondents received standardized information pertaining to the study and completed a preliminary phone screening. Subjects who met eligibility were invited to a formal, on-site screening at the clinic.

Eligibility criteria

Eligible participants were [1] aged 21 years or older and [2] met ACR 1990 classification criteria and ACR 2010 diagnostic criteria for fibromyalgia. Individuals were excluded if they had [1] prior experience with Tai Chi training or similar types of complementary therapy (Qi Gong or yoga) in the past year; [2] serious medical conditions limiting ability to participate in Tai Chi or Aerobic Exercise intervention; [3] diagnosed medical conditions that are known to contribute to fibromyalgia symptomology; [4] thyroid disease, inflammatory arthritis, systemic lupus erythematosus, rheumatoid arthritis, myositis, vasculitis, or Sjogren's syndrome; [5] an inability to pass the Physical Activity Readiness Questionnaire (PAR-Q); [6] a score less than 24 on the Mini-Mental Status evaluation; [7] plans to relocate from the region during trial period; [8] verbal confirmation of pregnancy or planned pregnancy during trial period; or [9] were non-English speaking.

Screening procedures

During the baseline screening evaluation, participants completed a pre-randomization assessment evaluating general health and functional status, as well as physical,

psychological, and psychosocial functioning. A rheumatologist completed a tender point survey to confirm a fibromyalgia diagnosis. All randomized participants who completed the NEO-Five Factor Inventory and other measures were included in this analysis.

Measures

NEO-Five Factor Inventory-3

The NEO-Five Factor Inventory-3 (NEO-FFI-3) is a validated self-report inventory that evaluates the Big Five personality traits: (1) Agreeableness—the tendency of an individual to be altruistic, warm, and trustworthy; (2) Conscientiousness—the tendency of an individual to demonstrate self-discipline; (3) Extraversion—how outgoing and social an individual is; (4) Neuroticism—the tendency of an individual to experience negative emotion; and (5) Openness—the level of general appreciation for variety and new experiences [23]. The inventory consists of 60 items, with 12 items assessing each personality domain. Participants rate each item on a 5-point Likert scale, scored from 0 (disagree strongly) to 4 (agree strongly). Scores range from 0 to 48 for each domain; higher scores indicate higher levels of that personality trait.

Revised Fibromyalgia Impact Questionnaire

The revised version of the Fibromyalgia Impact Questionnaire (FIQR) is a well-validated multidimensional scale that assesses the health status of fibromyalgia patients by measuring pain, fatigue, stiffness, tenderness, balance, sleep, memory, environmental sensitivity, physical functioning, anxiety, and depression [24]. The questionnaire consists of 20 items rated on a 0–10 scale. Total scores range from 0 to 100, calculated as the sum of three domains: function, overall impact, and symptom severity. Higher total scores indicate higher overall fibromyalgia impact.

Symptom Severity Scale

The Symptom Severity Scale (SSS) is a two-part instrument that assesses fibromyalgia symptoms, including fatigue, waking unrefreshed, cognitive symptoms, and 41 other somatic symptoms commonly related to fibromyalgia, such as muscle pain, muscle weakness, and chest pain [25]. The SSS is calculated by the sum of the severity of symptoms. The SSS scores range from 0 to 12, with higher scores indicating greater symptom severity.

Hospital Anxiety and Depression Scale

The Hospital Anxiety and Depression Scale (HADS) is a validated instrument measuring the presence and severity of anxiety and depression [26]. The questionnaire consists of two subscales: HADS-A assessing anxiety and HADS-D assessing depression. Each subscale contains seven items rated on a 0–3 scale. Subscale scores range from 0 to 21, with higher scores indicating higher anxiety or depression.

Perceived Stress Scale

The Perceived Stress Scale is a validated and widely used psychological instrument that measures the perception of stress [27]. Stress is defined as the degree to which an individual deems his or her life unpredictable, uncontrollable, and overwhelming over the past month. The scale is comprised of ten items rated on a 5-point Likert scale ranging from 0 (never) to 4 (very often). Scores range from 0 to 40, with higher scores indicating higher perceived stress.

Short Form-36 Health Survey

The Short Form-36 (SF-36) Health Survey is a validated measure of health status and quality of life with well-documented psychometric properties [28]. It consists of 36 questions that give two aggregate scores: the physical component summary (PCS) score and the mental component summary (MCS) score. Items are transformed into a 0–100 point scale, with higher scores indicating better perceived health status.

Social Support Survey

The Medical Outcomes Study Social Support Survey is a 19-item validated evaluation of social support [29]. The Social Support Survey measures subscale domains that include emotional/information support, tangible support, affectionate support, and positive social interaction support. Items are rated on a scale of 1 (none of the time) to 5 (all of the time). Scores range from 19 to 95, with higher scores indicating more social support.

Self-efficacy

Self-efficacy, the belief that one has the capacity and power to accomplish a task, was measured by a modified eight-item Arthritis Self-Efficacy Scale (ASES-8) [30]. This validated scale consists of eight items rated on a 10-point Likert scale from 1 (very uncertain) to 10 (very certain). Higher scores indicate more self-efficacy.

Outcome Expectations for Exercise

The Outcome Expectations for Exercise Scale is a validated measure that assesses outcome expectations and perceived physical and mental benefits of exercise [31]. The scale is comprised of item items rated on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Higher scores indicate higher outcome expectations for exercise.

Five Facet Mindfulness Questionnaire

The Five Facet Mindfulness Questionnaire (FFMQ) is a validated 39-item self-report questionnaire which measures five facets of mindfulness: observing, describing, acting with awareness, non-judging, and non-reacting to inner experience [32]. Each item is rated on a 5-point Likert scale, ranging from 1 (never or rarely true) to 5 (very often or always true). Scores range from 39 to 195. Higher scores indicate higher levels of mindfulness.

Statistical analysis

All data were statistically evaluated for normality of distribution and values are all presented as mean \pm standard deviation, unless otherwise stated. Pearson's correlation was performed to assess associations between personality dimensions and measures of health and fibromyalgia impact. To examine the relationships after adjustment for potential confounders, multivariable linear regression was performed, controlling for age, gender, body mass index (BMI), and living situation (i.e., whether or not participants were living alone). Models were checked for influential points using standard regression diagnostics.

Mediation analysis was performed to investigate the potential mediating effects of anxiety and depression in the relationship between personality and fibromyalgia impact (Fig. 1). Mediation analysis was done according to the criteria set by Baron and Kenny [33]. A variable is considered a mediator if

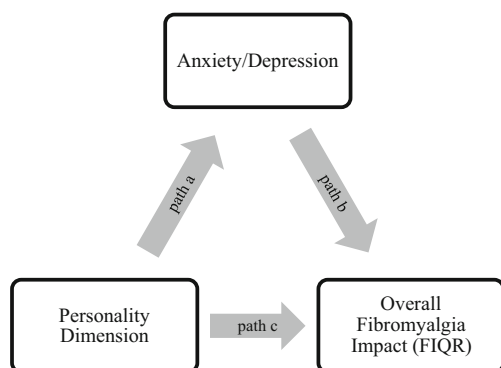


Fig. 1 Mediation model: relationship between personality dimension, anxiety/depression, and overall fibromyalgia impact

(1) the independent variable (i.e., personality dimension) significantly associates with the presumed mediator (i.e., anxiety/depression) (path a), (2) the presumed mediator significantly associates with the outcome variable (i.e., overall fibromyalgia impact) (path b), (3) the independent variable significantly associates with the outcome variable (path c), and (4) the relationship between the independent variable and outcome variable is no longer significant after controlling for the mediator (path c'). All analyses were performed using SAS 9.4. Significance level was set at $P \leq 0.05$.

Results

Baseline demographic and clinical characteristics

Data analysis was based on 92 participants (Table 1). The mean age was 52.3 years, 94% were female, 52% were white, and 51.1% lived alone. The average body mass index (BMI) was 30.1 kg/m² and the average duration of body pain was 13.8 years. The mean FIQR score was 58.3, indicating moderate to severe fibromyalgia among the participants.

Association between personality and health outcomes

Table 2 shows Pearson's correlation coefficients between personality dimensions and all outcome measures. Higher levels of neuroticism were significantly associated with higher overall fibromyalgia impact ($r = 0.34$; $P = 0.001$) and symptom severity ($r = 0.29$; $P = 0.006$). Higher neuroticism was also associated with higher levels of anxiety ($r = 0.61$; $P < 0.0001$), depression ($r = 0.53$; $P < 0.0001$), and stress ($r = 0.64$; $P < 0.0001$). In addition, higher neuroticism was associated with worse mental component quality of life ($r = -0.65$; $P < 0.0001$), and lower social support ($r = -0.33$; $P = 0.002$), self-efficacy ($r = -0.23$; $P = 0.03$), and mindfulness ($r = -0.50$; $P < 0.0001$). In contrast, higher levels of conscientiousness and extraversion were generally associated with better psychological health (i.e., lower scores on PSS and HADS and higher scores on SF-36-MCS) and psychosocial health outcomes (e.g., more self-efficacy). Openness and agreeableness showed a similar trend, but only had four and one significant associations, respectively. None of the five personality dimensions were significantly associated with physical component of quality of life.

Multivariable linear regression

Table 3 shows the associations between personality dimensions and health outcomes after multivariable linear regression, controlling for age, gender, BMI, and living situation. The associations between personality and health outcomes

Table 1 Baseline characteristics and health outcomes ($N = 92$)

Demographic	
Age	52.3 ± 12.1
Female, n (%)	87 (94.6%)
White, n (%)	48 (52.2%)
Body mass index (BMI)	30.1 ± 6.2
Duration of body pain (years)	13.8 ± 10.8
Level of education, n (%)	
High school diploma/GED or lower	22 (23.9%)
Some college or college degree	54 (58.7%)
Graduate school or higher	16 (17.4%)
Lives alone, n (%)	47 (51.1%)
NEO-FFI-3	
Neuroticism [range 0–48]	23.1 ± 7.2
Extraversion [range 0–48]	25.7 ± 6.0
Agreeableness [range 0–48]	34.2 ± 5.6
Openness [range 0–48]	30.9 ± 6.6
Conscientiousness [range 0–48]	31.1 ± 6.8
FIQR [range 0–100]	58.3 ± 18.8
Symptom severity [range 0–12]	8.9 ± 1.9
HADS-anxiety [range 0–21]	8.6 ± 3.8
HADS-depression [range 0–21]	7.4 ± 4.2
Perceived stress [range 0–40]	19.9 ± 7.4
SF-36 mental component [range 0–100]	41.3 ± 11.0
SF-36 physical component [range 0–100]	29.5 ± 7.9
Social Support [range 1–5]	3.3 ± 1.0
Self-Efficacy [range 1–10]	5.1 ± 2.0
Outcome Expectations for Exercise [range 1–5]	3.8 ± 0.7
Mindfulness [range 39–195]	133.4 ± 20.2

NEO-FFI-3, NEO-Five Factor Inventory-3; FIQR, Revised Fibromyalgia Impact Questionnaire; HADS, Hospital Anxiety and Depression Scale; SF-36, Short Form-36, a measure of quality of life; Social Support, measured by the Medical Outcomes Study Social Support Survey; Self-Efficacy, measured by the Arthritis Self-Efficacy Scale-8; Mindfulness, measured by the Five Facet Mindfulness Questionnaire. Data are presented as mean ± standard deviation unless otherwise indicated

remained significant after adjustment, with a few exceptions. Notably, extraversion was no longer significantly associated with overall fibromyalgia impact and self-efficacy. Baseline scores on agreeableness were no longer significantly associated with any outcome. Higher openness was no longer significantly associated with mental component quality of life. Although the association between openness and depression remained significant, standard regression diagnostics revealed that there was one outlier that significantly affected the result. When this influential point was removed from the analysis, the association between openness and depression became insignificant (P value changed from 0.047 to 0.15).

Table 4 illustrates trends in associations after multivariable linear regression. Worse health outcomes were defined as higher levels of fibromyalgia impact, symptom severity,

anxiety, depression and stress, and lower scores in quality of life, social support, self-efficacy, outcome expectations, and mindfulness. Better health outcomes were defined as the opposite (i.e., lower levels of fibromyalgia impact, symptom severity, anxiety, depression, and stress, and higher scores in quality of life, social support, self-efficacy, outcome expectations, and mindfulness). Higher neuroticism was generally associated with worse health outcomes. Higher levels of conscientiousness and extraversion were generally associated with better health outcomes. Higher openness was also associated with better health outcomes, but only a few of the associations were statistically significant.

Mediating effects of anxiety and depression

Results of the mediation analysis support the hypothesis that anxiety and depression mediate the effect of personality on fibromyalgia impact. However, only the mediation models with neuroticism as the independent variable completely fulfilled the criteria set by Baron and Kenny. The multivariable linear regression showed that higher levels of neuroticism were significantly associated with anxiety (path a; $\beta = 0.32$; $P < 0.0001$) and FIQR (path c'; $\beta = 0.81$; $P = 0.002$) (Fig. 2a). Anxiety was significantly associated with FIQR (path b; $\beta = 2.25$; $P = 0.0004$). When controlling for anxiety, the association between neuroticism and FIQR was no longer significant (path c'; $\beta = 0.10$; $P = 0.73$), suggesting that anxiety significantly mediated the effects of neuroticism on overall fibromyalgia impact.

Similarly, higher levels of neuroticism were significantly associated with depression (path a; $\beta = 0.31$; $P < 0.0001$), and depression was significantly associated with FIQR (path b; $\beta = 2.08$; $P = 0.0001$) (Fig. 2b). However, when controlling for depression, the previously significant association between neuroticism and FIQR became insignificant (path c'; $\beta = 0.16$; $P = 0.58$). This suggested that depression mediated the effects of neuroticism on overall fibromyalgia impact as well.

Discussion

This is the first study to explore associations between the Big Five personality traits and quality of life, social support, self-efficacy, outcome expectations for exercise, and mindfulness in adult patients with fibromyalgia. We found that higher neuroticism was associated with higher overall fibromyalgia impact, symptom severity, anxiety, depression, stress, and worse mental component quality of life. Higher neuroticism was also associated with lower self-efficacy, mindfulness, and social support. Of note, higher conscientiousness and extraversion were generally associated with better psychological health (less anxiety, depression, and stress, and better mental component quality of life) and health-related outcomes such as more

Table 2 Correlation coefficients between personality and health outcomes* ($N = 92$)

Health outcomes	Personality dimensions				
	Agreeableness	Conscientiousness	Extraversion	Openness	Neuroticism
FIQR ^a	-0.03	-0.15	-0.23	-0.20	0.34
Symptom Severity ^a	0.13	-0.24	-0.23	-0.04	0.29
HADS-anxiety ^a	-0.16	-0.29	-0.24	-0.08	0.61
HADS-depression ^a	-0.07	-0.30	-0.53	-0.26	0.53
Perceived Stress ^a	-0.14	-0.42	-0.30	-0.03	0.64
SF-36 Mental Component Score	0.22	0.47	0.45	0.21	-0.65
SF-36 Physical Component Score	-0.17	-0.16	-0.05	0.01	0.15
Social Support	0.17	0.13	0.27	0.10	-0.33
Self-Efficacy	-0.13	0.25	0.22	0.08	-0.23
Outcome Expectations for Exercise	0.18	0.23	0.12	0.28	-0.05
Mindfulness	0.14	0.47	0.35	0.30	-0.50

FIQR, Revised Fibromyalgia Impact Questionnaire; HADS, Hospital Anxiety and Depression Scale; SF-36, Short Form-36, a measure of quality of life; Social Support, measured by the Medical Outcomes Study Social Support Survey; Self-Efficacy, measured by the Arthritis Self-Efficacy Scale-8; Mindfulness, measured by the Five Facet Mindfulness Questionnaire

*Italic correlations indicate statistical significance (P value < 0.05)

^a Higher scores indicate worse health

social support, self-efficacy, outcome expectations, and/or mindfulness. In addition, the effect of neuroticism on fibromyalgia impact was mediated by anxiety and depression.

Of the five personality traits, only neuroticism was associated with worse health outcomes. This finding is consistent with the results of other studies. Malin and Littlejohn found

Table 3 Associations between personality and fibromyalgia impact, psychosocial factors, and health outcomes

Health Outcomes	Personality dimension beta (95% CI)*				
	Agreeableness	Conscientiousness	Extraversion	Openness	Neuroticism
FIQR ^a	-0.04 (-0.74, 0.66)	-0.44 (-0.99, 0.12)	-0.61 (-1.22, 0.01)	-0.35 (-0.94, 0.24)	0.81 (0.30, 1.33)
Symptom Severity ^a	0.04 (-0.03, 0.12)	-0.07 (-0.13, -0.01)	-0.07 (-0.14, -0.01)	0.003 (-0.06, 0.07)	0.08 (0.02, 0.13)
HADS-Anxiety ^a	-0.09 (-0.23, 0.05)	-0.17 (-0.28, -0.06)	-0.14 (-0.26, -0.01)	-0.01 (-0.13, 0.11)	0.32 (0.23, 0.40)
HADS-Depression ^a	-0.03 (-0.18, 0.13)	-0.20 (-0.32, -0.08)	-0.36 (-0.48, -0.24)	-0.13 (-0.26, -0.002)	0.32 (0.21, 0.42)
Perceived Stress ^a	-0.18 (-0.47, 0.11)	-0.49 (-0.70, -0.29)	-0.38 (-0.63, -0.13)	-0.02 (-0.26, 0.23)	0.68 (0.51, 0.85)
SF-36 Mental Component Score	0.42 (-0.01, 0.85)	0.77 (0.46, 1.07)	0.80 (0.45, 1.15)	0.29 (-0.08, 0.66)	-1.05 (-1.30, -0.80)
SF-36 Physical Component Score	-0.28 (-0.58, 0.02)	-0.17 (-0.43, 0.08)	-0.11 (-0.39, 0.18)	-0.03 (-0.29, 0.24)	0.18 (-0.06, 0.41)
Social Support	0.03 (-0.01, 0.07)	0.03 (-0.01, 0.06)	0.04 (0.01, 0.08)	0.03 (-0.01, 0.06)	-0.05 (-0.08, -0.02)
Self-Efficacy	-0.05 (-0.13, 0.03)	0.08 (0.02, 0.15)	0.07 (-0.003, 0.14)	0.01 (-0.05, 0.08)	-0.07 (-0.13, -0.01)
Outcome Expectations for Exercise	0.02 (-0.01, 0.05)	0.03 (0.002, 0.05)	0.01 (-0.02, 0.04)	0.03 (0.01, 0.05)	-0.01 (-0.03, 0.02)
Mindfulness	0.64 (-0.12, 1.40)	1.39 (0.86, 1.93)	1.35 (0.72, 1.97)	0.87 (0.24, 1.49)	-1.52 (-2.02, -1.02)

FIQR, Revised Fibromyalgia Impact Questionnaire; HADS, Hospital Anxiety and Depression Scale; SF-36, Short Form-36, a measure of quality of life; Social Support measured by the Medical Outcomes Study Social Support Survey; Self-Efficacy, measured by the Arthritis Self-Efficacy Scale-8; Mindfulness measured by the Five Facet Mindfulness Questionnaire

Italic P values indicate statistical significance (P value < 0.05)

*All models were adjusted for age, gender, BMI, and living situation

^a Higher scores indicate worse health

Table 4 Significant associations between personality and fibromyalgia impact, psychosocial factors, and health outcomes

Variable	Personality dimension ^a				
	Agreeableness	Conscientiousness	Extraversion	Openness	Neuroticism
FIQR					●
Symptom Severity		▲	▲		●
HADS-anxiety		▲	▲		●
HADS-depression		▲	▲	▲	●
Perceived Stress		▲	▲		●
SF-36 Mental Component Summary		▲	▲		●
SF-36 Physical Component Summary					
Social Support			▲		●
Self-Efficacy		▲			●
Outcome Expectations for Exercise		▲		▲	
Mindfulness		▲	▲	▲	●

FIQR, Revised Fibromyalgia Impact Questionnaire; HADS, Hospital Anxiety and Depression Scale; SF-36, Short Form-36, a measure of quality of life; Social Support, measured by the Medical Outcomes Study Social Support Survey; Self-Efficacy, measured by the Chronic Pain Self-Efficacy scale; Mindfulness, measured by the Five Facet Mindfulness Questionnaire

^a All models were adjusted for age, gender, BMI, and living situation

▲ Indicates personality trait is associated with better health outcomes. Better health outcomes are defined as lower scores in symptom severity, anxiety, depression, and perceived stress, and higher scores in quality of life, social support, self-efficacy, outcome expectations, and mindfulness

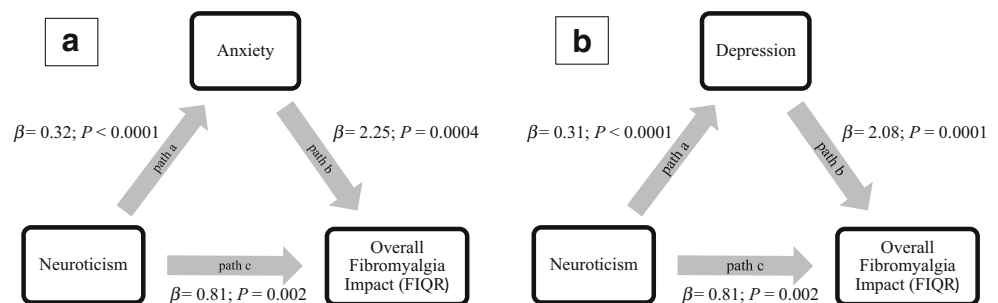
● Indicates personality trait is associated with worse health outcome. Worse health outcomes are defined as higher scores in symptom severity, anxiety, depression, and perceived stress, and lower scores in quality of life, social support, self-efficacy, outcome expectations, and mindfulness

that neuroticism was significantly associated with the basic characteristics of fibromyalgia such as pain, sleep, fatigue, and confusion [9]. In agreement with our results, they found neuroticism had strong associations with common fibromyalgia comorbidities of depression, anxiety, and stress. Furthermore, our finding that neuroticism significantly associated with higher FIQR scores and symptom severity complements, the results of other studies that found high neuroticism was associated with high levels of chronic pain [11] and pain catastrophizing [14] in fibromyalgia patients.

Two personality traits (conscientiousness, extraversion) were found to generally associate with better psychological health and related health outcomes. This is similar to the results of other studies as well. Higher extraversion and lower

neuroticism in this study were associated with less anxiety and depression, which align with the findings of a previous study that showed that higher extraversion and lower neuroticism were linked with better affective states and less psychosocial problems [15]. In this study, higher conscientiousness was associated with lower symptom severity and stress, which is comparable to earlier findings associating the trait with less chronic pain [11]. Despite the evidence supporting the attenuating effects of certain personality traits on the clinical symptoms of fibromyalgia, some studies have found differing results. Higher conscientiousness, for example, has been linked with pain catastrophizing rather than better health outcomes associated with fibromyalgia [14]. Nevertheless, the present study has found new associations showing that higher levels

Fig. 2 Linear regression results superimposed on the proposed mediation model with **a** anxiety and **b** depression as the mediator between neuroticism and overall fibromyalgia impact



of conscientiousness was significantly associated with higher self-efficacy, outcome expectations for exercise, and mindfulness, while higher extraversion was associated with more social support and mindfulness.

The effect of personality on the clinical symptoms of fibromyalgia may relate to a person's ability to cope with stress. Personality and coping has been extensively studied, and current literature suggests that the interaction between personality, stress, and coping can predict both mental and physical well-being [5]. A review and meta-analysis on this subject have linked extraversion, conscientiousness, and openness to effective coping strategies directed at successfully dealing with stress [5, 34]. These strategies include seeking support, emotional regulation, acceptance, and engagement aimed at controlling, adapting, and adjusting to the stressor. Neuroticism, in contrast, is linked with ineffective coping techniques like avoidance, denial, and disengagement. Inadequate coping to stress is common among fibromyalgia patients [6, 7]. Indeed, poor coping may underlie recent evidence that physical and psychological trauma can precipitate the development of fibromyalgia [35]. Some studies suggest that personality can facilitate the emergence of poor coping and can modulate a person's response to stress, which can ultimately exacerbate the symptoms of fibromyalgia [8, 10]. As a personality trait, neuroticism reflects emotional reactivity and a tendency to experience distress. Individuals who score high in neuroticism are often characterized as people who worry a lot, are depressed, and are easily upset or irritated. Therefore, when fibromyalgia patients with neurotic personalities are impaired by their functional limitations, they are more susceptible to poor coping and perceiving their own life negatively. This may explain why higher neuroticism in the present study was associated with worse psychosocial factors such higher perceived stress, and lower mental quality of life, social support, self-efficacy, and mindfulness.

Results of the mediation analysis from the current study suggest that one dimension of personality has both direct and indirect effects on overall fibromyalgia impact. The indirect effects of neuroticism on fibromyalgia impact were mediated through both anxiety and depression. This suggests that personality may contribute to the development of mood disorders as well, which may subsequently impair patients' ability to cope with their syndrome. The mediation results emphasize the importance of addressing psychological factors in the management of fibromyalgia [35]. More specifically, the study suggests that treating anxiety and depression in patients with high levels of neuroticism is essential for alleviating overall fibromyalgia impact. Furthermore, the mediation analysis also shows that the extent and severity of one's fibromyalgia impact is a product of a complex interaction between personality and psychological variables. Future research should investigate other potential mediators and psychological factors that may influence one's fibromyalgia condition.

Our study had limitations. Since this study was a cross-sectional secondary analysis of data that was collected for the purpose of comparing fibromyalgia treatment interventions, we are unable to draw definitive conclusions from our findings. Furthermore, our study sample was not an epidemiological representative of everyone with fibromyalgia. The patients were all willing participants in a Tai Chi vs. aerobic exercise study at an urban tertiary academic hospital. These conditions consequently limit the generalizability of our results to other fibromyalgia populations. Future studies aimed at evaluating the associations between personality and fibromyalgia impact should be performed to confirm our results.

In conclusion, our study demonstrates that personality is associated with the clinical symptoms of fibromyalgia and psychosocial health outcomes. Our mediation results suggest that the treatment of comorbid mood disorders may potentially reduce the symptoms of fibromyalgia. Because personality may interact with a patient's ability to cope with their condition, its assessment may have value in guiding treatment plans and improving patient outcomes. Furthermore, the identification of certain personality traits that impact fibromyalgia may help identify vulnerable individuals as potential targets for psychotherapeutic treatment. Patients with high neuroticism, for instance, may benefit from cognitive behavioral therapy that aims to reduce their maladaptive responses stemming from their personality. Future studies should further investigate the factors that influence the condition to better understand the nature of chronic musculoskeletal pain. Longitudinal studies exploring how personality in conjunction with anxiety and depression affect patient outcomes are warranted.

Acknowledgements The authors gratefully appreciate Teresa Wu for her contribution to the initial manuscript writing. We also thank Stephanie Hyon and Michelle Park for feedback on the written manuscript. We thank our study staff who tirelessly collected the data and the study participants who took the time to complete each outcome measure.

Disclaimer The contents of this manuscript are solely the responsibility of the authors and do not necessarily represent the official views of the NCCIH/NIH. The investigators are solely responsible for the content of the manuscript and the decision to submit for publication.

Funding The study was supported by the National Center for Complementary and Integrative Health (NCCIH) of the National Institutes of Health (R01 AT006367, K24 AT007323, and K23 AT009374) and the National Center for Research Resources, National Institutes of Health (UL1 RR025752), and the National Center for Advancing Translational Sciences, National Institutes of Health (UL1TR000073 and UL1TR001064).

Compliance with ethical standards

This study was approved by the Tufts University Human Institutional Review Board.

Disclosures None.

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