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Review

A meta-analysis of studies with the Minnesota Multiphasic Personality Inventory in fibromyalgia patients

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ABSTRACT

The Minnesota Multiphasic Personality Inventory (MMPI) has been widely used to assess personality and psychopathology in patients diagnosed with fibromyalgia, and the results have been contradictory. This work aims primarily at analysing whether the available empirical results with this instrument allow for a conclusion about personality traits and psychopathology of patients with fibromyalgia. Complementary, we evaluated whether the MMPI was able to discriminate these patients from healthy control groups. We carried a search on Medline, PsycINFO and Cochrane Database of Systematic Reviews, about studies evaluating personality and psychopathology of fibromyalgia patients with the MMPI, and the reference lists of retrieved studies were scanned for additional articles. A total of 11 studies fulfilled the inclusion criteria and were included. The hypochondriasis, depression, hysteria and schizophrenia scales were the more frequently elevated clinical scales across the included studies. A statistically significant heterogeneity was observed in all clinical scales. This meta-analysis confirmed the existence of a significant elevation in the neurotic triad. The considerable heterogeneity suggests that the fibromyalgia population is a heterogeneous group regarding personality and psychopathology profiles. The MMPI showed to be able to discriminate female patients with fibromyalgia from healthy volunteers.

1. Introduction

Fibromyalgia (FM) is a common chronic syndrome mainly characterized by widespread musculoskeletal pain (Malin & Littlejohn, 2012; Staud, 2007). Its prevalence varies from 2 to 4% in the general population and is considerably higher in women than in men (ratio of 9:1, respectively), according to Fitzcharles and Yunus (2012). Although it has become very probable that the illness has a neurobiological substrate including subtle disturbances in physiological regulatory systems (Van Houdenhove & Luyten, 2007), and dysfunctions in the nervous system pain processing may explain the constant pain in the absence of tissue damage (Bellato et al., 2012), the etiology of fibromyalgia remains unknown.

Fibromyalgia was defined by the American College of Rheumatology (ACR) 1990 classification criteria as the presence of widespread pain for at least 3 months, combined with tenderness in 11 or more of 18 specific anatomical points, known as tender points, when a pressure of 4 kg/cm is applied (Wolfe et al., 1990). The pain often co-exists with other symptoms, such as fatigue, poor quality sleep, cognitive disturbance and emotional distress (Malin & Littlejohn, 2012). Although the 1990 ACR classification has been the predominant diagnostic criteria, these criteria are broad and non-specific, resulting in a high variability among diagnosed individuals (Wilson, Robinson, & Turk, 2009), not only in the symptomology but also in the underlying biologic, psychological, and cognitive factors (Giesecke et al., 2003).

Despite the lack of consensus among clinicians and researchers, the role of a complex interaction between biological, psychological and social factors in the onset and evolution of fibromyalgia is generally accepted (Bernardy, Klose, Busch, Choy, & Häuser, 2013; Eich, Hartmann, Muller, & Fischer, 2000; Thieme, Turk, Gracely, Maixner, & Flor, 2015). A biopsychosocial model of the etiology and pathogenesis of FM has been proposed, in which physiological, psychological and social factors are interacting in different ways and at different stages, as precipitating, predisposing, and perpetuating, suggesting that multiple pathways may lead to the causation and persistence of the illness (Eich et al., 2000). As a psychological factor, personality may play a role as predisposing and perpetuating (Van Houdenhove, Kempke, & Luyten, 2010; Van Houdenhove, Luyten, & Egle, 2009). Within this framework, FM can be conceptualized as the end stage of an accumulation of biological and

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psychosocial vulnerability factors, over time, which have a formative influence on the development of the locomotor system and lead, in interaction with later stress, to dysfunctional states (Eich et al., 2000). In the same vein, Thiagarajah, Guymer, Leech, and Littlejohn (2014) have conceptualized a diathesis-stress model of fibromyalgia that implies an understanding of vulnerability factors to fibromyalgia, which contribute towards the perpetuation of a pathological response to a stressor. The symptoms of fibromyalgia and stress would then contribute to the prolongation of symptoms, as the pain from fibromyalgia could continue to be a source of physical stress and chronic stress symptoms could feed back into the HPA axis.

Research has found heterogeneity in FM samples, with differences between patients in a continuum of physical disability and psychological distress. Thieme, Turk, and Flor (2004) identified three subgroups of fibromyalgia patients: dysfunctional, with greater pain severity and interference, greater psychological distress and lower activity, interpersonally distressed, and adaptive copers, with lower pain severity and interference and less distress. Giesecke et al. (2003) found a group of fibromyalgia patients who exhibit extreme tenderness but lack any associated psychological/cognitive factors, an intermediate group with moderate tenderness and normal mood, and a group in whom mood and cognitive factors may be significantly influencing the symptom expression and report. Thus, studies have found diversity not only in clinical symptoms of FM patients, but also in the relative contribution of associated biological and psychological factors.

Pertaining to psychopathology in FM, fibromyalgia has been linked to mood disorders in 50–70% of patients, more precisely, with major depression (Arnold et al., 2006; Arroita et al., 2009) anxiety disorders (Raphael, Janal, Nayak, Schwartz, & Gallagher, 2006) and a prevalence rate of any psychiatric disorder significantly higher than the one of healthy control subjects and the estimated prevalence in the general population (Uguz et al., 2010). The prevalence rate of personality disorders has ranged from 31.1% (Uguz et al., 2010) and 8.7% only (Thieme et al., 2004). However, it is worth mentioning that the higher rates of psychiatric comorbidities may be biased by the fact that most studies with FM have used clinical samples of tertiary-care centers (Williams & Clauw, 2009).

In comparison with rheumatoid arthritis, which has been the most used chronic pain group in studies with FM, the FM samples has shown more depression (Wolfe & Michaud, 2009), more depression and anxiety (Ramundo, 2000; Walker et al., 1997), less mental health (Salaffi et al., 2009), and more alexithymia (Sayar, Gulec, & Topbas, 2004). However, some studies have found no differences between the two conditions in depression (Ahles, Yunus, & Masi, 1987; Çeliker & Borman, 2001; Ofluoglu et al., 2005) and in lifetime history of any psychiatric disorder (Ahles, Khan, Yunus, Spiegel, & Masi, 1991).

Studies have found differences within the fibromyalgia patients, varying from patients showing no evidence of psychological disturbance to patients with severe disturbance (Belenguer, Ramos-Casals, Siso, & Rivera, 2009; Claros et al., 2006; Oswald, Salemi, Michel, & Sprott, 2008; Souza et al., 2009), and, accordingly to Raphael et al. (2006), FM group and women without FM had similar risk of lifetime major depression disorder.

In respect of personality, several studies have found higher neuroticism in FM patients than in healthy controls (Malt, Olafsson, Lund, & Ursin, 2002; Martín, Luque, Solé, Mengual, & Granados, 2000; Martin-McAllen, 1997).

2. The Minnesota Multiphasic Personality Inventory and fibromyalgia

The Minnesota Multiphasic Personality Inventory (MMPI) is the most widely used self-report questionnaire for the assessment of personality and psychopathological features in adults, in several contexts (Graham, 2011; Greene, 2000). This inventory has been extensively used in the medical setting, in health and chronic disease contexts (Arbisi & Butcher, 2004; Ardiç & Toraman, 2002; Malin & Littlejohn, 2012), leading to a collection of substantial empiric data. These data provide an objective basis for the inferences based on the MMPI regarding emotional reactions, psychological characteristics, and personality traits of medical patients. Globally, the research of personality factors in the assessment of chronic pain has been one of the most common uses of MMPI, having demonstrated that the chronic patients' patterns are virtually the same cross-culturally (Arbisi & Butcher, 2004). Pertaining to chronic pain, Keller and Butcher (1991) have found a predominant MMPI clinical profile in the chronic pain patients, mainly characterized by elevations in scales that identify features related to hypochondriasis, hysteria and depression, which have been named *neurotic triad*.

The MMPI has revealed significant differences between patients with fibromyalgia and healthy individuals, with the former presenting more elevations in the clinical profile (e.g., Gonzalez, Baptista, Branco, & Novo, 2015; Pérez-Pareja, Sesé, González-Ordi, & Palmer, 2010; Vural, Berkol, Erdogdu, Kucukserat & Aksoy, 2014). In some cases, FM group has clinically significant elevations in several scales (Gonzalez, 2014; Pérez-Pareja et al., 2010), whereas in other cases, although significantly higher than healthy controls, only two scales are clinically elevated in the FM group (e.g., Vural, Berkol, Erdogdu, Kucukserat & Aksoy, 2014). MMPI has also identified different profiles among fibromyalgia patients, namely the normal profile, (i.e., no clinical significant score), a chronic pain typical profile (i.e., with features associated to hypochondriasis and hysteria, and depression), and, in some cases, a concomitant elevation of other clinical scales (i.e., elevation of at least four clinical scales), identifying a psychopathological profile (Ahles, Yunus, Riley, Bradley, & Masi, 1984; Bennett et al., 1996; Carette et al., 1994; Porter-Moffitt et al., 2006; Yunus, Ahles, Aldag, & Masi, 1991).

The number of identified profile types varied between two (Claros et al., 2006) and four (e.g., Porter-Moffitt et al., 2006), and the proportion of patients in each profile type varied across the studies, with some studies founding a huge prevalence of psychopathological profile (Claros et al., 2006; Porter-Moffitt et al., 2006) and others founding a small prevalence of psychopathological profile (Yunus et al., 1991) and a predominant normal profile (Ahles, Yunus, Gaulier, Riley, & Masi, 1986). Moreover, whereas some studies identified a neurotic triad profile, the most commonly associated with chronic pain (Ellertsen, Værøy, Endresen, & Førre, 1991; Gonzalez et al., 2015), others identified a *Conversion V* profile (Bennett et al., 1996; Binder et al., 2000; Claros et al., 2006), in which hypochondriasis and hysteria are significantly elevated and greater than depression by eight or more points, meaning that psychological suffering would be translated into enhanced physical symptoms. Finally, within the psychopathological profile, the clinically significant elevations range from four (e.g., Johnson et al., 2010; Trygg, Lundberg, Rosenlund, Timpka, & Gerdle, 2002) to seven (e.g., Claros et al., 2006; Kaplan, Meadows, Vincent, Logigian, & Steere, 1992).

In respect of comparison with rheumatoid arthritis, the FM group has shown higher scores in several clinical scales (Ahles et al., 1984; Payne et al., 1982; Wolfe et al., 1984), and FM group have less patients with the normal profile (Wolfe et al., 1984), and more patients with the psychopathological profile (Ahles et al., 1984) than rheumatoid arthritis patients. FM group has higher scores than other pain groups with chronic non widespread pain in four or more clinical scales (Pérez-Pareja et al., 2010; Porter-Moffitt et al., 2006; Trygg et al., 2002).

In conclusion, there is a considerable diversity in the syndrome of fibromyalgia, in what concerns the association between physical symptoms and psychopathological features. The data about personality profiles in FM and differences between fibromyalgia and healthy controls is also inconclusive. To our best knowledge, there is no meta-analysis of psychopathology and/or personality in fibromyalgia, which would help clarify these distinct and contradictory findings, coming from different kinds of samples and assessment methods.

Concerning the psychometric instruments used to assess psychopathology and personality in FM samples, the majority of them assess a

particular aspect only (e.g., depression, anxiety, or alexithymia), and assess symptomatology more than extended personality profiles, i.e., without considering the relation among different features. And, what is most important, they do not control test-taking attitudes, accuracy and other validity aspects of the responses. Concerning to FM, some authors highlight the risk of malingering, as a clinical condition that lack a clear organic basis, which make difficult to obtain an objective measure of pain and disability (Pérez-Pareja et al., 2010; Vural, Berkol, Erdogdu, Kucukserat & Aksoy, 2014). Mittenberg, Patton, Canyock, and Condit (2002) state that simulation may be present in up to 35% of FM cases.

MMPI is a multiphasic instrument that overcomes these limitations, as it comprises several personality and psychopathology dimensions, and enables the control of response attitudes and protocols validity. The MMPI allows the assessment of normal or pathological features of symptomatology intensity and, simultaneously, the relative importance of different psychological and psychopathological characteristics (e.g., if "body focused" anxiety about health and illness, as signalled by hypochondriasis scale, is or is not greater than negative emotionality and distress, as signalled by depression scale, and still if this distress significantly impairs cognitive functioning, which may be signalled by psychasthenia and schizophrenia scales. MMPI has several scales to control response tendencies and response consistency throughout the test, and profile validity (e.g., tendency to insincerity and to pathology denial or exacerbation) (Graham, 2011; Greene, 2000). Therefore, it has been used to detect malingering of pain (Arbisi & Butcher, 2004) and it is considered an appropriate and useful instrument for a clinical assessment of fibromyalgia (Belenguer et al., 2009; Trygg et al., 2002) and to characterize a specific pattern of responding of fibromyalgia patients (Pérez-Pareja et al., 2010).

3. Objectives

Thereby, due to the diversity of empirical data about psychopathological characteristics in fibromyalgia population with MMPI assessment, it is important to clarify to what extent is the MMPI able to discriminate personality and psychopathology features of patients with fibromyalgia. To our knowledge, this is the first pooled analysis to investigate the MMPI profile in fibromyalgia. Our first goal was to verify if the distress, depression and somatic anxiety that has been found in FM are expressed in MMPI clinical elevations. Complementarily, our second goal was to compare FM profiles with healthy controls profiles and identify the major differences between them.

4. Method

4.1. MMPI – background and description

The original MMPI was developed in 1943 and was reformulated in 1989 (MMPI-2) (Graham, 2011). A new normative sample was used in the MMPI-2, which translated into an average reduction of the profile elevation of 5 T-score points across all scales (Greene, 2000; Keller, 1991). Therefore, the MMPI-2 uses a T-score cut-off ≥65 to express clinical significance compared to a T-score cut-off ≥70 in the MMPI.

The inventory comprises multiple validity scales (being three the most commonly used, in both versions of MMPI, to determine the subject's test-taking attitude and to identify an invalid profile), and ten standard clinical scales, which reflect different psychological conditions (Graham, 2011). The three mentioned validity scales are *L* (Lie), *F* (Infrequency) and *K* (Correction), and the ten clinical scales are *Hs* (Hypochondriasis), *D* (Depression), *Hy* (Hysteria), *Pd* (Psychopathic deviate), *Mf* (Masculinity-femininity), *Pa* (Paranoia), *Pt* (Psychastenia), *Sc* (Schizophrenia), *Ma* (Hypomania) and *Si* (Social introversion).

4.2. Literature search

A literature search was carried out in the following electronic databases, from database inception to 31 December 2016: Medline, PsycINFO and Cochrane Database of Systematic Reviews. The search terms aimed at retrieving studies focusing on the application of the MMPI in patients diagnosed with fibromyalgia. Thus, the terms 'Minnesota Multiphasic Personality Inventory' OR 'MMPI' and 'Minnesota Multiphasic Personality Inventory-2' OR 'MMPI-2' were paired with the term 'fibromyalgia' to identify titles, keywords or abstracts with reference to these terms. Search was restricted to publications in English, French, Spanish, and Portuguese language. The reference list of the retrieved articles was searched by two authors independently, with all potential references added to the output.

4.3. The studies included

We selected original research (observational or experimental) that evaluated personality and psychological features with MMPI or MMPI-2 scale, in adult patients (≥18 years) with fibromyalgia (even if as a subgroup). Despite the differences between the diagnostic criteria, we made no restrictions to this aspect. Studies that used other versions of the MMPI, such as MMPI-2-RF, were excluded.

The title and abstract of the studies identified during the literature search were independently reviewed by the first and third authors. Full-text versions were obtained for all potential abstracts to determine if the study met the eligibility criteria. The same authors independently examined the full-text publications and excluded the studies that did not report data for all the ten clinical scales of the MMPI. The outcome of the selection process was discussed between both authors and any disagreements regarding the studies' eligibility were resolved by the second author.

The data from each study was extracted into an electronic data extraction form by the two authors independently. The data included study identification, number of patients with fibromyalgia and number of healthy volunteers, study population characteristics (sex, age, duration of symptoms and literacy level), fibromyalgia diagnostic criteria, MMPI version, mean T-scores and standard deviations for the ten standard clinical scales and the three validity scales (*L*, *F*, and *K*) of MMPI.

The quality of individual studies and the methods used for study selection have the potential to introduce bias into the meta-analysis (O'Shea & Dickens, 2014). Therefore, the quality of the included studies was assessed through three predefined criteria: a) results for validity scales presented; b) fibromyalgia diagnostic criteria reported; c) MMPI version specified. Each criterion was rated as "yes", "unclear/unsure" or "no", and the overall risk of bias as "low", "high" or "unclear". If at least one criterion was not presented or was unclear/unsure, the study was considered as having a high risk of bias. All studies were included in the meta-analysis regardless of their risk of bias.

4.4. Meta-analytic approach

Two distinct pooled analyses were performed, one to identify the MMPI scales clinically elevated in fibromyalgia patients and the other to evaluate the MMPI ability to discriminate between these patients and healthy individuals. The mean T-scores and corresponding standard deviations from each clinical scale were pooled from the included studies. One study (Claros et al., 2006), presented separate results for two subgroups of fibromyalgia (typical chronic pain profile [group A] and psychological maladjustment profile [group B]). In this case, each subgroup was considered an independent study. Therefore, the number of studies was 11.

As two versions of the MMPI were used in the selected studies, and each one has different cut-off to differentiate normal and clinical values (Graham, 2011; Greene, 2000), the respective cut-off value (i.e., 70 for MMPI and 65 for MMPI-2) was subtracted to the mean T-score of each

scale. This allowed us to estimate a mean distance to the cut-off (adjusted mean) for all the clinical scales. Positive values of adjusted mean T-scores represented a clinically significant elevation of a MMPI scale. To account for the fact that the results of smaller studies are subject to greater sampling variation and are, therefore, less precise, the weight of each study was calculated as the inverse of the variance of the effect estimate (i.e., one divided by the standard error squared) (Higgins & Green, 2011). Consequently, more weight was given to those studies with larger sample sizes and to those presenting more precise results.

An adjusted weighted mean, the respective standard error and 95% confidence interval were calculated for each of the clinical scales. The Chi-squared test (χ^2) was used to evaluate if the mean T-scores of each clinical scale varied among the studies. This value was compared to the tabulated values of the χ^2 distribution to assess its statistical significance and, consequently, to infer about the presence of heterogeneity. Additionally, the I^2 index allowed quantifying the heterogeneity of each scale across studies. The I^2 reflects the percentage of the variability in effect estimates that is due to heterogeneity rather than chance. Values of I^2 ranging from 0% to 40% correspond to non-relevant heterogeneity, 30% to 60% represent moderate heterogeneity, 50% to 90% represent substantial heterogeneity, and 75% to 100% reflect considerable heterogeneity (Higgins & Green, 2011).

Due to the considerable heterogeneity of effects in the first meta-analysis, interpreting the weighted adjusted means to infer about the clinical significance of the respective scales did not prove appropriate. Thus, we carried out an alternative approach to infer which MMPI scales were clinically elevated by identifying those presenting positive mean scores more frequently across the studies. We did not do the random effects model because we did not have comparative effects like mean differences.

Complementarily to the pooled analysis to identify clinically elevated scales, we aimed to assess the ability of MMPI to discriminate patients with fibromyalgia from healthy individuals (controls). Therefore, it was pre-planned to conduct a meta-analysis including only those studies that, besides reporting MMPI T-scores of patients with fibromyalgia, also reported scores for a control group of healthy volunteers. For each scale, a mean T-score absolute difference between the fibromyalgia and the healthy control groups was calculated. First, a fixed-effects analysis was performed for each scale. When the heterogeneity for a given scale revealed to be statistically significant, a random-effects model was used. This latter model considers the heterogeneity in the effect estimates and weights the studies relatively more equally than a fixed-effects model when in the presence of heterogeneity (Higgins & Green, 2011). This analysis was carried out with RevMan 5.3.

We planned a sensitivity analysis a priori to evaluate if the pooled estimates were robust to the risk of bias of the included studies. This method consisted in repeating the two meta-analytic procedures excluding the studies with high risk of bias.

5. Results

A total of 40 studies were retrieved from the literature search. Nine records were duplicates and removed. Following the review based on the title and abstract, 26 articles potentially met the eligibility criteria. The review of the full-text versions resulted in the exclusion of eleven articles due to full or partial absence of results of the MMPI clinical scales. In addition, three studies were excluded, as one reported the T-scores based on the original 1943 MMPI norms, one did not present T-score results exclusively for the subgroup of patients with fibromyalgia, and one did not report standard T-scores. Furthermore, two studies did not report the standard deviations, and the other summarised raw scores only. Despite successful attempts to communicate with the authors of these publications, we only obtained the standard deviations for one of the studies, excluding the other two from the analysis. Therefore, ten articles were included in the first pooled analysis. In that one of the articles (Claros et al., 2006) reports results of two FM samples, 11 studies were considered. Of those, four studies – Claros et al. (2006), Johnson et al. (2010), and Vural, Berkol, Erdogdu, Kucukserat & Aksoy (2014) – also reported MMPI T-scores for a control group of healthy volunteers and were included in the second pooled analysis. In sum, we included all studies that (a) have used the whole set of clinical scales, and (b) have published or delivered results with standard T-scores, with means and standard deviations (Fig. 1).

The studies included in the meta-analysis are summarised in Table 1.

The studies reported original research and were published between 1991 and 2015. Overall, the sample size included 461 (range: 11–103) patients with fibromyalgia. Half of the studies ($n = 5$) included females only. The proportion of women was much higher than men across the majority of the remaining studies. Six studies used the 1990 ACR diagnostic criteria. Study's populations varied in terms of age, symptom duration, literacy level and most of them did not report and/or control recruitment conditions, as disability level, features associated with diagnostic and symptoms duration, and psychiatric comorbidities. Three studies used the MMPI, while the remaining studies used the MMPI-2. The majority of studies ($n = 10$) reported the validity scales.

The assessment of the risk of bias of included studies is shown in Table 2 and revealed four “high risk” studies.

The adjusted mean T-scores of each MMPI scale reported in the individual studies are summarised in Table 3.

The *Hs*, *D*, *Hy* and *Sc* scales were the ones that revealed a higher frequency of studies with positive mean values than negative ones. The *Hy* scale was the most frequently elevated (10/11 studies), followed by the *Hs* scale (9/11 studies) and the *D* and *Sc* scales (7/11 studies).

Pertaining to the neurotic triad, and the relative elevation of the three scales involved, in nine of the eleven samples included in the analysis, the elevations in *Hs* and *Hy* scales predominate over *D* scale: in five studies, the triad configuration is represented by code *312* (i.e., the highest scale is *Hy*, followed by *Hs*, and thirdly by *D*) and in other four studies, the triad configuration is represented by code 132 (i.e., the highest scale is *Hs*, followed by *Hy* and then by *D*). In seven studies, the elevations in the neurotic triad are associated with elevation of *Sc* scale.

The results of the pooled analysis for each MMPI clinical scale and the corresponding heterogeneity (I^2) are summarised in Table 4.

The *Hs*, *D* and *Hy* were the only scales showing positive values. The *Hy* scale was the most elevated (adjusted weighted mean = 6.75, 95% CI [5.79, 7.70]), followed by the *Hs* scale (adjusted weighted mean = 5.74, 95% CI [4.88, 6.61]). All the remaining scales showed negative values, with the Mf scale presenting the lowest adjusted weighted mean (−16.67, 95% CI [−17.50, −15.83]). All p-values for the χ^2 test were statistically significant, considering a significance level of 0.05 and 10 degrees of freedom, and eight out of ten MMPI scales showed $I^2 > 80\%$). In the sensitivity analysis, all scales showed statistical significance in the χ^2 test and nine out of ten scales showed I^2 values ≥80% (see Table 4).

The results of the second meta-analytic procedure and the respective sensitivity analysis are summarised in Table 5.

This meta-analytic procedure included the studies by Claros et al. (2006), Johnson et al. (2010) and Vural, Berkol, Erdogdu, Kucukserat & Aksoy (2014). Nevertheless, we considered four studies, as the two subgroups of patients of Claros et al. (2006) were considered two independent studies. The sensitivity analysis excluded the study by Vural, Berkol, Erdogdu, Kucukserat & Aksoy (2014), as it was identified as having a high risk of bias. The three studies had matched FM and control samples according to age. Pertaining to sex, only two studies had matched their samples; Johnson et al. (2010) had significant differences in the proportion of males, with 63.3% in the FM sample and 83.7% in healthy controls.

Patients with fibromyalgia showed higher weighed mean T-scores in all MMPI scales compared to healthy individuals except for the *K* scale, in which higher mean scores were observed in the control group. With the exception of the *F* and *Mf* scales, the weighed mean difference

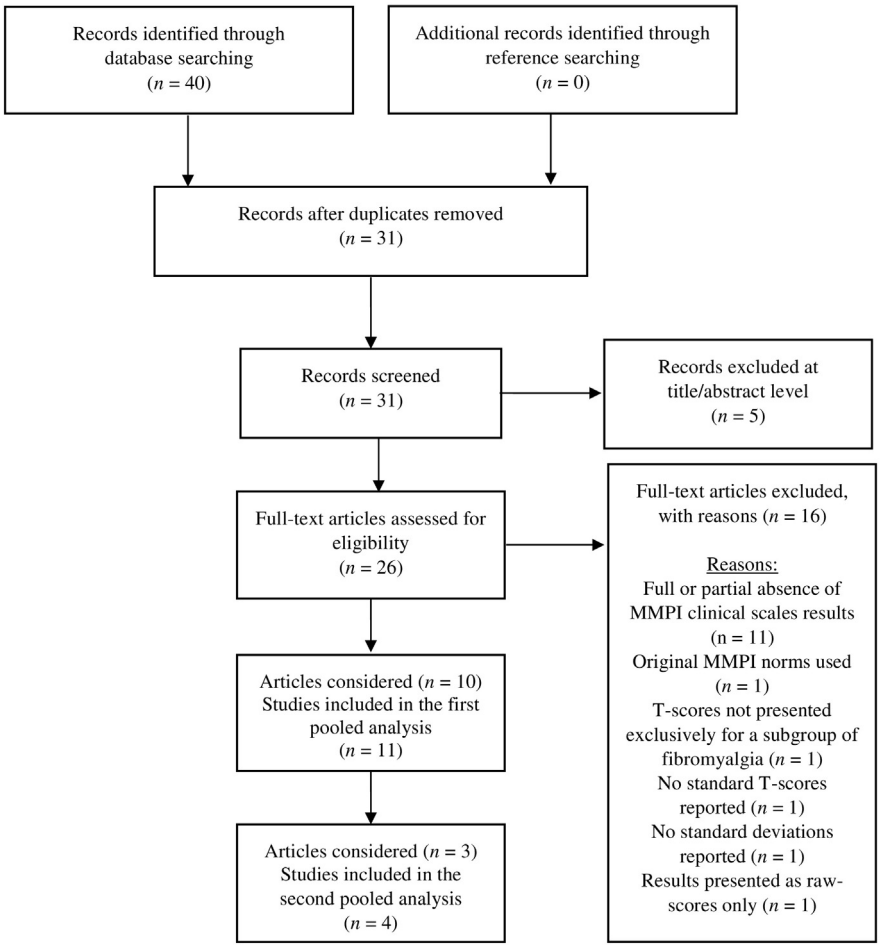

Fig. 1. Flow diagram of literature search: modified from the preferred reporting items for systematic reviews and meta-analysis statement flow diagram. (Moher, Liberati, Tetzlaff, Altman, & PRISMA Group, 2010).

between both groups was statistically significant for all MMPI scales. The *Hs* scale showed the highest mean difference (22.80, 95% CI [15.84, 29.76]), followed by the *Hy* (21.65, 95% CI [17.13, 26.18]) and *D* (20.82, 95% CI [16.03, 25.62]) scales. A statistically significant heterogeneity was observed for all mean difference estimates except for the *Pd* and *Mf* scales. The sensitivity analysis, which excluded studies with high risk of bias, showed similar findings. Still, the mean T-score difference between fibromyalgia patients and healthy individuals regarding the *L*, *K* and *Si* scales lost the statistical significance ($p = 0.25$, $p = 0.06$, and $p = 0.07$, respectively).

6. Discussion

This work aimed primarily to obtain a robust characterization of the personality and psychopathological traits of individuals with fibromyalgia using the MMPI. At the outset, a pooled analysis of adjusted weighted mean T-scores for each MMPI clinical scale from selected studies was conducted to identify which scales were clinically elevated. Scales showing positive mean values were considered to be clinically elevated and were suggestive of particular psychological and psychopathological characteristics.

We found a statistically significant heterogeneity in the weighted mean score estimates of each scale, with the majority showing I^2 values above the 75% threshold (considerable heterogeneity) (Higgins & Green, 2011). These findings reflect the high inter-variability observed in each MMPI scale across the selected studies.

Other studies have reported distinct MMPI profiles, or subgroups, among individuals with fibromyalgia (Ahles et al., 1984; Yunus et al., 1991). This factor alone may have contributed to the high level of heterogeneity observed.

The characterization of the study samples in the articles is often limited to an extent that does not allow the identification of various important factors that may vary across studies and are likely to affect the responses to the MMPI. These include the fibromyalgia status (i.e., time between the onset of the syndrome and the start of treatment, intensity of symptoms, and degree of functionality), which is associated with different emotional reactions, levels of psychological suffering and somatic concerns that influence the elevation of the MMPI scales; the sociodemographic and psychosocial characteristics of the participants (i.e., age, educational level, professional status, and significant life events), which are implied in the reactivity to internal and external stressors and in the attitude of response to the MMPI; and the inclusion of patients with psychiatric pathology associated to fibromyalgia, leading to significant changes in the MMPI profile. This diversity in the clinical expression of fibromyalgia has led to the development of several categorization proposes including signs of psychopathological severity (Belenguer et al., 2009).

Of note, the considerable heterogeneity observed in this analysis does not suggest the unreliability of the MMPI in the evaluation of personality traits and psychopathology in patients with fibromyalgia. In fact, the inherent heterogeneity of the clinical scales was acknowledged as a positive feature that allows an accurate reflection of the heterogeneous nature of some syndromes (Ben-Porath, Graham, Hall, Hirschman, & Zaragoza, 1995). Thus, these results reflect and confirm the high variability reported in fibromyalgia and the inexistence of a unique and specific MMPI profile. Additionally, the lack of homogeneity

Table 1
Data extraction form.

Author/year	Participants in each group (fibromyalgia and healthy control [when applicable])	Study population characteristics	Fibromyalgia diagnostic	Mean T-scores and standard deviations for the validity and clinical scales of MMPI/MMPI-2		
Gonzalez et al. (2015)	Fibromyalgia: 50	Gender: 50 F Age (years): $M = 46.96$; $SD = 10.96$ Symptom duration (years): $M = 13.28$; $SD = 9.63$	ACR 1990 criteria		$N = 50$	
				MMPI-2 scales	$M \pm SD$	
				L	64.06 ± 11.50	
				F	65.70 ± 12.27	
				K	44.48 ± 8.15	
				Hs	79.00 ± 11.13	
				D	75.34 ± 11.83	
				Hy	75.88 ± 12.92	
				Pd	58.70 ± 10.66	
				Mf	51.26 ± 8.48	
				Pa	59.30 ± 11.79	
				Pt	63.96 ± 10.45	
				Sc	68.04 ± 11.74	
				Ma	56.24 ± 9.67	
				Si	55.86 ± 9.35	
Vural, Berkol, Erdogdu, Kucukserat & Aksoy (2014)	Fibromyalgia: 72 Healthy control: 64	Gender: 72 F Age (years): $M = 37.56$; $SD = 5.12$ Symptom duration (months): M = 14.64; SD = 10.79	ACR 1990 criteria		$N = 72$	$N = 64$
				MMPI-2 scales	$M \pm SD$	$M \pm SD$
				L	53.33 ± 11.16	51.25 ± 9.51
				F	51.04 ± 8.70	47.50 ± 10.06
				K	48.22 ± 9.80	55.83 ± 10.30
				Hs	65.44 ± 8.29	50.33 ± 7.61
				D	62.96 ± 11.64	43.38 ± 6.76
				Hy	73.78 ± 8.35	57.13 ± 8.63
				Pd	56.15 ± 12.21	47.04 ± 19.62
				Mf	50.74 ± 10.48	48.29 ± 11.04
				Pa	54.74 ± 10.47	46.54 ± 6.60
				Pt	60.07 ± 9.38	46.75 ± 8.78
				Sc	57.67 ± 11.97	46.33 ± 9.10
				Ma	50.37 ± 8.09	51.54 ± 11.72
				Si	60.48 ± 9.60	47.67 ± 10.49
Vural, Berkol, Erdogdu, Pekedis, et al. (2014)	Fibromyalgia: 18	Gender: 18 F Age (years): $M = 35.43$; $SD = 5.33$	ACR 1990 criteria		$N = 18$	
				MMPI-2 scales	$M \pm SD$	
				L	55.43 ± 11.37	
				F	50.64 ± 7.47	
				K	52.00 ± 10.36	
				Hs	63.86 ± 6.62	
				D	58.57 ± 10.97	
				Hy	71.21 ± 8.84	
				Pd	53.86 ± 9.70	
				Mf	48.21 ± 10.28	
				Pa	51.00 ± 9.66	
				Pt	56.93 ± 9.47	
				Sc	52.86 ± 7.61	
				Ma	48.43 ± 7.60	
				Si	58.64 ± 8.71	
Johnson et al. (2010)	Fibromyalgia: 49 Healthy control: 49	Gender: 18 F/31 M Age (years): $M = 34.24$; $SD = 8.7$ Literacy level (years): $M = 13.55$; $SD = 1.72$	ACR 1990 criteria		$N = 49$	$N = 49$
				MMPI-2 scales	$M \pm SD$	$M \pm SD$
				L	53.45 ± 9.49	52.41 ± 9.34
				F	62.24 ± 14.98	48.53 ± 10.80
				K	45.04 ± 11.47	52.33 ± 9.50
				Hs	75.37 ± 13.78	47.84 ± 7.54
				D	68.57 ± 15.7	48.88 ± 9.95
				Hy	69.39 ± 13.42	45.45 ± 6.41
				Pd	58.08 ± 11.31	46.59 ± 8.20
				Mf	51.35 ± 9.41	47.24 ± 12.13
				Pa	61.27 ± 15.03	47.27 ± 10.59
				Pt	64.39 ± 13.75	46.18 ± 8.90
				Sc	68.86 ± 16.39	47.37 ± 8.95
				Ma	53.78 ± 10.57	47.37 ± 8.95
				Si	58.61 ± 14.25	49.45 ± 9.78
Sala et al. (2009)	Fibromyalgia: 30	Gender: 29 F/1 M Age (years): $M = 55.4$; $SD = 7.4$ Literacy level (years): $M = 9.8$; $SD = 4.5$	ACR 1990 criteria		$N = 30$	
				MMPI-2 scales	$M \pm SD$	
				L	56.5 ± 10.6	
				F	59.6 ± 13.3	
				K	49.0 ± 9.5	
				Hs	80.9 ± 11.8	
				D	70.9 ± 10.7	
				Hy	75.2 ± 13.9	
				Pd	51.4 ± 11.3	
				Mf	46.4 ± 7.8	
				Pa	58.0 ± 11.7	
				Pt	63.4 ± 13.6	

(continued on next page)

Table 1 (*continued*)

Author/year	Participants in each group (fibromyalgia and healthy control [when applicable])	Study population characteristics	Fibromyalgia diagnostic	Mean T-scores and standard deviations for the validity and clinical scales of MMPI/MMPI-2		
				Sc	65.9 ± 13.4	
				Ma		50.4 ± 9.5
				Si	60.2 ± 11.4	
Claros et al. (2006)	Fibromyalgia:	Gender:	ACR 1990 criteria		$N = 51$	$N = 24$
	Study (sample A): Typical chronic pain profile: 51	69 F/6 M		MMPI-2 scales	$M \pm SD$ (A)	$M \pm SD$ (B)
		Age (years):		*L*	63.58 ± 8.54	55.92 ± 9.76
	Study (sample B) Psychological maladjustment profile: 24	$M = 49.03$; $SD = 10.9$		*F*	52.13 ± 7.68	98.56 ± 12.74
				K	51.00 ± 6.21	42.83 ± 6.51
				Hs	74.83 ± 11.92	79.94 ± 9.87
				D	64.21 ± 10.73	75.61 ± 9.10
				Hy	72.21 ± 12.05	76.39 ± 12.21
				Pd	53.92 ± 10.46	60.22 ± 11.71
				Mf	50.50 ± 6.72	47.95 ± 10.15
				Pa	55.21 ± 8.79	65.86 ± 11.75
				Pt	57.06 ± 8.87	70.73 ± 7.85
				Sc	56.13 ± 8.98	73.51 ± 11.46
				Ma	52.23 ± 8.89	52.33 ± 11.70
				Si	52.88 ± 8.16	66.37 ± 9.39
	Healthy control: 55				$N = 55$	
				MMPI-2 scales	$M \pm SD$	
				L	55.58 ± 9.14	
				F	50.42 ± 9.70	
				K	50.87 ± 9.25	
				Hs	52.89 ± 12.45	
				D	48.24 ± 10.61	
				Hy	50.96 ± 10.54	
				Pd	46.56 ± 9.54	
				Mf	50.27 ± 9.49	
				Pa	47.45 ± 9.08	
				Pt	42.24 ± 11.44	
				Sc	47.95 ± 10.84	
				Ma	46.68 ± 9.39	
				Si	52.89 ± 8.97	
Gerson and Fox (2003)	Fibromyalgia: 20	Gender: 20 F	Non-available		$N = 20$	
				MMPI-2 scales	$M \pm SD$	
				L	56.84 ± 13.04	
				F	64.16 ± 11.33	
				K	50.79 ± 13.43	
				Hs	88.95 ± 8.17	
				D	82.26 ± 10.69	
				Hy	93.42 ± 9.67	
				Pd	66.58 ± 13.58	
				Mf	49.05 ± 9.20	
				Pa	67.11 ± 16.34	
				Pt	74.16 ± 9.68	
				Sc	73.05 ± 10.42	
				Ma	55.53 ± 9.48	
				Si	54.84 ± 10.31	
Trygg et al. (2002)	Fibromyalgia: 33	Gender: 33 F	ACR 1990 criteria		$N = 33$	
				MMPI scales	$M \pm SD$	
		Age (years):		*L*	58.25 ± 6.72	
		$M = 46.2$; $SD = 8.4$		*F*	68.50 ± 15.52	
				K	52.13 ± 7.89	
		Pain duration (years):		*Hs*	80.53 ± 8.73	
		$M = 7.6$; $SD = 4.1$		*D*	81.50 ± 10.92	
				Hy	78.59 ± 10.36	
				Pd	66.34 ± 15.02	
				Mf	51.75 ± 8.74	
				Pa	65.53 ± 12.11	
				Pt	64.66 ± 11.20	
				Sc	71.88 ± 14.69	
				Ma	56.66 ± 10.01	
				Si	60.25 ± 9.26	
Kaplan et al. (1992)	Fibromyalgia: 11	Gender: 9 F/2 M	Non-available		$N = 11$	
				MMPI scales	$M \pm SD$	
		Age (years):		*Hs*	84.3 ± 16.7	
		$M = 42.8$; $SD = 9.5$		*D*	77.2 ± 16.0	
				Hy	82.3 ± 12.7	
		Literacy level (years):		*Pd*	67.4 ± 14.8	
		$M = 12.2$; $SD = 1.6$		*Mf*	53.4 ± 14.7	
				Pa	66.9 ± 11.6	
				Pt	67.2 ± 15.8	
				Sc	75.0 ± 20.4	

Table 1 (*continued*)

Author/year	Participants in each group (fibromyalgia and healthy control [when applicable])	Study population characteristics	Fibromyalgia diagnostic	Mean T-scores and standard deviations for the validity and clinical scales of MMPI/MMPI-2		
				Ma	53.9 ± 9.4	
				Si		58.3 ± 14.4
Yunus et al. (1991)	Fibromyalgia: 103 • Normal profile: 27 • Chronic pain profile: 52 • Psychological disturbance profile: 24	Normal profile Age (years): *M* = 46.1 Symptom duration (years): 11.4 Chronic pain profile Age (years): *M* = 48.8 Symptom duration (years): 10.5 Psychological disturbance profile Age (years): *M* = 43.3 Symptom duration (years): 6.6	Widespread musculoskeletal pain and at least 5 tender points	*N* = 103 MMPI scales *L* *F* *K* *Hs* *D* *Hy* *Pd* *Mf* *Pa* *Pt* *Sc* *Ma* *Si*	*M* ± *SD* 51.9 ± 8.0 52.5 ± 9.4 53.5 ± 10.8 67.2 ± 8.8 60.1 ± 12.9 67.7 ± 9.6 56.4 ± 9.1 49.5 ± 9.1 53.1 ± 10.2 58.9 ± 10.7 58.3 ± 9.8 53.7 ± 10.5 49.0 ± 11.2	

Note. *M* = Mean; *SD* = Standard Deviation; ACR = American College of Rheumatology; MMPI = Minnesota Multiphasic Personality Inventory; F = Females; M = Males; *L* = Lie; *F* = Infrequency; *K* = Correction; *Hs* = Hypochondriasis; *D* = Depression; *Hy* = Hysteria; *Pd* = Psychopathic Deviate; *Mf* = Masculinity/Femininity; *Pa* = Paranoia; *Pt* = Psychasthenia; *Sc* = Schizophrenia; *Ma* = Hypomania; *Si* = Social Introversion.

indicates that patients within the fibromyalgia score considerably differently in the clinical scales, suggesting that this population is a heterogeneous group regarding personality and psychopathology profiles.

The statistical significance of the heterogeneity of all clinical scales remained unchanged in the sensitivity analysis, which suggests that the heterogeneity observed was not due to the inclusion of high risk of bias studies.

Due to the considerable heterogeneity, interpreting the weighted adjusted means to infer about the clinical significance of the respective scales did not prove appropriate. Thus, we carried out an alternative approach to infer which MMPI scales were clinically elevated by identifying those presenting positive adjusted mean scores more frequently across the studies. We found that the scales that identify hypochondriasis, depression, hysteria, and schizophrenia were the scales with higher rates of positive scores and, therefore, more frequently elevated across the studies. The *Hy* scale was the most elevated scale in all studies but one, followed by the *Hs*, which was the second most elevated scale in nine studies, and *D* and *Sc* were the third most elevated ones in seven studies. In most of the studies included in the meta-analysis, the profiles have a configuration closer to the Conversion V identified in fibromyalgia patients (Malin & Littlejohn, 2012), in which depression is lower than hypochondriasis and hysteria, and less similar to typically neurotic profiles, in which the depression is similar or more elevated than the other two scales. This is suggestive of a neurotic profile with possible somatic conversion, in which somatic anxiety and preoccupation with the body and with health overcomes psychological anxiety and distress (Ekselius, Bengtsson, & Knorring, 1998).

Moreover, in the studies included in the meta-analysis the elevations in these three scales are associated with elevation in *Sc*, which seem to be related to feelings of alienation and being misunderstood, more than to psychotic ideation (Gerson & Fox, 2003; Kaplan et al., 1992; Sala et al., 2009; Trygg et al., 2002). Thereby, FM does not present the profile that has been more typically associated with chronic pain (i.e., the neurotic triad profile; Arbisi & Butcher, 2004; Graham, 2011; Greene, 2000), and the data is also consistent with studies that enhance differences in FM in relation to other chronic pain conditions, as in the later, only *Hs* and not the whole triad scales tend to be elevated (Sala et al., 2009), and the secondary *Sc* elevation is not present (Sala et al., 2009; Trygg et al., 2002).

However, given the heterogeneity of inter-studies results, it is possible that different profile configurations exist in each sample.

The objective of the second meta-analysis was to evaluate the capability of the MMPI to discriminate between patients with fibromyalgia and healthy individuals. This was carried out by comparing the absolute difference in the mean score of each MMPI scale between the two groups.

Regarding the MPPI validity scales, the fibromyalgia patients scored higher in the scales that identify insincerity (*L*) and infrequency (*F*) comparing to healthy controls. Elevations in these scales have also been reported in other studies (Palmer, Borrás, Pérez-Pareja, Sesé, & Vilariño, 2013; Pérez-Pareja et al., 2010). The higher scores in the Lie (*L*) scale suggest defensiveness from the fibromyalgia patients and a tendency to place themselves in a socially favourable light. On the other hand, the higher scores in Infrequency (*F*) scale indicate a tendency to identify clinical symptomatology and a possible over reporting of psychopathology. This tendency to exaggerate or even simulate the symptoms has been identified in fibromyalgia patients, according to Ramírez, Ordib, Santamaría, Nieto, and Morales (2013). Although further research is needed, the exacerbation of symptoms by these patients may be related to a psychological overload due to the persistent suffering, which is not acknowledged or valued as a disease.

Table 2
Assessment of risk of bias of included studies.

Study	Validity scales presented	Fibromyalgia diagnostic criteria reported	MMPI version specified	Risk of bias[a]
Gonzalez et al. (2015)	Yes[b]	Yes[b]	Yes	Low
Vural, Berkol, Erdogdu, Kucukserat & Aksoy (2014)	Yes	Yes	No	High
Vural, Berkol, Erdogdu, Pekedis et al. (2014)	Yes	Yes	No	High
Johnson et al. (2010)	Yes	Yes	Yes	Low
Sala et al. (2009)	Yes	Yes	Yes	Low
Claros et al. (2006)	Yes	Yes	Yes	Low
Gerson and Fox (2003)	Yes[b]	No	Yes	High
Trygg et al. (2002)	Yes	Yes	Yes	Low
Kaplan et al. (1992)	No	No	Yes	High
Yunus et al. (1991)	Yes	Yes	Yes	Low

[a] Studies reporting all three criteria were considered as having a low risk of bias; studies not reporting one or more criterion were considered as having a high risk of bias.
[b] Data obtained upon request to the authors.

Table 3
Adjusted mean T-scores of MMPI clinical scales by individual study.

Study	Adjusted mean T-score of MMPI clinical scale									
	Hs	*D*	*Hy*	*Pd*	*Mf*	*Pa*	*Pt*	*Sc*	*Ma*	*Si*
Gonzalez et al. (2015)	14.00	10.34	10.88	−6.30	−13.74	−5.70	−1.04	3.04	−8.76	−9.14
Vural, Berkol, Erdogdu, Kucukserat & Aksoy (2014)	0.44	−2.04	8.78	−8.85	−14.26	−10.26	−4.93	−7.33	−14.63	−4.52
Vural et al. (2014a)	−1.14	−6.43	6.21	−11.14	−16.79	−14.00	−8.07	−12.14	−16.57	−6.36
Johnson et al. (2010)	10.37	3.57	4.39	−6.92	−13.65	−3.73	−0.61	3.86	−11.22	−6.39
Sala et al. (2009)	15.90	5.90	10.20	−13.60	−18.60	−7.00	−1.60	0.90	−14.60	−4.80
Claros et al. (2006)[a]	9.83	−0.79	7.21	−11.08	−14.50	−9.79	−7.94	−8.87	−12.77	−12.12
Claros et al. (2006)[b]	14.94	10.61	11.39	−4.78	−17.05	0.86	5.73	8.51	−12.67	1.37
Gerson and Fox (2003)	23.95	17.26	28.42	1.58	−15.95	2.11	9.16	8.05	−9.47	−10.16
Trygg et al. (2002)	10.53	11.15	8.59	−3.66	−18.25	−4.47	−5.34	1.88	−13.34	−9.75
Kaplan et al. (1992)	14.30	7.20	12.30	−2.60	−16.60	−3.10	−2.80	5.00	−16.10	−11.70
Yunus et al. (1991)	−2.80	−9.90	−2.30	−13.60	−20.50	−16.90	−11.10	−11.70	−16.30	−21.00

MMPI = Minnesota Multiphasic Personality Inventory; *SD* = Standard deviation; F = Females; M = Males; *L* = Lie; *F* = Infrequency; *K* = Correction; *Hs* = Hypochondriasis; *D* = Depression; *Hy* = Hysteria; *Pd* = Psychopathic Deviate; *Mf* = Masculinity/Femininity; *Pa* = Paranoia; *Pt* = Psychasthenia; *Sc* = Schizophrenia; *Ma* = Hypomania; *Si* = Social Introversion.
[a] Subgroup of fibromyalgia patients with a typical chronic pain profile.
[b] Subgroup of fibromyalgia patients with a psychological maladjustment profile.

The Correction (*K*) scale was the only scale with lower scores in the fibromyalgia population, in comparison to healthy controls. This finding suggests that the fibromyalgia patients have less psychological resources to overcome obstacles and adversities and, specifically, reduced ability to cope with demanding situations (Greene, 2000).

With the exception of the Masculinity/Femininity (*Mf*) scale, the mean differences were statistically significant for all clinical scales (Table 5). These findings substantiate the ability of MMPI to discriminate personality and psychological traits between fibromyalgia patients and healthy individuals. One study, developed by Pérez-Pareja et al. (2010), which compared the patterns of response with MMPI between fibromyalgia patients and a healthy control group, showed that the Masculinity/Femininity (*Mf*) and Social introversion (*Si*) were the only clinical scales that did not show statistically significant differences between the groups. Although included in the MMPI clinical profile, these scales (*Mf* and *Si*) are not considered true clinical scales (Friedman, Bolinskey, Levak, & Nichols, 2014; Graham, 2011; Greene, 2000). Thus, they do not indicate the presence of clinical symptomatology, but rather specific behavioral attitudes and tendencies regarding adequacy to the role of gender and social orientation. Moreover, this analysis allowed to identify two clusters of clinical scales based on the magnitude of the mean score differences. One cluster included the scales that showed the highest mean differences (*Hs*, *D*, and *Hy*). This cluster suggests the existence of a higher elevation of these scales in fibromyalgia patients, similarly to what was observed in the first pooled analysis. The second cluster consisted of the scales that identify psychopathic deviate (*Pd*) and schizophrenia (*Sc*), which showed lower mean differences than the first cluster, although scoring considerably higher than the remaining scales. Pérez-Pareja et al. (2010) also reported a significant elevation of these two scales in fibromyalgia patients, which showed the highest mean differences compared to healthy individuals. In fibromyalgia patients with a high psychological disturbance profile, one or both of these scales often appear elevated (Ahles et al., 1984; Gonzalez, 2014; Payne et al., 1982; Porter-Moffitt et al., 2006).

These findings should be interpreted with caution for two main reasons. First, a significant heterogeneity was observed in all but the *Pd* and *Mf* scales. Second, in the case of random-effects, the confidence intervals (prediction intervals) are considerably wide, indicating several heterogeneous possibilities for the mean differences. Nonetheless, the considerably high mean differences and the fact that the mean T-scores from each scale were consistently higher in the fibromyalgia group strengthens our conclusions, clearly indicating that both populations can be discriminated based on the MMPI scores.

The sensitivity analysis carried out for this meta-analytic procedure influenced the initial findings. Namely, the heterogeneity of the *L*, *Hs*, *Hy* and *Ma* scales was no longer statistically significant, which allowed the use of a fixed effect model for these scales. Although only small increases in the mean differences were observed, these results are more robust and more reliably interpreted due to the demonstration of homogeneity. As such, we can more certainly conclude that the fibromyalgia patients score particularly higher in the *Hs* and *Hy* scales in

Table 4
Pooled analysis with adjusted weighted mean T-score for MMPI clinical scales and sensitivity analysis for the studies with "low risk of bias".

Pooled analysis of all included studies ($n = 11$)				Sensitivity analysis of "low risk of bias" studies ($n = 7$)		
Clinical scale	Adjusted weighted mean (T-score)	Confidence interval (95%)	I^2	Weighted mean	Confidence interval (95%)	I^2
Hs	5.74	[4.88, 6.61]	97%***	6.61	[5.53; 7.68]	98%***
D	3.04	[1.98, 4.10]	96%***	3.67	[2.43; 4.90]	97%***
Hy	6.75	[5.79, 7.70]	95%***	4.19	[2.99; 5.40]	95%***
Pd	−9.49	[−10.48, −8.49]	84%***	−9.97	[−11.10; −8.85]	89%***
Mf	−16.67	[−17.50, −15.83]	74%***	−17.05	[−17.99; −16.12]	85%***
Pa	−9.32	[−10.34, −8.30]	92%***	−9.25	[−10.44; −8.05]	96%***
Pt	−3.12	[−4.05, −2.19]	94%***	−3.13	[−4.23; −2.03]	96%***
Sc	−4.28	[−5.31, −3.25]	96%***	−3.68	[−4.89; −2.47]	97%***
Ma	−13.61	[−14.49, −12.73]	68%***	−13.15	[−14.24; −12.06]	77%**
Si	−8.99	[−9.92, −8.06]	95%***	−10.18	[−11.28; −9.08]	97%***

Positive values of adjusted weighted mean T-scores represent a clinically significant elevation of the respective clinical scale. I^2 = heterogeneity index; *Hs* = Hypochondriasis; *D* = Depression; *Hy* = Hysteria; *Pd* = Psychopathic Deviate; *Mf* = Masculinity/Femininity; *Pa* = Paranoia; *Pt* = Psychasthenia; *Sc* = Schizophrenia; *Ma* = Hypomania; *Si* = Social Introversion.
** $p < 0.01$.
*** $p < 0.001$.

Table 5
Pooled analysis to evaluate the ability of the MMPI scales to discriminate fibromyalgia patients from healthy individuals (Control), and sensitivity analysis including "low risk of bias" studies only.

Pooled analysis of all included studies ($n = 4$)					Sensitivity analysis of "low risk of bias" studies ($n = 3$)			
MMPI scale	I^2	Analysis model[a]	Weighted mean T-score difference (fibromyalgia minus control)	95% CI	I^{2b}	Analysis model[a]	Weighted mean T-score difference (fibromyalgia minus control)	Confidence interval (95%)[c]
L	62%	FE	2.98	[0.85, 5.10]**	73%*	RE	3.65	[−3.64, 9.87]
F	99%***	RE	16.76	[−4.15, 37.66]	99%***	RE	21.19	[−7.54, 49.92]
K	80%**	RE	−5.71	[−9.58, 1.83]***	85%**	RE	−5.06	[−10.33, 0.21]
Hs	91%***	RE	22.80	[15.84, 29.76]***	22%	FE	26.12	[23.41, 28.82]***
D	81%**	RE	20.82	[16.03, 25.62]***	86%**	RE	21.19	[14.10, 28.28]***
Hy	79%**	RE	21.65	[17.13, 26.18]***	0%	FE	23.88	[21.23, 26.53]***
Pd	35%	FE	10.62	[8.56, 12.68]***	47%	FE	11.23	[8.79, 13.68]***
Mf	48%	FE	0.95	[−0.96, 2.85]	59%	FE	0.37	[−1.87, 2.61]
Pa	85%***	RE	11.99	[6.84, 17.15]***	84%**	RE	13.40	[6.91, 19.89]***
Pt	93%***	RE	18.72	[11.45, 25.99]***	91%***	RE	20.60	[12.09, 29.11]***
Sc	93%***	RE	16.60	[8.53, 24.67]***	94%***	RE	18.41	[7.75, 29.08]***
Ma	73%*	RE	4.00	[0.22, 7.77]*	0%	FE	5.90	[3.55, 8.26]***
Si	90%***	RE	8.92	[2.78, 15.06]**	92%***	RE	7.56	[−0.75, 15.88]

n = Number of studies; CI = confidence interval; I^2 = heterogeneity index; FE = fixed effects; RE = random effects; MMPI = Minnesota Multiphasic Personality Inventory; *SD* = Standard deviation; F = Females; M = Males; *L* = Lie; *F* = Infrequency; *K* = Correction; *Hs* = Hypochondriasis; *D* = Depression; *Hy* = Hysteria; *Pd* = Psychopathic Deviate; *Mf* = Masculinity/Femininity; *Pa* = Paranoia; *Pt* = Psychasthenia; *Sc* = Schizophrenia; *Ma* = Hypomania; *Si* = Social Introversion.

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

[a] Random-effects model was used when the heterogeneity of a given scale showed to be statistically significant.

comparison to the healthy volunteers, these differences being statistically significant. The sensitivity analysis also influenced the results for the *K* and *Si* scales, which lost statistical significance. This finding is consistent with the study by Pérez-Pareja et al. (2010).

Our findings provide evidence of the existence of psychopathological symptoms associated with fibromyalgia, such as anxiety, depression, and other personality characteristics, namely difficulties to overcome everyday problems and a tendency to react with pessimist thoughts. Nonetheless, the difficulty to differentiate between the factors contributing to the fibromyalgia status and what results from the psychological experience of the syndrome and of the associated functional impairment remains a challenge. Although some of them are more symptomatic and may be consequent to the syndrome, others are more stable and, because of that, are most likely to be antecedent. Namely, *D* scale identifies characteristics related to depressive and anxiety symptoms, less stable, while *Hs* scale identifies more stable and sometimes chronic characteristics (Greene, 2000). According to Sala et al. (2009), a higher score in *Hs* scale is associated with worse treatment response. Within the scope of the diathesis-stress model of disease, in which personality is part of a set of risk factors associated with the development of fibromyalgia (Thiagarajah et al., 2014), some personality and psychopathology features would be antecedent and make people more vulnerable to stressors in the environment, leading to the development of the syndrome. The possibility to explore the true meaning of mean scores in groups of patients is limited, because only the analysis of individual profiles can show the magnitude of each scale elevation and the association pattern among the scales.

Regarding the diagnosis of fibromyalgia, more emphasis should be given to the psychological evaluation and MMPI provides relevant specific information about personality and psychopathology, which should be considered in each individual case, together with other patient data (clinical history and course of life) in multidisciplinary evaluations. Pertaining to the psychological intervention with fibromyalgia patients, cognitive behavioral intervention is fairly recommended as an effective and well established treatment for fibromyalgia (Glombiewski et al., 2010; Lee, Ellis, Price, & Baranowski, 2013), but the focus on individual psychological and personality assessment is not so enhanced. We think individual assessment is always needed, for a deeper understanding of personality relevant features as antecedents of fibromyalgia or just symptomatic consequences, and, given the evidence that personality factors influence the emotional response to subjective experience of pain, the MMPI-2 can provide important information about this response and identify individual characteristics that may impede or promote recovery and adaptation to the pain condition (Arbisi & Butcher, 2004).

6.1. Study limitations

This work had some limitations. First, the EMBASE database was not used in the literature search, due to lack of institutional access to this database. This database is recommended for comprehensive literature searches (Higgins & Green, 2011) and it is plausible to assume that we may have failed to identify other potentially eligible studies. Second, the diminished number of available published studies to include in the analysis, which became even less due to the inclusion criteria established. Despite communication with the authors, we could not obtain the complete MMPI results from two selected studies. This could constitute a source of potential bias as their inclusion could have influenced our conclusions. Third, due to lack of information in the included studies, it was not possible to assess some quality criteria more thoroughly, such as if there was any conflict of interest and if patients were recruited in an unbiased manner.

The control of gender and age in the included studies would have been appropriate, but we did not do it in order to enable the inclusion of the biggest number of studies. However, the included studies in the first meta-analysis did not have an abnormal heterogeneity concerning these two variables. The mean age had a variation between 34 and 55 years and most of the studies included females. If we have made the selection with more strict criteria concerning age and sex it would not be possible to make the proposed meta-analysis. In any case, the second meta-analysis comprised studies in which the effects of age variable were controlled, and the effects of sex variable was partially controlled (i.e., with the exception of one study that did not match controls to FM patients on sex, all the other studies did match FM and controls on sex and age). Globally, we may consider these variables have not influenced the observed differences between FM patients and controls in MMPI results.

Moreover, despite the significant heterogeneity observed for all clinical scales in the first meta-analytic procedure, we did not carry out a random-effects analysis. This was due to the impracticality of doing the referred analysis with the method chosen to perform the first meta-analytic procedure. Nonetheless, the heterogeneity observed

would not be influenced by the type of model used and, consequently, the interpretation of the weighted mean distances would still not be recommended.

6.2. Conclusions

This meta-analysis confirms the existence of a significant elevation in the neurotic triad, and that hypochondriasis, depression and hysteria are the more frequently elevated clinical scales in fibromyalgia patients. Globally, this triad has a configuration type Conversion V. According to Greene (2000), this configuration suggests that patients are converting personality distressing troubles into somatic complaints, which are more socially acceptable. The overall elevation reflects the amount of psychological distress that the person is experiencing, and the lower the elevation of D scale compared to Hs and Hy scales, the more severe, longstanding, and resistant to change are the person defenses against facing the actual source of distress. Generally, this profile represents an emphasis on physical complaints along with the denial of psychological basis.

A significant heterogeneity was observed in all MMPI clinical scales among the studies included in the meta-analysis. The high variability, both intra and inter-studies, must be carefully considered and has implications for the interpretation of this meta-analysis results. On one hand, these results add to the existing data that reported the presence of variability among patients diagnosed with fibromyalgia, suggesting that the fibromyalgia population is in fact a heterogeneous group regarding personality and psychopathology profiles. Therefore, fibromyalgia syndrome would be a "final common pathway" (Eich et al., 2000), reflecting the different combination and relative contribution of each etiological factor, i.e., if musculoskeletal symptoms dominate the experiences of some patients with FMS, psychological factors would dominate the experiences of others (Wilson et al., 2009), and personality may certainly play an important role in some cases. On the other hand, the high inter-studies variability may also be related to the different samples characteristics, namely the recruitment context itself, as many studies do not report these conditions and, among those who do, there are differences. From our point of view, further research on this matter will require studies with a tighter control of the participants' sociodemographic characteristics, associated features as pain level and disability degree, and comorbidities, and this information should be reported. Moreover, only studies focused on community-based samples will enable a finer conclusion about the degree of psychopathological features in this population, as other types of samples may artificially increase these features (Williams & Clauw, 2009).

The fibromyalgia patients scored higher in all clinical scales in comparison to the healthy control group, allowing us to conclude that MMPI was able to discriminate patients with fibromyalgia from healthy individuals. As the ratio between female and male FM-patients is approximately 9:1, the studies incorporated in this meta-analysis included far more female patients than male patients, which makes appropriate to generalize the results to the female fibromyalgia patients only.

Although the meta-analysis has shown that fibromyalgia patients had different MMPI profiles than healthy controls, we cannot assume that this profile is typical of fibromyalgia patients only. We intend to address the matter of specificity in another study, by comparing fibromyalgia patients with patients of another rheumatic condition. Most of the studies report that the FM group has more personality and/or clinical psychopathology (Ahles et al., 1984; Gerson & Fox, 2003; Payne et al., 1982; Pérez-Pareja et al., 2010; Porter-Moffitt et al., 2006; Trygg et al., 2002; Wolfe et al., 1984) and this next study will compare FM and other rheumatic condition, to explore in depth the whole set of MMPI dimensions, including personality psychopathology disorders, content and supplementary scales, which enables a broadband assessment of personality and psychopathology and factors associated with the subjective experience of pain (Arbisi & Butcher, 2004), as well the identification of emotional and psychological resources and personality vulnerabilities (Graham, 2011).

We think that, despite the fact that the second meta-analysis includes few studies, it is important due to its greater ecological value; it compares patients and healthy controls that were assessed in the same time frame and cultural context, with similar ages, which prevents the reported effect (e.g., Ahles et al., 1986) of using interpretative norms.

Therefore, we consider that, despite the small number of studies and the considerable heterogeneity found, this meta-analysis brings important results, which can be valuable for researchers in this field and present the starting point of further research.

The results about personality profile of fibromyalgia patients with the MMPI are very diverse, and this meta-analysis assessed the magnitude of existing differences, therefore being a step forward in this field.

The validity scales should be further explored in future research. Besides *K* scale, which indicates less psychological resources to face distress, the *L* scale mean is high, showing that some FM patients reveal the tendency to present themselves in an unrealistic and excessively positive way, and to exacerbate distress (i.e., overly value any unusual experience, sensation or thought), as the *F* scale mean is also high. These results should be further explored in future studies, considering more specific MMPI validity indicators, namely *Fp* scale (infrequency-psychopathology), as a supplement to the *F* scale in identifying infrequent responding. It would also be important to integrate data of MMPI PSY-5 scales (five scales pertaining to Personality Psychopathology Disorders), which are not usually reported in published research. Future studies should consider and report information about potential elevations in personality disorders scales and their relations with clinical disorders scales.

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