

# Universidad de Huelva

Departamento de Didácticas Integradas



## Physical activity, physical exercise and positive psychology in fibromyalgia

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presentada por:

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Bajo la dirección de los doctores:

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matemáticas y la actividad física y deportiva**

## **ACTIVIDAD FÍSICA, EJERCICIO FÍSICO Y PSICOLOGÍA POSITIVA EN FIBROMIALGIA**



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***INTERNATIONAL DOCTORAL THESIS***

**PHYSICAL ACTIVITY, PHYSICAL EXERCISE AND  
POSITIVE PSYCHOLOGY IN FIBROMYALGIA**

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# Universidad de Huelva

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Que la Tesis Doctoral Titulada “Actividad física, ejercicio físico y psicología positiva en fibromialgia”, cuyo autor es D. Manuel J. Arrayás Grajera, ha sido realizada bajo nuestra dirección y consideramos que reúne las condiciones para su lectura y defensa, pudiendo optar al Grado de Doctor, siempre que así lo considere el tribunal.

Fdo.: Inmaculada Tornero Quiñones. Fdo.: Ana Carbonell Baeza. Fdo.: Fernando Estévez López

Octubre 2023



A mis padres y hermana,  
a los que les debo lo que fui,  
lo que soy y, en parte,  
lo que seré.

A mi mujer,  
por ser ejemplo de tesón y capacidad,  
por hacerme mejor en todo, incluido mejor investigador,  
por su aliento y confianza constantes,  
por darme el espacio necesario para que esta tesis sea una realidad.

A mi hija,  
por aparecer en el momento exacto y demostrarme que,  
si al dar un paso te caes, la única opción para aprender es,  
volver a levantarte e intentarlo de nuevo.

A mi hermano,  
porque cuando las cosas no iban bien,  
siempre supiste sacarme de la espiral.



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# **1. ABSTRACT**

## **1. ABSTRACT**

Fibromyalgia, a disease of unknown aetiology, is characterised by the presence of chronic pain, stiffness, fatigue and sleep disturbances, leading to significant functional limitations as well as increased demand for healthcare and burden for relatives. It also affects mental health, with high rates of depression and anxiety. However, little research has explored the positive psychology resources, such as subjective well-being, dispositional optimism and emotional repair in women with fibromyalgia. Identifying deficits in these positive resources and finding ways to enhance them may be crucial in helping women with fibromyalgia to adapt to this incurable disease. Physical activity is a recognised determinant of health in fibromyalgia. Nevertheless, it is unclear whether this association also applies to positive psychology resources.

This Doctoral Thesis aimed to improve positive psychology resources in people with fibromyalgia. Firstly, we compared the levels of positive psychology resources (subjective well-being, dispositional optimism and emotional repair) between women with fibromyalgia and age-matched controls with a case-control study. Secondly, we explored the cross-sectional association between objectively measured physical activity and positive psychology resources in women with fibromyalgia. Thirdly, we conducted a quasi-experimental study to analyse the effects of a 24-week intervention of land- and water-based exercise on positive psychology resources.

Collectively, the knowledge gained from the present Doctoral thesis may help to better understand positive psychology resources in women with fibromyalgia. It was observed that women with fibromyalgia have deficits in positive psychology resources. Interestingly, we showed that to engage in higher levels of light physical activity is

associated with having more positive psychology resources in women with fibromyalgia. Moreover, a physical exercise intervention, regardless of land- or water-based, had no effects on positive psychology resources in women with fibromyalgia. The only exception was that positive affect increased in those who engaged in water-based exercise but this benefit was not maintained after 12 weeks of follow-up.

## **2. RESUMEN**

## **2. RESUMEN**

La fibromialgia, una enfermedad de etiología desconocida, se caracteriza por la presencia de dolor crónico, rigidez, fatiga y trastornos del sueño, lo que conlleva limitaciones funcionales significativas, así como unos mayores costes económicos para el sistema sanitario y una carga para los familiares. También afecta a la salud mental, con altas tasas de depresión y ansiedad. Sin embargo, existe poca investigación que haya explorado los recursos de psicología positiva, como el bienestar subjetivo, el optimismo disposicional y la reparación emocional en mujeres con fibromialgia. Identificar déficits en estos recursos positivos y encontrar formas de mejorarlos puede ser crucial para ayudar a las mujeres con fibromialgia a adaptarse a esta enfermedad incurable.

La actividad física es un determinante importante de la salud en mujeres con fibromialgia. Sin embargo, se desconoce si también lo es para los recursos de psicología positiva. Esta Tesis Doctoral tuvo como objetivo mejorar los recursos de psicología positiva en personas con fibromialgia. En primer lugar, comparamos los niveles de recursos de psicología positiva (bienestar subjetivo, optimismo disposicional y reparación emocional) entre mujeres con fibromialgia y controles del mismo sexo y edad en un estudio de casos y controles. En segundo lugar, exploramos la asociación transversal entre la actividad física medida objetivamente y los recursos de psicología positiva en mujeres con fibromialgia. En tercer lugar, llevamos a cabo un estudio cuasi-experimental para analizar los efectos de una intervención de 24 semanas de ejercicio en seco y en agua sobre los recursos de psicología positiva. En conjunto, el conocimiento generado por esta Tesis Doctoral puede contribuir a comprender mejor los recursos de psicología positiva en mujeres con fibromialgia. Se observó que las mujeres con fibromialgia tienen déficits en los recursos de psicología positiva. Además, mostramos que participar en niveles más altos de actividad física ligera se asoció con tener más recursos de psicología positiva en mujeres

con fibromialgia. Por último, un programa de ejercicio físico, ya sea en seco o en agua, no tuvo efectos en los recursos de psicología positiva en mujeres con fibromialgia. La única excepción fue que el afecto positivo aumentó en aquellas que participaron en ejercicio acuático, pero este beneficio no se mantuvo tras 12 semanas de seguimiento después de la finalización del ejercicio físico.

# **3. GENERAL INTRODUCTION**

### **3. GENERAL INTRODUCTION**

#### **3.1. Fibromyalgia**

Fibromyalgia is a disease characterised by chronic widespread pain as its core symptom (Frederick Wolfe et al., 2011). Fibromyalgia is common, with a prevalence of approximately 2% (Heidari, Afshari, & Moosazadeh, 2017). The literature consistently shows a greater prevalence of fibromyalgia among women when compared to men (Heidari et al., 2017). In past decades, there has been a substantial evolution in the conceptualisation and definition of fibromyalgia. Particularly, the field has moved from the initial classification criteria focused on the presence of tender points and introduced in 1990 (Wolfe et al., 1990) to a broader characterisation of fibromyalgia including additional symptoms (Wolfe et al., 2011) such as, for instance, fatigue, poor sleep and psychological symptoms (e.g., depression and nervousness (Wolfe et al., 2016, 2011). Changes in the diagnostic criteria have led to a more equitable female-to-male ratio, approximately (~1.5:1), in comparison to historically reported figures (9:1), (Wolfe, Walitt, Perrot, Rasker, & Ha, 2018).

Due to its array of symptoms, fibromyalgia imposes a burden on patients, their families, and society (Arnold et al., 2008; Schaefer et al., 2016). For patients, fibromyalgia exerts a substantial burden that detrimentally affects their daily lives (Climent-Sanz et al., 2021). Family members often experience distress that may lead to tendencies toward excessive protectiveness and over-involvement in the care of the patient, resulting in challenges in establishing appropriate boundaries (Montesó-curto et al., 2021). In economic terms, people with fibromyalgia often necessitate heightened utilization of healthcare resources, thereby imposing additional demands on healthcare systems (Onghia et al., 2022).

### 3.2. Mental health

Mental health refers to a state of mental well-being that enables people to cope with the stresses of life, realise their abilities, learn well and work well, and contribute to their communities (Freeman, 2022). Mental health is an integral component of health and well-being and is more than the absence of disease (Freeman, 2022). Among other factors, mental health is determined by people's levels of negative and positive psychology resources. Negative psychology resources (also known as vulnerability) refer to the susceptibility or predisposition of an individual to experience adverse mental health outcomes or difficulties when facing stressors or challenges (Castleden, McKee, Murray, & Leonardi, 2011; Luthar, Cicchetti, & Becker, 2000). Positive psychology resources (also known as resilience) refer to the ability to maintain positive functioning in the face of adversity and challenges (Castleden et al., 2011; Luthar et al., 2000).

Fibromyalgia often has a negative impact on mental health (Kleykamp et al., 2021). Historically, the majority of psychological research has focused on negative aspects of mental health ( Seligman & Csikszentmihalyi, 2000). For instance, it is well-known that the prevalence of depression and anxiety is high in people with fibromyalgia; namely, 43% and 30% respectively (Kleykamp et al., 2021). However, scarce attention has been dedicated to positive aspects of mental health. Among positive psychology resources, a number of them are promising in promoting adaptation to fibromyalgia such as, for instance, subjective well-being, dispositional optimism and emotional repair (Sturgeon & Zautra, 2013; Zautra, Johnson, & Davis, 2005). Subjective well-being is people's emotional (affect) and cognitive (satisfaction with life) evaluation of their own life (Ed Diener, Suh, Lucas, & Smith, 1999). Dispositional optimism is a prevailing belief that positive outcomes will occur in the future while negative occurrences will be minimal (Scheier, Carver, & Bridges, 1994). Emotional repair entails individuals' perceived

capacity to independently regulate their emotional states, amplifying positive emotions while mitigating negative ones (Ruiz-Aranda, Salguero, & Fernández-Berrocal, 2010). To date, little is known about whether people with fibromyalgia experience deficits on positive psychology resources and, if so, how to target them. Thus, to identify deficits in modifiable positive psychology resources and, if so determine how to improve them, is of interest in order to promote adaptation to live with a disease that has no cure.

### 3.3. Physical activity and physical exercise

Physical activity, defined as any bodily movement produced by skeletal muscles that result in energy expenditure above basal metabolic rate (Caspersen, Powell, & Christenson, 1985), is a well-known behavioural determinant of health in fibromyalgia (Gavilán-Carrera et al., 2023; Gavilán-Carrera et al., 2019). In general, more physical activity is associated with lower severity of symptoms of fibromyalgia (Gavilán-Carrera et al., 2023; Gavilán-Carrera et al., 2019). Nevertheless, it remains uncertain to what extent this association also extends to positive psychology resources. Also, there is still a lack of consensus regarding the recommended intensity of physical activity for individuals with fibromyalgia. Conventional health promotion approaches within the general population have historically emphasised moderate-to-vigorous physical activity levels. Nevertheless, emerging evidence suggests that light physical activity may help to promote health (Batacan Jr, Duncan, Dalbo, Tucker, & Fenning, 2015; Chastin et al., 2019), particularly among inactive and unfit individuals, such as people with fibromyalgia (Segura-Jiménez et al., 2015). Thus, more research is needed to understand the association of physical activity, including its intensity levels, and positive psychology resources in people with fibromyalgia.

Physical exercise is a subset of physical activity that is planned, structured and repetitive and has as a final or an intermediate objective the improvement or maintenance of

physical fitness (Caspersen et al., 1985). Physical exercise is recommended as the first-line therapy in the management of fibromyalgia (Kundakci et al., 2022; Macfarlane et al., 2017). However, several questions remain to be responded. First, past studies have mostly focused on pain and further evidence for other aspects such as mental health is needed (Andrade, Hech, & Mendes, 2020). Second, the setting in which exercise is performed may influence the outcomes. Particularly, it is unclear whether land-based exercise or water-based exercise is more advisable in fibromyalgia. Third, the long-term effects of physical exercise in fibromyalgia are unknown because it is often omitted the study of the persistence of the changes in outcomes after physical exercise cessation (Estévez-López et al., 2021). Thus, to address these questions is of clinical interest.

# 4. AIMS

#### 4. AIMS

The **overall aim** of the investigations summarised in this Doctoral Thesis was to improve positive psychology resources in people with fibromyalgia.

The **specific aims** of the separate studies were the following:

- To compare the levels of positive psychology resources (i.e., subjective well-being, dispositional optimism and emotional repair) in a large sample of women with fibromyalgia (cases) and age-matched women without fibromyalgia (controls) [**Study I**].
- To examine the association of objectively measured physical activity (i.e., light, moderate and vigorous physical activity as well as number of daily steps) with positive psychology resources (i.e., subjective well-being, dispositional optimism and emotional repair) in women with fibromyalgia [**Study II**].
- To determine (i) the effects of a 24-week intervention of land- and water-based exercise on positive psychology resources (i.e., subjective well-being, dispositional optimism and emotional repair) and (ii) the persistence of the changes in the outcomes after 12 weeks of follow-up [**Study III**].

# **5. OBJETIVOS**

## 5. OBJETIVOS

El **objetivo general** de las investigaciones resumidas en esta Tesis Doctoral fue mejorar los recursos de psicología positiva en personas con fibromialgia.

Los **objetivos específicos** de los estudios individuales fueron los siguientes:

- Comparar los niveles de recursos de psicología positiva (es decir, bienestar subjetivo, optimismo disposicional y reparación emocional) en una muestra amplia de mujeres con fibromialgia (casos) y mujeres de la misma edad sin fibromialgia (controles) [**Estudio I**].
- Examinar la asociación entre la actividad física medida objetivamente (es decir, actividad física ligera, moderada y vigorosa, así como el número de pasos diarios) y los recursos de psicología positiva (es decir, bienestar subjetivo, optimismo disposicional y reparación emocional) en mujeres con fibromialgia [**Estudio II**].
- Determinar (i) los efectos de una intervención de 24 semanas de ejercicios en seco y en agua sobre los recursos de psicología positiva (es decir, bienestar subjetivo, optimismo disposicional y reparación emocional) y (ii) la persistencia de los cambios en los resultados 12 semanas después de la finalización del ejercicio [**Estudio III**].

# **6. GENERAL METHODS**

## 6. GENERAL METHODS

### 6.1. The Al-Ándalus Project – Design

The present Doctoral Thesis was conducted using data from the cross-sectional and quasi-experimental studies of the al-Ándalus project. The Al-Andalus project, was conducted in Andalusia (southern Spain) from 2011 to 2017, and it was a comprehensive, multi-centric study with the overarching goals of enhancing the diagnosis and characterization of fibromyalgia, identifying prognostic factors associated with the disease, and assessing the efficacy of exercise as a therapeutic intervention. This project comprises two distinct components, each employing different methodological approaches:

1. The Al-Andalus Cohort Study: This longitudinal investigation includes 2- and 5-year follow-ups.
2. The Al-Andalus Trial: A quasi-randomized controlled trial.

### 6.2. The Al-Ándalus Project cohort study – Participants

The Al-Ándalus project aimed to recruit a fibromyalgia sample representative of the Andalusian population (i.e. 8 provinces from southern Spain). The project selected a common criteria in clinical studies ( $k$  of 10-50%). For a confidence interval level of 95% a sample consisting of 300 participants were needed to obtain an accuracy of 11%. The sample was oversized in order to prevent loss of information and more than 600 participants were initially recruited (more information in flowchart diagrams of studies I and III).

In 2011/2012 (baseline) patients were contacted through fibromyalgia associations from the 8 provinces of Andalusia. In 2013/2014 and 2016/2017 the cohort was contacted again for the follow-up evaluations.

### 6.3. The Al-Ándalus Project cohort study – Procedures

A very similar evaluation process was performed at 3 time points. The assessments were carried out in 2 alternate days. The whole evaluation process was performed by researchers who had previously received specific training to ensure harmonization of data collection.

On day one, the Mini Mental State Examination and tender points examination was performed by the researchers and anthropometry and body composition were also assessed. Participants also filled out the modified 2010 American college Rheumatology preliminary criteria, sociodemographic data and several questionnaires that would be reviewed by the research team.

On day two, physical fitness assessment was undertaken. Finally, participants received instructions on how to complete the sleep diary and the accelerometers were provided. The accelerometers and sleep diaries were returned to the research team 9 days later.

### 6.4. The Al-Ándalus trial – Participants

The Al-Ándalus trial was registered as a 24-week randomized controlled exercise trial with a 12-week follow-up. Participants were allocated to the land-based exercise, water-based exercise or usual care (control) groups. The sample was oversized in order to compensate loss to follow-up and a recruitment of 180 women with fibromyalgia (60 in each group) was initially planned.

### 6.5. The Al-Ándalus trial – Procedures

Assessments were conducted at baseline, at the end of the exercise intervention (week 24) and at 12-week follow-up (week 36). Same protocol for evaluation as described for

the Al-Ándalus cohort study was also carried out in this trial at each time-point. The land- and water-based exercise intervention of the project is described in annex 1.

### 6.6. Ethical Issues

The project was performed following the ethical guidelines of the Declaration of Helsinki, last modified in 2000. Ethics approval was obtained by the Ethics Committee of Hospital Virgen de las Nieves in Granada, Spain, that granted approval for the study designs, the research protocols, and the informed consent procedures.

### 6.7. Methodological Overview of studies

Table 1 provides an overview of the used specific methods of each study included in this Doctoral Thesis.

**Table 1.** Overview of the methods of this Doctoral Thesis

<b>Study</b>	<b>Design</b>	<b>Participants</b>	<b>Independent variable(s)</b>	<b>Dependent variable(s)</b>
I	Case-control	Women with fibromyalgia ( <i>n</i> =437), controls ( <i>n</i> =206)	Cases vs. controls	Positive psychology resources; i.e., subjective well-being (Positive and Negative Affect Schedule (Annexe II) and the Satisfaction with Life Scale (Annexe III)), dispositional optimism (Life Orientation Test-Revised (Annexe IV)) and emotional repair (Trait Meta-Mood Scale (Annexe V))
II	Cross-sectional	Women with fibromyalgia ( <i>n</i> =419)	Objectively measured physical activity (accelerometry)	Satisfaction with Life Scale (Annexe III), dispositional optimism (Life Orientation Test-Revised (Annexe IV)) and emotional repair (Trait Meta-Mood Scale (Annexe V))
III	Quasi-experimental	Women with fibromyalgia ( <i>n</i> =250)	Land ( <i>n</i> =83) Water ( <i>n</i> =85) Control ( <i>n</i> =82)	emotional repair (Trait Meta-Mood Scale (Annexe V))

# **7. RESULTS**

7.1. STUDY I–  
Fibromyalgia: evidence for  
deficits in positive  
psychology resources. A  
case-control study from the  
Al-Ándalus project

**Study 1 – Fibromyalgia: evidence for deficits in positive psychology resources. a case-control study from the Al-Ándalus project**

**PUBLISHED: International Journal of Environmental Research and Public Health (2021) (Annexe VI).**

**Arrayás-Grajera, M.J.; Tornero-Quiñones, I.; Gavilán-Carrera, B.; Luque-Reca, O.; Peñacoba-Puente, C.; Sierra-Robles, Á.; Carbonell-Baeza, A.; Estévez-López, F.**

**ABSTRACT**

**Purpose:** Positive psychology is the study of positive subjective experience and individual traits. To identify deficits in positive psychology in fibromyalgia may inform targets for management. Therefore, the aim of the present case-control study was to compare the levels of positive affect, negative affect, satisfaction with life, optimism and emotional repair in a large sample of women with fibromyalgia (cases) and age-matched peers without fibromyalgia (controls). **Methods:** This cross-sectional study included 437 women with fibromyalgia (51.6±7.1 years old) and 206 age-matched women without fibromyalgia (50.6±7.2 years old). Participants self-reported their levels of (i) subjective well-being on the Positive and Negative Affect Schedule and the Satisfaction with Life Scale, (ii) dispositional optimism on the Life Orientation Test-Revised and (iii) emotional repair on the Trait Meta-Mood Scale. Multivariate analysis of covariance (MANCOVA) was conducted to compare the levels of positive psychology between women with and without fibromyalgia. **Results:** In comparison to peers without fibromyalgia, women with fibromyalgia showed lower levels of positive affect, satisfaction with life, optimism and emotional repair and higher levels of negative affect. Large effect sizes were found for

positive affect, negative affect and satisfaction with life (all, Cohen's  $d \geq 0.80$ ) and small-to-moderate for emotional repair and optimism (both, Cohen's  $d \geq 0.50$ ). **Conclusion:** In conclusion, women with fibromyalgia experience deficits on positive psychology resources. Thus, to develop tailored therapies for fibromyalgia focusing on enhancing deficits on positive psychology resources may be of clinical interest, which remains to be corroborated in future research.

**Keywords:** Chronic pain; Emotional intelligence; Persistent physical symptoms; Resilience (psychological); Subjective well-being; Vulnerability (psychological).

## **INTRODUCTION**

Fibromyalgia is a chronic disease characterised by widespread musculoskeletal pain and additional physical and psychological symptoms that usually include fatigue, poor sleep quality, stiffness, depression, anxiety, and cognitive difficulties (Ablin & Wolfe, 2017; F Wolfe et al., 1990). As a consequence, people with fibromyalgia report substantial functional limitations, which may lead to high health resource use and lost productivity resulting in significantly higher costs (Chandran et al., 2012; Lee et al., 2016). In fibromyalgia, the exclusive focus on negative aspects has traditionally dominated (M. E. P. Seligman & Csikszentmihalyi, 2000). However, positive psychology has been defined as the scientific study of positive experiences and positive individual traits (Duckworth, Steen, & Seligman, 2005) which refers to people's ability to maintain a positive functioning in the face of adversity and challenges (Castleden et al., 2011; Luthar et al., 2000).

In fibromyalgia, previous case-control research has extensively focused on the affective sources such as positive and negative affect (Hassett et al., 2008; van Middendorp et al.,

2008; Alex J Zautra, Fasman, et al., 2005) that are the emotional components of subjective well-being; i.e., people's evaluations of their lives (Ed Diener, Oishi, & Lucas, 2003). In comparison to peers without fibromyalgia, those with the disease have reduced levels of positive affect and increased levels of negative affect (Hassett et al., 2008; van Middendorp et al., 2008; Alex J Zautra, Fasman, et al., 2005). However, scarce attention has been paid to the cognitive-, emotional- and personality-related aspects of positive psychology despite they may play a key role in adaptation to chronic pain (Sturgeon & Zautra, 2010). Satisfaction with life is the cognitive component of subjective well-being; i.e., the cognitive evaluation of one's life (E Diener, 2000; Ed Diener et al., 2003). It has been observed that satisfaction with life is low in people with chronic pain (Boonstra, Reneman, Stewart, Post, & Schiphorst Preuper, 2013; Brox, Storheim, Holm, Friis, & Et, 2005). Dispositional optimism (herein after referred to as optimism) is the generalised expectancy that good things will happen in the future and bad things will be minimal (Scheier et al., 1994). In the general population, higher optimism is related to better health (Barnett & Anderson, 2020; Conversano et al., 2010; Hajek & König, 2019). In fibromyalgia, higher optimism is associated with less perceived goals barriers during disease flares (Affleck et al., 2001; Jansen, Linder, Ekholm, & Ekholm, 2011). Emotional repair is the ability that people have to regulate their emotional states themselves (Ruiz-Aranda et al., 2010) enhancing the positive states and minimising those which are negative. In people with chronic pain, higher emotional repair is associated with lower pain (González, V., Ramírez-Maestre, C., & Herrero, 2007). Collectively, it seems that satisfaction with life, optimism and emotional repair may play a role in adaptation to fibromyalgia. However, previous case-control studies did not comprehensively characterise the levels of affective, cognitive and personality aspects of positive psychology in fibromyalgia. To address this gap in the knowledge may help to develop

tailored therapies focused on enhancing fibromyalgia deficits on positive psychology and, consequently, the severity of the disease.

Therefore, the aim of the present case-control study was to compare the levels of positive affect, negative affect, satisfaction with life, optimism and emotional repair in a large sample of women fibromyalgia (cases) and age-matched women without fibromyalgia (controls). On the basis of the previous evidence, the hypothesis of the present study is that, in comparison to controls, women with the disease have more unfavourable scores in all these positive psychology resources.

## **METHODS**

### ***Participants***

Participants from the eight provinces of Andalusia (southern Spain) were recruited for the present case-control study through local fibromyalgia associations, via e-mail, letter, telephone or university press. Additionally, participants with fibromyalgia (cases) were asked to recruit non-fibromyalgia (control) participants with similar age and socio-demographic characteristics to conduct comparisons between groups. All potential participants ( $n = 960$ ) gave their written informed consent after receiving detailed information about the study aims and procedures before taking part in the study. The inclusion criteria for participants with fibromyalgia were: (1) to be an adult woman (aged 18 to 65 years old); (2) to have a medical diagnosis of fibromyalgia from a rheumatologist (participants were requested to provide their medical records to confirm their diagnosis); (3) to meet the 1990 American College of Rheumatology (ACR) fibromyalgia criteria (Segura-Jiménez et al., 2014; Frederick Wolfe et al., 2010). The inclusion criteria for control participants were: (1) to be an adult woman (aged 18 to 65 years old); (2) not to meet the 1990 ACR fibromyalgia criteria (Frederick Wolfe et al., 2010). Additionally,

those fibromyalgia or controls participants with either acute/terminal illness (such as cancer, stroke, recent cardiopathy, severe coronary disease, schizophrenia, or any other disabling injury) or severe cognitive impairment, as defined by a score of less than ten on the Mini-Mental State Examination (MMSE) (Folstein, Folstein, & McHugh, 1975; Lobo, Ezquerra, Gómez Burgada, Sala, & Seva Díaz, 1979) were excluded. All tests were performed by the same trained researchers group to reduce inter-examiners error. The study was reviewed and approved by the Ethics Committee of the “*Hospital Virgen de las Nieves*” (Granada, Spain); registration number: 15/11/2013-N72. The ethical guidelines of the Declaration of Helsinki (modified in 2000) were followed.

### ***Measures***

*The MMSE* (Folstein et al., 1975; Lobo et al., 1979) was used as a screening test to determine whether a participant experienced severe cognitive impairment (i.e., an exclusion criterion). The MMSE assesses five areas of cognitive function: orientation, immediate memory, attention/concentration, delayed recall, and language.

*Socio-demographic data* was recorded using a self-report questionnaire in which participants indicated their date of birth, marital status (i.e., married, single, separated, divorced, and widow), education level (i.e., unfinished studies, primary studies, secondary studies and university studies), time since fibromyalgia diagnosis (< 1 year, 1-5 years and > 5 years) and time since first symptoms until fibromyalgia diagnosis (< 1 year, 1-5 years and > 5 years).

*A physical examination of tender points according to the 1990 ACR fibromyalgia criteria* (Segura-Jiménez et al., 2014; Frederick Wolfe et al., 2010) was performed using a standard pressure algometer (FPK 20; Wagner Instruments, Greenwich, CT, USA). Those participants who (i) reported widespread musculoskeletal pain for, at least, 3 months and

(ii) reported pain at a pressure of  $\leq 4\text{kg/cm}^2$  in, at least, 11 tender points, were classified as meeting the 1990 ACR fibromyalgia criteria.

*The Positive and Negative Affect Schedule* (PANAS) (Estévez-López et al., 2016; Sandin et al., 1999; Watson, Clark, & Tellegen, 1988) is a 20-item questionnaire with a 5-point Likert scale (from 1=“very slightly or not at all” to 5=“extremely”) that assess two subscales, positive and negative affect. The scores of the PANAS range from 10 to 50, where higher scores reflect greater positive affect or negative affect. We use the trait time-frame version of the PANAS; i.e., “in general” directions. The 2-factor structure of the PANAS has shown satisfactory psychometric properties in fibromyalgia (Estévez-López et al., 2016). In the present study, Cronbach's alpha was 0.91 for positive affect and 0.91 for negative affect.

*The Satisfaction With Life Scale* (SWLS) (Atienza, Pons, Balaguer, & Garcia-Merita, 2000; E Diener, Emmons, Larsen, & Griffin, 1985) is a 5-item questionnaire with a 7-point Likert scale (from 1 = “strongly disagree” to 7 = “strongly agree”). The score of the SWLS ranges from 5 to 35, where a higher score reflects greater satisfaction with life. In the present study, Cronbach's alpha for satisfaction with life was 0.86.

*The Life Orientation Test-Revised* (LOT-R) (Ferrando, Chico, & Tous, 2002; Landero Hernández, R. y González Ramírez, 2009; Otero, Luengo, Romero, Gómez, & Castro, 1998; Scheier et al., 1994) is a 10-item questionnaire with a 5-point Likert scale (from 0 = “Strongly disagree” to 4 = “Strongly agree”). LOT-R is comprised of three positively worded items (e.g., “I’m always optimistic about my future”), three negatively worded items (e.g., “I hardly ever expect things to go my way”) and four filler that are not considered in the LOT-R score. The score of the LOT-R ranges from 0 to 24, where a higher score reflects greater dispositional optimism. In the present study, Cronbach's alpha for optimism was 0.70.

*The emotional repair scale of the Trait Meta-Mood Scale (TMMS-ER)* (Fernandez-Berrocal, Extremera, & Ramos, 2004; Salovey, Mayer, Goldman, Turvey, & Palfai, 1995) is a 8-item questionnaire with a 5-point Likert scale (from 1 = “strongly disagree” to 5 = “strongly agree”). The score of the emotional repair scale of the TMMS ranges from 8 to 40, where a higher score reflects the perceived ability to enhance positive emotional states and minimize negative ones. In the present study, Cronbach's alpha for emotional repair was 0.90.

### ***Procedure***

Assessments took place over three consecutive days. On day 1, the MMSE were interviewed, socio-demographic data were collected and a tender point examination was conducted. On day 2, participants filled out the PANAS, SWLS, LOT-R, and TMMS-ER questionnaires at home without supervision. On day 3, participants returned the questionnaires to the research team who reviewed all of them and potential doubts were resolved.

### ***Statistical analysis***

Descriptive statistics include means and standard deviations for continuous variables as well as frequency and percentage for categorical variables. Internal consistency of the instruments was assessed by Cronbach's  $\alpha$  coefficient with acceptable values  $\geq 0.70$  (Nunnally & Bernstein, 1994). Before main analyses, *t*-test or chi-square test analysis (in continuous or categorical variables, respectively) were used to identify differences between groups (i.e., participants with and without fibromyalgia) in the potential sociodemographic confounders; namely, age, marital status and education level.

Statistical differences in education level between women with and without fibromyalgia were found and, thus, it was included as a covariate in all the analysis.

Multivariate analysis of covariance (MANCOVA) was conducted to compare the mean scores of fibromyalgia and non-fibromyalgia groups on positive psychology resources. In MANCOVA, group was entered as the independent variable, all the positive psychology resources were entered as dependent variables and educational level (covariate). The effect size was calculated using Cohen's *d* (standardised mean differences) to compare all the positive psychology variables. Cohen's *d* values were interpreted as small (~0.2), medium (~0.5) or large (~0.8) effects (Nakagawa & Cuthill, 2007).

All analyses were performed using Statistical Package for Social Sciences (IBM SPSS Statistics for Windows, version 26.0; Armonk, NY, USA), and the level of statistical significance was set at  $\alpha = 0.05$  (two-tailed).

## **RESULTS**

Figure 1 shows the flowchart of the participants. Table 1 shows the characteristics of the 643 participants (437 women with fibromyalgia and 206 non-fibromyalgia women).

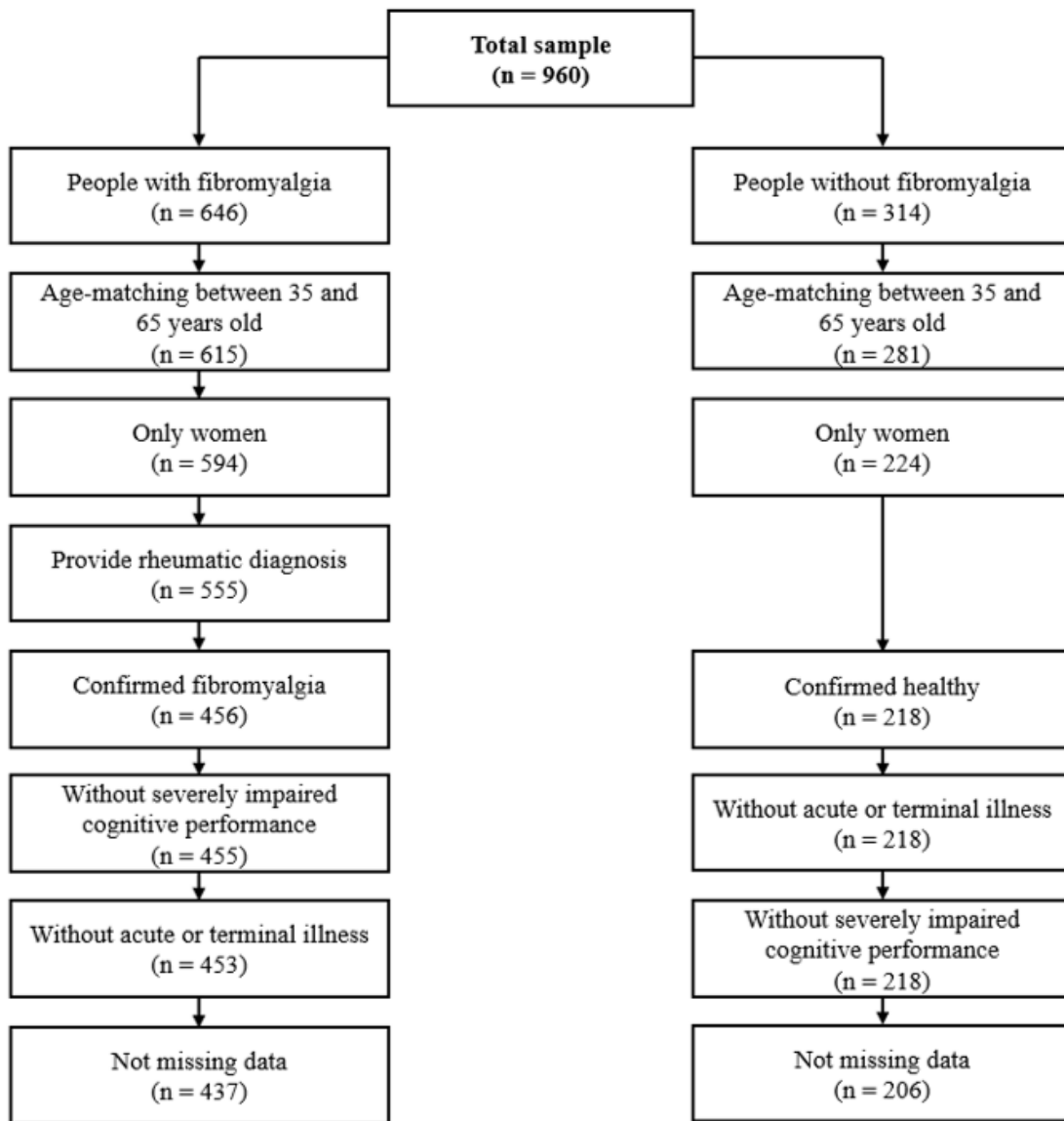


Figure 1. Flowchart of the participants

**Table 1.** Characteristics of the participants (n = 643)

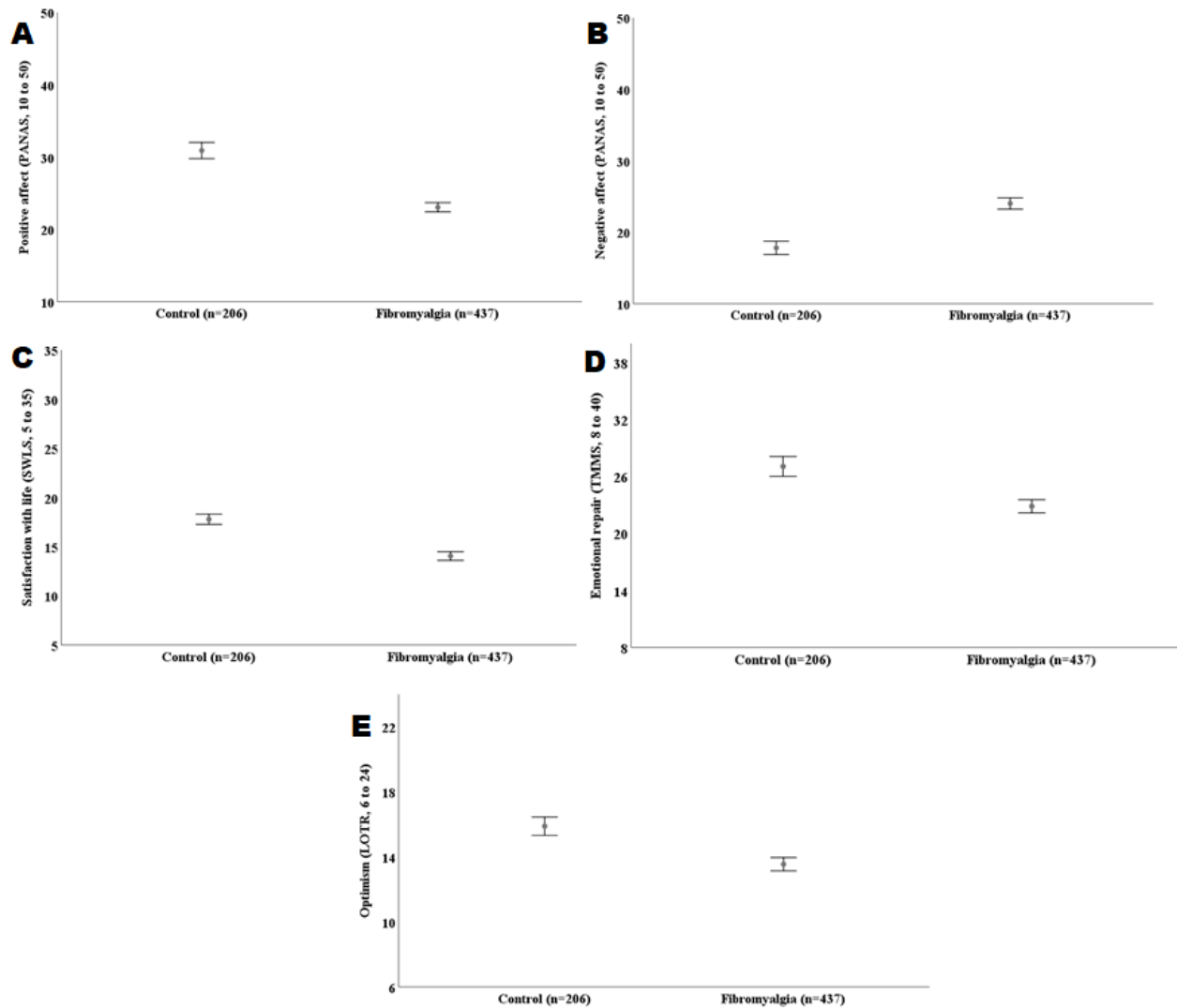
Characteristics	Fibromyalgia (n = 437)	Control (n = 206)	p-value
Age, mean (SD)	51.6 (7.1)	50.6 (7.2)	0.081
Education level, n (%)			0.004
Unfinished studies	40 (9.2)	11 (5.3)	
Primary studies	210 (48.1)	81 (39.3)	
Secondary studies	126 (28.8)	65 (31.6)	
Tertiary studies	61 (14.0)	49 (23.8)	
Marital status, n (%)			0.700
Married	332 (76.0)	149 (72.3)	
Single	34 (7.8)	21 (10.2)	
Separated/Divorced	50 (11.4)	26 (12.6)	
Widow	21 (4.8)	9 (4.4)	
Missing data		1 (0.5)	
Time since fibromyalgia diagnosis, n (%)			
< 1 year	28 (6.6)		
1- 5 years	147 (34.6)		
> 5 years	250 (58.8)		
Missing data	12 (2.7)		
Time since first symptoms until fibromyalgia diagnosis, n (%)			
< 1 year	41 (9.6)		
1- 5 years	181 (42.6)		
> 5 years	203 (47.8)		
Missing data	12 (2.7)		

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Analysis were conducted controlled for age and education level

A significant effect of group emerged on positive psychology resources ( $V = .241$ ,  $F(5, 636) = 40.43$ ,  $p < 0.001$ ) adjusting for age and education level. Figure 2 (panel A to E), shows that women with fibromyalgia have lower levels of positive affect ( $F(1, 640) = 154.47$ , panel A), satisfaction with life ( $F(1, 640) = 100.23$ , panel C), emotional repair ( $F(1, 640) = 40.33$ , panel D), and optimism ( $F(1, 640) = 36.78$ , panel E), and higher levels

of negative affect ( $F(1, 640) = 82.59$ , panel B), than women without fibromyalgia (all  $p$ 's $<0.001$ ). The effect sizes were medium (0.56 for emotional repair and 0.53 for optimism) and large (1.07 for positive affect, -0.79 for negative affect and 0.87 for satisfaction with life).



**Figure 2.** Panel A to E: Levels of positive affect, negative affect, satisfaction with life, emotional repair and optimism in 437 women with and without fibromyalgia. PANAS: Positive and Negative Affect Schedule. SWLS: Satisfaction With Life Scale. TMMS: Trait Meta Mood Scale. LOT-R: Life Orientation Test Revised.

## DISCUSSION

The aim of the present study was to compare the levels of positive affect, negative affect, satisfaction with life, emotional repair and optimism between women with fibromyalgia and age-matched peers without fibromyalgia (cases and controls, respectively). As we hypothesised, women with fibromyalgia experienced deficits in positive psychology resources. Large effect sizes were found for the three components of subjective well-being (namely, positive affect, negative affect and satisfaction with life; all, Cohen's  $d \geq 0.80$ ). Effect size ranged from small to medium for emotional repair and optimism. The comprehensive characterisation of the positive psychology of women with fibromyalgia provided in the present study may inform the development of tailored therapies for this disease. For instance, therapies targeting at improving positive affect may be a priority in fibromyalgia in order to improve the markedly high deficits observed in these resources of positive psychology.

In the present study, women with fibromyalgia experienced lower positive affect and higher negative affect than women without fibromyalgia, which concurs with previous findings from smaller samples (Estévez-López et al., 2015; Goubert & Trompetter, 2017; Holmes, 2017; León-Vega & Arias-Congrains, 2012; van Middendorp et al., 2008; Alex J Zautra, Johnson, & Davis, 2005). Indeed, Zautra et al. (Alex J Zautra, Fasman, et al., 2005) and Hassett et al. (Hassett et al., 2008) underlined that, in fibromyalgia, positive affect and negative affect are more deteriorated than in women without fibromyalgia even than in other rheumatic conditions (e.g. osteoarthritis). Previous case-control studies did not analyse satisfaction with life, which is the cognitive component of subjective well-being. The present findings have confirmed that, in comparison to peers without fibromyalgia, women with the disease have lower levels of satisfaction with life. This finding is in line with several previous studies from chronic musculoskeletal pain (Anke,

Damsgård, & Røe, 2013; Björnsdóttir, Jónsson, & Valdimarsdóttir, 2014; Boonstra et al., 2013; McNamee & Mendolia, 2014). Thus, it seems that fibromyalgia, similarly to other chronic pain conditions, imposes a burden on levels of subjective well-being in general and, particularly, on positive affect.

To the best of our knowledge, this is the first case-control study analysing levels of emotional repair and optimism in fibromyalgia and it demonstrates that women with the disease also have deficits in cognitive- and personality-related aspects of positive psychology. Reduced levels in emotional repair (González, V., Ramírez-Maestre, C., & Herrero, 2007) and optimism (Ramírez-Maestre, Esteve, & López, 2012) have been previously observed in other populations with chronic pain. Thus, our findings extend previous observations from other chronic pain populations to fibromyalgia.

Previous studies concluded that more favourable levels of positive affect and negative affect (Hassett et al., 2008; van Middendorp et al., 2008; Alex J Zautra, Fasman, et al., 2005), satisfaction with life (Raak, Hurtig, & Wahren, 2003), emotional repair (Luque-Reca et al., 2019) and optimism (Jansen et al., 2011) are associated with better adaptation to fibromyalgia (e.g., lower pain (A J Zautra et al., 2005), fatigue (Alex J Zautra, Fasman, Parish, & Davis, 2007) and disease severity (Estévez-López et al., 2015)). Therefore, they are considered resources of adaptation to fibromyalgia. As a group, women with fibromyalgia showed the largest deficit in positive affect and large deficits in negative affect and satisfaction with life. Thus, therapies may focus on enhancing subjective well-being as a priority when aiming at increasing positive psychology. The results of different studies collected in a previous meta-analysis revealed that positive psychology interventions do indeed significantly enhance well-being (Sin & Lyubomirsky, 2009). It is also important to note that fibromyalgia is a heterogeneous population (Estévez-López et al., 2017) and that decisions about aims of the therapy should be defined by a process

of shared-decision making with the person with the disease (Doebel, Macfarlane, & Hollick, 2020; Macfarlane et al., 2017).

Some limitations of the present study need to be mentioned. This study was conducted only in women and the findings are not generalisable to men. The study was cross-sectional designed. Thus, it precludes to determine the causality of the associations under study. Additionally, a group of people with a chronic disease similar to fibromyalgia (e.g., chronic fatigue syndrome or bowel syndrome) was not included. Thus, it is unknown whether our findings are specific to fibromyalgia or generalisable to other similar diseases. Future longitudinal research including women and men as well as another disease control group is of interest. Strengths of the present study are the inclusion of (i) a large sample, (ii) a comprehensive assessment of the affective-, cognitive- and personality-related aspects of positive psychology, (iii) a corroboration by the research team that cases meet the diagnosis of fibromyalgia by a physical examination and controls did not meet so.

## **CONCLUSIONS**

Women with fibromyalgia have lower values of positive affect, satisfaction with life, emotional repair and optimism and higher values of negative affect than women without fibromyalgia. Large effect sizes were found for positive affect, negative affect and satisfaction with life. Thus, to develop tailored therapies for fibromyalgia focusing on enhancing deficits on positive psychology resources may be of clinical interest, which remains to be corroborated in future research.

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## 7.2. STUDY 2 – Independent associations of physical activity with positive psychology resources in women with fibromyalgia: the Al-Ándalus project

**Study 2: Independent associations of Physical Activity with Positive Psychology Resources in women with Fibromyalgia: the Al-Ándalus Project**

**SUBMITTED**

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**ABSTRACT**

**Objective:** To examine the independent association of objectively measured physical activity levels and daily steps with positive psychology resources (positive and negative affect, satisfaction with life, dispositional optimism and emotional repair) in women with fibromyalgia. **Methods:** Four hundred and nineteen ( $51.8 \pm 7.9$  years old) women with fibromyalgia participated. Physical activity levels (light, moderate, and, vigorous), and daily steps were measured with triaxial accelerometry. The levels of (i) subjective well-being on the Positive and Negative Affect Schedule and the Satisfaction with Life Scale, (ii) dispositional optimism on the Life Orientation Test-Revised, and (iii) emotional repair on the Trait Meta-Mood Scale were reported by the participants themselves. **Results:** Regression models revealed positive independent associations between light physical activity and daily steps with positive affect, satisfaction with life, dispositional optimism, and emotional repair ( $\beta$  ranging from 0.162 to 0.221 and 0.113 to 0.147 respectively; all,  $p < 0.05$ ). Daily steps were negatively associated with negative affect ( $\beta=0.014$ ;  $p < 0.05$ ). Overall, participants on the highest tertiles of light physical activity had better scores of positive affect, satisfaction with life, dispositional optimism, and emotional repair (Cohen's  $d$  between 0.33 and 0.49). Participants on the highest tertiles

of daily steps had better scores of positive affect, satisfaction with life and emotional repair (Cohen's  $d$  between 0.31 and 0.38). **Conclusions:** higher levels of light physical activity and daily steps but not moderate-to-vigorous physical activity are associated with higher positive affect, satisfaction with life, dispositional optimism and emotional repair, as well as, lower negative affect. To avoid a decrease in their levels of positive psychological resources, patients should aim to be in the second or third tertile for both light physical activity and daily steps. In this population, future physical activity and daily steps intervention studies could benefit from these noteworthy results.

## **KEYWORDS**

GT3X+; accelerometry; affect; dispositional optimism; emotional intelligence; fibromyalgia; resilience (psychological); subjective well-being; vulnerability (psychological).

## **INTRODUCTION**

Fibromyalgia is a syndrome characterized by chronic and widespread musculoskeletal pain, often accompanied by other symptoms, such as fatigue, intestinal disorders and alterations in sleep and mood (Siracusa, Di Paola, Cuzzocrea, & Impellizzeri, 2021). Additionally, people with fibromyalgia experience deficits in positive psychology resources, defined as people's ability to maintain positive functioning in the face of adversity and challenges (Castleden, McKee, Murray, & Leonardi, 2011; Luthar, Cicchetti, & Becker, 2000), such as positive affect, satisfaction with life, optimism and emotional repair (Arrayás-Grajera et al., 2021). People with fibromyalgia usually reduce their physical activity to prevent an aggravation of their symptomatology (Björnsdóttir, Jónsson, & Valdimarsdóttir, 2013; Mcloughlin, Colbert, Stegner, & Cook, 2011).

However, avoiding physical activity negatively impacts psychological health (Fernando Estévez-López et al., 2015; Gavilán-Carrera et al., 2022; Lee et al., 2017; Luque-Reca et al., 2022; Mcloughlin et al., 2011; Soriano-Maldonado et al., 2016). To date, most of the psychology research has investigated mental illness and negative constructs of psychological health (Seligman & Csikszentmihalyi, 2000) while omitting positive psychology resources. A recent review on fibromyalgia (Vancampfort et al., 2022) relates physical activity to different variables and the majority of the psychological variables studied were negative. To understand whether physical activity is associated with positive psychology resources is of relevance to inform interventions.

Subjective well-being is a positive psychology resource that has two principal components: emotional (affect) and cognitive (satisfaction with life) (Diener, Emmons, Larsen, & Griffin, 1985). Although scarce research has studied the associations of physical activity with positive and negative affect in people with fibromyalgia, Munguía-Izquierdo et al. showed that more total physical activity was associated with better subjective well-being (Munguía-Izquierdo et al., 2021). To the best of our knowledge, the relationship of physical activity with satisfaction with life remains to be explored in fibromyalgia.

Dispositional optimism is the generalized expectancy that good things will happen in the future and bad things will be minimal (Scheier, Carver, & Bridges, 1994). Emotional repair is the perceived ability of people to regulate their emotional states themselves (Ruiz-Aranda, Salguero, & Fernández-Berrocal, 2010), enhancing positive states and minimizing negative ones. In fibromyalgia, higher levels of optimism and emotional repair have been associated with better health-related outcomes. For instance, higher optimism was associated with fewer perceived barriers to goal attainment during disease flares (Affleck et al., 2001; Jansen et al., 2011). Similarly, lower emotion perception and

management abilities were associated with more widespread pain (González et al., 2007). However, to the best of our knowledge, the association of physical activity with optimism and emotional repair has not been investigated in fibromyalgia.

Collectively, it appears that more physical activity may be associated with more positive psychological resources. However, previous literature is limited because did not comprehensively investigate different dimensions of objectively measured physical activity and positive psychology resources. Therefore, we aimed to examine the association of objectively measured physical activity (i.e., light, moderate and vigorous physical activity as well as the number of daily steps) with positive psychology resources (i.e., positive affect, satisfaction with life, dispositional optimism and emotional repair) and negative affect in women with fibromyalgia.

## **MATERIALS AND METHODS**

### ***Participants***

To ensure a representative sample of people with fibromyalgia from the Andalusian population in southern Spain, the required sample size was calculated (n=300) and was described elsewhere (Segura-Jiménez, et al. 2015). Participants from the eight provinces of Andalusia (southern Spain) were recruited through local fibromyalgia associations via e-mail, letters, telephone, or university press. All potential participants (n = 607) gave their written informed consent after receiving detailed information about the study's aims and procedures before taking part in the study. The inclusion criteria for participants were as follows: (1) being an adult woman (aged 18 to 65 years old) (21 men were excluded); (2) a medical diagnosis of fibromyalgia from a rheumatologist (participants were requested to provide their medical records to confirm their diagnosis); and (3) meeting the 1990 American College of Rheumatology (ACR) fibromyalgia criteria (Segura-

Jiménez, et al., 2014; Wolfe et al., 1990) (99 women were excluded). Additionally, women with fibromyalgia with either acute/terminal illness (such as cancer, stroke, recent cardiopathy, severe coronary disease, schizophrenia or any other disabling injury) (two women were excluded) or severe cognitive impairment, as defined by a score of less than ten on the Mini-Mental State Examination (MMSE) (Folstein, Folstein, & McHugh, 1975; Lobo, Ezquerra, Gómez Burgada, Sala, & Seva Díaz, 1979), were excluded (one woman was excluded). Thus, 484 women with fibromyalgia met the inclusion criteria. All tests were performed by the same trained group of researchers to reduce inter-examiner error. The study was reviewed and approved by the Ethics Committee of the Hospital Virgen de las Nieves (Granada, Spain), registration number: 15/11/2013-N72 and The ethical guidelines of the Declaration of Helsinki (modified in 2000) were followed.

### *Measures*

The Mini-Mental State Examination (MMSE) (Folstein et al., 1975; Lobo et al., 1979) was used as a screening test to determine whether a participant had experienced severe cognitive impairment (i.e., an exclusion criterion). The MMSE assesses five areas of cognitive function: orientation, immediate memory, attention/concentration, delayed recall, and language.

Sociodemographic data were recorded using a self-report questionnaire in which participants indicated their date of birth, marital status (i.e., married, single, separated, divorced, and widowed), education level (i.e., unfinished studies, primary studies, secondary studies, and university studies), time since fibromyalgia diagnosis (<1, 1–5, and >5 years), and time since first symptoms until fibromyalgia diagnosis (<1, 1–5, and >5 years).

Physical examination of tender points according to the 1990 ACR fibromyalgia criteria (Segura-Jiménez, et al., 2014; Wolfe et al., 1990) was performed using a standard pressure algometer (FPK 20; Wagner Instruments, Greenwich, CT, USA). Trained researchers performed this examination. Participants who (i) reported widespread musculoskeletal pain for at least 3 months and (ii) reported pain at a pressure of  $\leq 4$  kg/cm<sup>2</sup> in at least 11 tender points were classified as meeting the 1990 ACR fibromyalgia criteria.

Body weight (kg) and total body fat (%) were assessed via bioelectrical impedance using the InBody R20 body composition analyzer (Biospace). Patients were instructed not to shower, engage in intense physical activity, or consume significant amounts of food or liquids within two hours prior to the measurement. Patients removed their clothing and any metal objects from their bodies during the evaluation.

#### ***Positive and negative affect***

The Positive and Negative Affect Schedule (PANAS) is a questionnaire, consisting of 20 items, that measures positive and negative affect using a 5-point Likert scale (ranging from 1 = “very slightly or not at all” to 5 = “extremely”). This scale, which has been validated for fibromyalgia (Estévez-López et al., 2016), produces scores that range from 10 to 50, with higher scores indicating higher levels of positive or negative affect. In this study, we used the trait time-frame version of the PANAS with “in general” instructions. In line with previous research (Estévez-López et al., 2016; Sandin et al., 1999; Watson, Clark, & Tellegen, 1988), the psychometric properties of the subscales in our study were satisfactory, obtaining a Cronbach's alpha of 0.91 for both positive and negative affect.

#### ***Satisfaction with life***

The Satisfaction with Life Scale (SWLS) is a questionnaire, comprising five items that utilizes a 7-point Likert scale (ranging from 1 = “strongly disagree” to 7 = “strongly

agree”), to assess satisfaction with life. The SWLS score ranges from 5 to 35, with higher scores indicating greater satisfaction with life. In this study, the Cronbach’s alpha coefficient for the satisfaction with life scale was 0.86 (Atienza, Pons, Balaguer, & Garcia-Merita, 2000; Diener et al., 1985).

### ***Dispositional optimism***

The Life Orientation Test-Revised (LOT-R) is a questionnaire consisting of ten items that utilize a 5-point Likert scale (ranging from 0 = “strongly disagree” to 4 = “strongly agree”) to measure dispositional optimism. The LOT-R includes three positively worded items (e.g., “I’m always optimistic about my future”), three negatively worded items (e.g., “I hardly ever expect things to go my way”), and four fillers that are not considered in the LOT-R score. The LOT-R score ranges from 0 to 24, with higher scores indicating greater dispositional optimism. In this study, Cronbach’s alpha coefficient for optimism was 0.70 (Ferrando, Chico, & Tous, 2002; Landero Hernández & González Ramírez, 2009; Otero, Luengo, Romero, Gómez, & Castro, 1998; Scheier, Carver, & Bridges, 1994).

### ***Emotional repair***

The Trait Meta-Mood Scale (TMMS) assesses three dimensions of emotional intelligence. In the present study, only the emotional repair subscale (TMMS-ER) is administered, which is composed of eight items using a 5-point Likert scale (from 1 = “strongly disagree” to 5 = “strongly agree”). The TMMS-ER score ranges from 8 to 40, with higher scores indicating a perceived ability to enhance positive emotional states and minimize negative ones. The Cronbach’s alpha coefficient for emotional repair in this study was 0.90 (Fernandez-Berrocal, Extremera, & Ramos, 2004; Salovey, Mayer, Goldman, Turvey, & Palfai, 1995).

### ***Physical activity levels and daily steps***

Patients wore the GT3X+ triaxial accelerometer (ActiGraph) on the hip for 9 days, 24 hours per day, except during water-based activities. Activity counts were measured at a rate of 30 Hz and stored at an epoch length of 1 minute (Sasaki, John, & Freedson, 2011). Accelerometer-wearing time was obtained by subtracting the sleeping time and non-wearing periods from each day. Sleeping time was obtained from a sleep diary in which patients reported the time they went to bed and the time they woke up. Non-wearing periods were obtained by applying Choi's algorithm (Choi, Ward, Schnelle, & Buchowski, 2012). Bouts of 90 continuous minutes of 0 counts were considered non-wearing periods. A total of seven continuous days of recording, with a minimum of 10 valid hours per day, was the minimum criterion for inclusion in the study analysis. Light, moderate and vigorous physical activity levels and daily steps were calculated based on the recommended physical activity vector magnitude cut-off points (Aguilar-Farías, Brown, & Peeters, 2014; Sasaki et al., 2011): 200-2689, 2690-6166 and  $\geq 6167$  counts per minute, respectively. Data download, reduction, cleaning, and analyses were performed using ActiGraph desktop software, ActiLife, version 6.11.7.

### ***Procedure***

Assessments were performed over three consecutive days. On day 1, the MMSE was conducted, fibromyalgia diagnosis was confirmed, sociodemographic data were collected, body composition was evaluated and a tender point examination was conducted. On day 2, participants completed the PANAS, SWLS, LOT-R, and TMMS-ER questionnaires at home without supervision. On day 3, the participants returned the questionnaires to the research team, who reviewed all of them, and potential doubts were resolved. Subsequently, a GT3X+ triaxial accelerometer was given to the patients to wear

on the hip for 9 days, and a sleep diary. After 9 days, the patients returned the accelerometer and sleep diary.

### *Statistical Analysis*

Descriptive statistics included means and standard deviations for continuous variables and frequencies and percentages for categorical variables. Internal consistency of the instruments was assessed using Cronbach's  $\alpha$  coefficient with acceptable values  $\geq 0.70$  (Nunnally & Bernstein, 1994). The association of physical activity levels and daily steps with positive psychological resources was analyzed using linear regression. Positive psychological resources were entered as dependent variables in separate models, and each of the physical activity levels and daily steps measures were entered as independent variables. The models were adjusted for potential confounders (age and fat percentage). The normality assumption (assessed with Q-Q plots), as well as the linearity and homoscedasticity assumptions (assessed through studentized residuals) were reasonably met. Furthermore, global physical activity profile was divided into tertiles (where tertile 1 [T1] represented the group with the lowest physical activity levels and the fewest daily steps group and tertile 3 [T3] represented the group with the highest physical activity levels and most daily steps group). The differences in the positive psychological resources between tertiles were used to assess the potential clinical relevance of physical activity levels and daily steps in relation to positive psychological resources in women with fibromyalgia, and one-way analysis of covariance (ANCOVA) with SNK (Student-Newman-Keuls) for multiple comparisons was used to assess the differences in the positive psychological resources (dependent variable) across physical activity levels and daily steps tertiles (independent variable). Age and fat percentage were included as covariates. The effect size was calculated using Cohen's  $d$  (standardized mean

differences) to measure the differences on positive psychological variables between physical activity and daily steps tertiles. Cohen's *d* values were interpreted as small (~0.2), medium (~0.5), or large (~0.8) (Nakagawa & Cuthill, 2007). All analyses were performed using the Statistical Package for the Social Sciences (IBM SPSS Statistics for Windows, version 26.0; Armonk, NY, USA), and the level of statistical significance was set at  $\alpha = 0.05$  (two-tailed).

## **RESULTS**

A total of 484 participants agreed to wear an accelerometer, 55 women did not meet the accelerometer criteria, and 10 had missing fat percentage data. Therefore, the final sample was comprised of 419 women with fibromyalgia. The clinical characteristics of the patients are summarized in Table 1. About half of the sample had been diagnosed for more than five years (56.8%) and had a 5-year experience of symptoms prior to diagnosis (47.5%) at the time of the study. Three out of four women with fibromyalgia were married (76.1%) and slightly more than half had incomplete or primary studies (58.5%). More than 90% of the physical activity performed was light physical activity, and the average number of daily steps per patient was slightly higher than 7,000 steps.

**Table 1.** Clinical characteristics of the sample (n = 419)

Variables	Mean (SD) or n (%)
Age (years), mean (SD)	51.8 (7.9)
Total Body Fat percentage, mean (SD)	40.1 (7.6)
Time since fibromyalgia diagnosis (years), mean (SD)	5.81 (1.7)
< 1 year, <i>n</i> (%)	30 (7.2)
1-5 years, <i>n</i> (%)	140 (33.4)
> 5 years, <i>n</i> (%)	238 (56.8)
Missing data	11 (2.6)
Time since first symptoms until fibromyalgia diagnosis (years), mean (SD)	5.36 (1.9)
< 1 year, <i>n</i> (%)	38 (9.1)
1-5 years, <i>n</i> (%)	170 (40.6)
> 5 years, <i>n</i> (%)	199 (47.5)
Missing data	12 (2.9)
Marital status	
Married, <i>n</i> (%)	319 (76.1)
Single, separated, divorced or widowed, <i>n</i> (%)	100 (23.9)
Educational level	
Unfinished or primary studies, <i>n</i> (%)	245 (58.5)
Secondary studies, <i>n</i> (%)	116 (27.7)
University degree, <i>n</i> (%)	58 (13.8)
Positive affect (PANAS, 10 to 50), mean (SD)	22.8 (6.7)
Negative affect (PANAS, 10 to 50), mean (SD)	23.9 (8.3)
Satisfaction with life (SWLS, 5 to 35), mean (SD)	14.1 (4.5)
Optimism (LOT-R, 6 to 24), mean (SD)	6.9 (2.7)
Emotional repair (TMMS-ER, 8 to 40), mean (SD)	22.8 (7.3)
Light physical activity (min/day), mean (SD)	417.6 (92.0)
Moderate physical activity (min/day), mean (SD)	43.3 (29.3)
Vigorous physical activity (min/day), mean (SD)	0.40 (1.9)
Average daily steps, mean (SD)	7268.4 (2920.5)

PANAS, Positive and Negative Affect Schedule; SWLS, Satisfaction with Life Scale; LOT-R, Life Orientation Test-Revised; TMMS-ER, Trait Meta Mood Scale, emotional repair subscale; SD, standard deviation.

The independent associations of physical activity levels and daily steps with positive psychological resources are shown in Table 2. The analyses revealed positive independent associations between light physical activity (min/day) with positive affect, satisfaction with life, dispositional optimism, and emotional repair (all,  $p < 0.01$ ). Average daily steps was positively independently associated with dispositional optimism and emotional repair (both,  $p < 0.01$ ), and also independently associated with positive affect and satisfaction

with life (both,  $p < 0.05$ ). Negative independent associations were found between average daily steps and negative affect ( $p < 0.05$ ).

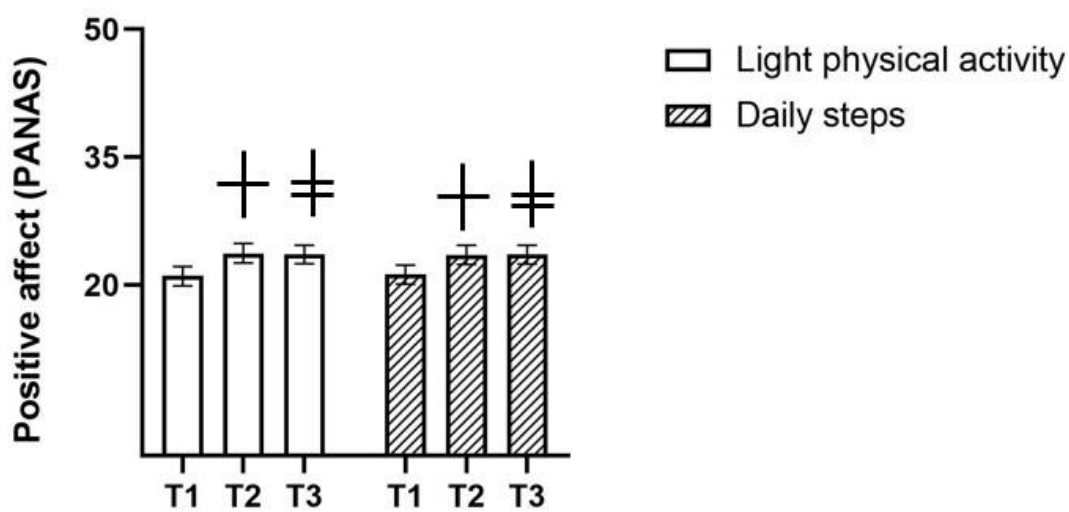
**Table 2.** Independent associations of physical activity levels and daily steps with positive psychology resources in women with fibromyalgia ( $n = 419$ )

		<i>b</i>	SE	$\beta$	$\Delta$ Adj. $R^2$
Positive affect	Light physical activity (min/day)	0.016	0.004	0.221**	0.049**
	Moderate physical activity (min/day)	0.012	0.011	0.053	0.004
	Vigorous physical activity (min/day)	0.181	0.171	0.052	0.004
	Daily steps (n/day)	0.000	0.000	0.142*	0.021*
Negative affect	Light physical activity (min/day)	-0.006	0.004	-0.070	0.024
	Moderate physical activity (min/day)	-0.019	0.014	-0.069	0.024
	Vigorous physical activity (min/day)	-0.089	0.209	-0.021	0.020
	Daily steps (n/day)	0.000	0.000	-0.014*	0.032*
Life satisfaction	Light physical activity (min/day)	0.008	0.002	0.162**	0.029**
	Moderate physical activity (min/day)	0.014	0.008	0.089	0.011
	Vigorous physical activity (min/day)	0.195	0.114	0.084	0.011
	Daily steps (n/day)	0.000	0.000	0.113*	0.016*
Optimism	Light physical activity (min/day)	0.005	0.001	0.179**	0.036**
	Moderate physical activity (min/day)	0.007	0.005	0.077	0.010
	Vigorous physical activity (min/day)	0.099	0.070	0.070	0.009
	Daily steps (n/day)	0.000	0.000	0.145**	0.024**
Emotional repair	Light physical activity (min/day)	0.016	0.004	0.201**	0.036**
	Moderate physical activity (min/day)	0.017	0.013	0.070	0.001
	Vigorous physical activity (min/day)	0.362	0.186	0.096	0.006
	Daily steps (n/day)	0.000	0.000	0.147**	0.017**

*b*: unstandardized regression coefficient;  $\beta$ : standardized regression coefficient with significance levels of *t*; *SE*: standard error;  $\Delta$  Adj.  $R^2$ : change in adjusted  $R^2$  with significance levels of *F*-change. All analyses were adjusted for age and fat percentage (%), which were entered into the first step. \* $p < 0.05$ ; \*\*  $p < 0.01$ .

The positive affect values across tertiles based on the distribution of the data for light physical activity and daily steps are plotted in Figure 1. There were differences in the positive affect score between the tertiles of light physical activity ( $F = 7.008$ ,  $p = 0.001$ ), and daily steps ( $F = 5.463$ ,  $p = 0.005$ ). The post-hoc analysis revealed that patients with the lowest light physical activity (1<sup>st</sup> tertile) presented lower positive affect scores than

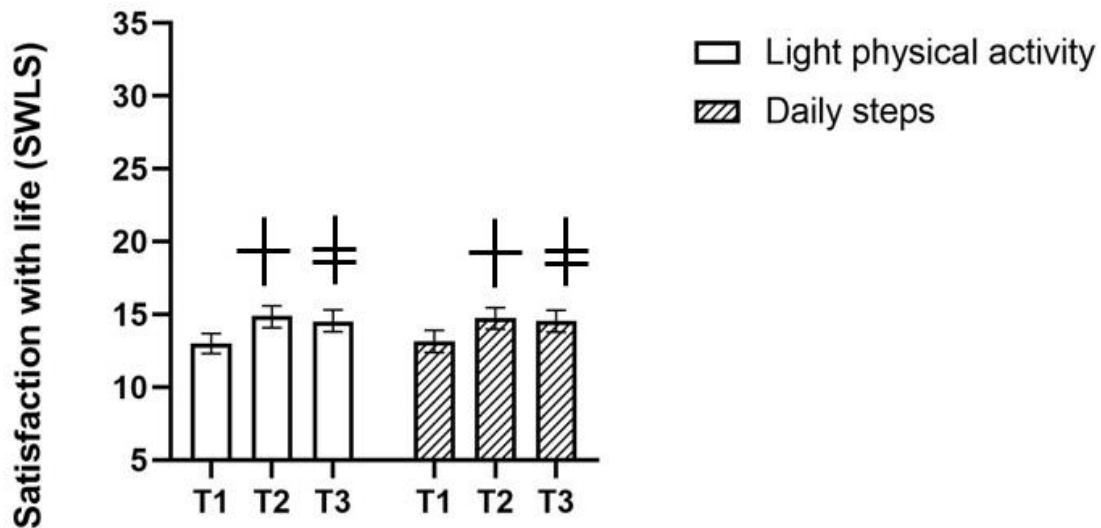
those in the 2<sup>nd</sup> and 3<sup>rd</sup> tertiles (21.1 vs 23.7 and 23.6 respectively; both  $p < 0.01$ ). Similarly, patients with the fewest daily steps (1<sup>st</sup> tertile) presented lower positive affect scores than those in the 2<sup>nd</sup> and 3<sup>rd</sup> tertiles (21.2 vs 23.6 and 23.6 respectively; both  $p = 0.01$ ). The effect sizes of all post-hoc analyses were between small and medium (between 0.31 and 0.39). A similar analysis was conducted with negative affect values across tertiles based on the distribution of the data for daily steps but no differences were found.



**Figure 1.** Positive affect values across tertiles based on the distribution of light physical activity data and daily steps. PANAS = Positive and Negative Affect Schedule; † = Significant differences between mean change of tertile 1 vs tertile 2. ‡ = Significant differences between mean change of tertile 1 vs tertile 3.

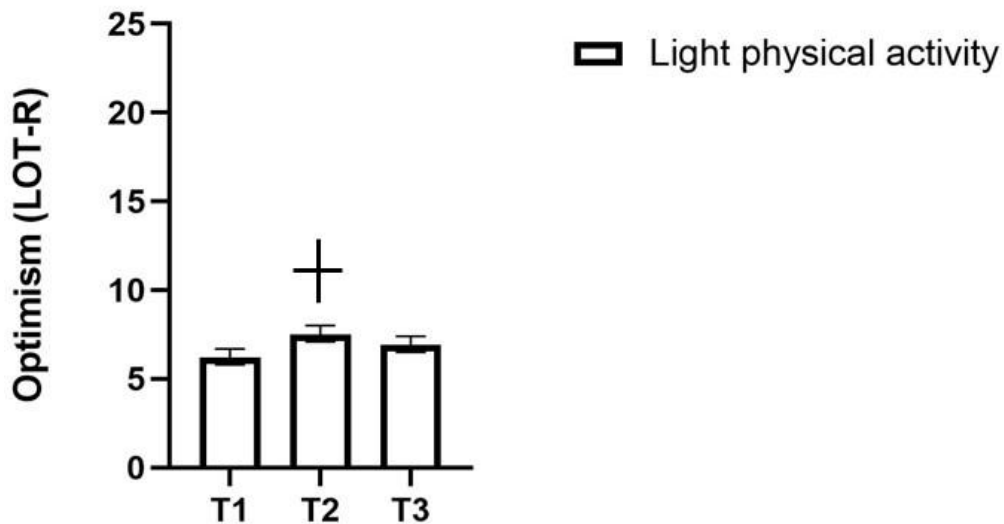
Satisfaction with life scores across tertiles, based on the distribution of the data for light physical activity, and daily steps, are shown in Figure 2. There were differences in satisfaction with life scores between the tertiles of light physical activity ( $F = 7.147$ ,  $p < 0.01$ ), and daily steps ( $F = 4.998$ ,  $p < 0.01$ ). Post-hoc analysis revealed that patients with the lowest light physical activity (1<sup>st</sup> tertile) presented lower satisfaction with life scores than those in the 2<sup>nd</sup> and 3<sup>rd</sup> tertiles (13.0 vs 14.9 and 14.5 respectively;  $p < 0.01$  and  $p =$

0.02 respectively), and those patients with the fewest daily steps (1<sup>st</sup> tertile) presented lower satisfaction with life scores than those in the 2<sup>nd</sup> and 3<sup>rd</sup> tertiles (13.1 vs 14.7 and 14.5 respectively;  $p = 0.01$  and  $p = 0.03$ ). The effect sizes of all post-hoc analyses were between small and medium (between 0.31 and 0.40).



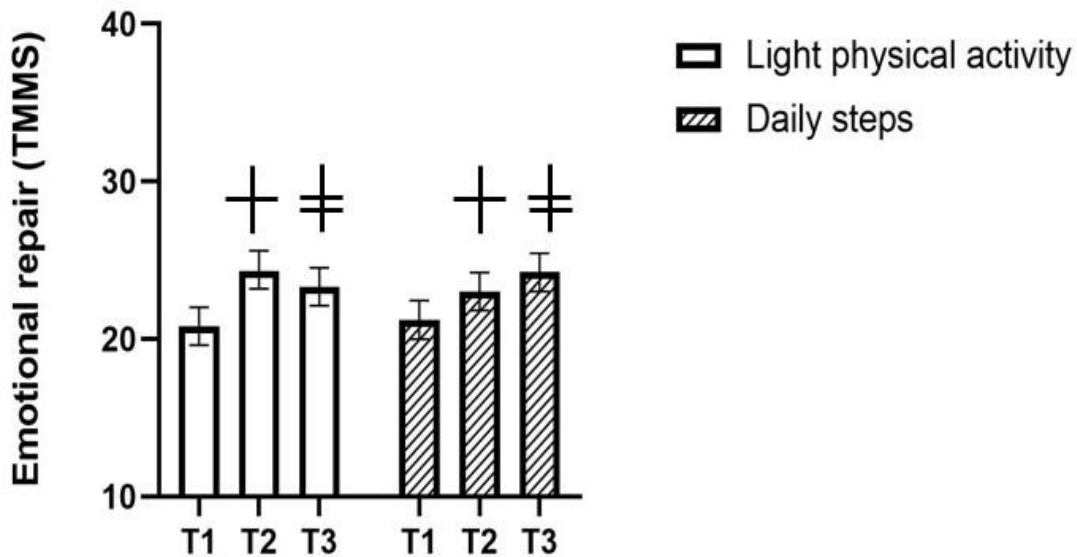
**Figure 2.** Satisfaction with life values across tertiles based on the distribution of light physical activity data and daily steps. SWLS = Satisfaction with Life Scale; † = Significant differences between mean change of tertile 1 vs tertile 2. ‡ = Significant differences between mean change of tertile 1 vs tertile 3.

There were differences in dispositional optimism scores between the tertiles of light physical activity ( $F = 7.661$ ,  $p < 0.01$ ) (Figure 3), but not for daily steps ( $F = 3.025$ ,  $p = 0.050$ ). The post-hoc analysis revealed that patients with the lowest light physical activity (1<sup>st</sup> tertile) presented lower dispositional optimism scores than those in the 2<sup>nd</sup> tertile (6.2 vs 7.5;  $p < 0.01$ ). The effect size of the post-hoc analyses was medium (0.46).



**Figure 3.** Optimism values across tertiles based on the distribution of light physical activity data and daily steps. LOT-R = Life Orientation Test-Revised; † = Significant differences between mean change of tertile 1 vs tertile 2. ‡ = Significant differences between mean change of tertile 1 vs tertile 3.

The emotional repair scores across tertiles based on the distribution of the data for light physical activity, and daily steps are shown in Figure 4. There were differences in the emotional repair scores between the tertiles of light physical activity ( $F = 8.870, p < 0.01$ ), and daily steps ( $F = 5.811, p < 0.01$ ). The post-hoc analysis revealed that patients with the lowest light physical activity (1<sup>st</sup> tertile) presented lower emotional repair scores than those in the 2<sup>nd</sup> and 3<sup>rd</sup> tertiles (20.8 vs 24.3 and 23.3, respectively;  $p < 0.01$  and  $p = 0.010$  respectively). Finally, patients with the fewest daily steps (1<sup>st</sup> tertile) presented lower emotional repair scores than those in the 3<sup>rd</sup> tertile (21.2 vs 24.2;  $p < 0.01$ ). The effect sizes of all post-hoc analyses were between small and medium (between 0.37 and 0.49).



**Figure 4.** Emotional repair values across tertiles based on the distribution of light physical activity data and daily steps. TMMS = Trait Meta-Mood Scale; † = Significant differences between mean change of tertile 1 vs tertile 2. ‡ = Significant differences between mean change of tertile 1 vs tertile 3.

## DISCUSSION

This study in women with fibromyalgia aimed at examining the cross-sectional independent associations of objectively measured physical activity levels with positive psychology resources. We found a remarkably robust pattern of independent associations showing that a global measure of physical activity (i.e., number of steps) was associated with more positive psychology resources (i.e., positive affect, satisfaction with life, optimism and emotional repair). These independent associations seemed to be specifically driven by light physical activity. In general, we found no robust independent associations of (i) moderate or vigorous physical activity with positive psychology resources and (ii) any physical activity measure with negative affect. To better understand the associations under study, we conducted additional analyses using tertiles of the

physical activity resulting in findings that were relatively consistent with the primary analyses (i.e., continuous scores of physical activity).

In fibromyalgia, there are no specific guidelines for the number of daily steps. However, the recommendation of 10,000 steps/day is widely accepted by the general population (Tudor-locke et al., 2011). Two recent meta-analysis (del Pozo Cruz, Gallardo-Gomez, del Pozo-Cruz, & Ding, 2022; Paluch et al., 2022) have reported slightly lower recommended steps per day (around 8000) by the general population. Women with fibromyalgia are less physically active than control peers (Segura-Jiménez, et al., 2015). Importantly, only 16% of women with fibromyalgia met the recommendations of 10,000 steps/day (Segura-Jiménez, et al., 2015). A prior intervention demonstrated that increasing the number of steps led to lower fibromyalgia severity and pain (Fontaine, Conn, & Clauw, 2010). In this line, our results also suggest a positive independent association between more steps and more positive psychological resources (higher levels of positive affect, satisfaction with life, dispositional optimism and emotional repair).

Prior research from our team highlighted the particularly promising role of light physical activity in fibromyalgia. Specifically, more light physical activity has shown associations with less pain, fatigue and fibromyalgia severity (Segura-Jiménez et al., 2017) as well as more quality of life (Gavilán-Carrera, 2019). In the present study, we extend that association from other health-related outcomes to positive psychology resources. In line with present findings ( $n=419$ ), a prior study observed associations between more light physical activity and more positive affect in 231 women with fibromyalgia (Ecija, Catala, Velasco, Pastor-Mira, & Peñacoba, 2022). Here, we found no associations between light physical activity and negative affect. Wiese, et al., (2018) proposed a hypothesis to explain the lack of association between physical activity and negative affect suggesting that rather than directly reducing negative affect, leisure-time physical activity may act

as a protective factor. Therefore, any influence of light physical activity would impact the protection against negative affect, potentially masking any observable effects. In summary, the present study showed that more light physical activity is associated with more positive psychology resources such as positive affect, satisfaction with life, dispositional optimism and emotional repair.

In our study, light physical activity was the only physical activity level associated with all psychological resources except negative affect, not being so for moderate and vigorous physical activity. A recent research has shown that moderate to vigorous physical activity is not associated with depressive symptoms and state anxiety in 386 women with fibromyalgia (Gavilán-Carrera et al., 2022). On the contrary, when sedentary time is theoretically substituted with moderate-to-vigorous physical activity in women with fibromyalgia (n=407), better scores in physical role, social functioning, and function were detected (Gavilán-Carrera, et al., 2019).

Taking all the above into account, our results suggest that women with fibromyalgia should be encouraged to increase their level of activity to reach the second and ideally third tertile of physical activity. This suggestion of avoiding the first tertile has been also recommended in the study by Soriano et al. (Soriano-Maldonado et al., 2015), in relation to the impact of the disease, in that of Segura-Jimenez et al. (Segura-Jiménez et al., 2017) in relation to the impact of the disease, pain, and fatigue. Along these lines, a previous study found that accumulating 30 minutes of a physically active lifestyle throughout the day produced clinically relevant changes in perceived physical function and pain in sedentary patients with fibromyalgia (Fontaine et al., 2010).

The results of this study show the relationship between light physical activity, and daily steps with the positive psychological resources presented by women with fibromyalgia, specifically subjective well-being (positive affect and satisfaction with life), optimism,

and emotional repair. This manifests a clinical relevance of the relationship established between physical activity, and positive psychology in patients with fibromyalgia, since it can be said that carrying out any physical activity, even if it is light, can increase the presence of positive psychology resources. Therefore, the clinical objective that we could consider is to promote an increase in physical activity, even if it is light.

This study presents some limitations. First, its cross-sectional design prevents investigating the temporality of the associations. All variables were assessed at a single time point, providing a measure of the intensity of the variables. However, it is recommended to incorporate repeated measurements over an extended period, such as assessing the frequency of affective well-being, to gain a more comprehensive understanding. Thus, longitudinal and intervention studies are required. Second, due to the small size of men, only women were analysed and our findings may not be generalisable to men. Third, participants were recruited mostly via local fibromyalgia associations and cultural differences in the experience of having fibromyalgia are plausible and don't let us generalize our findings to other populations with fibromyalgia not only outside of Spain but within Spain as well. Fourth, since participation in the study relied on volunteers, better psychological and physical health might be expected among the study sample than among the general population of people with fibromyalgia. Fifth, several variables were assessed using self-report instruments. However, although misreported answers are feasible, most of the questionnaires used in the present study have been shown to be reliable and valid in this population.

This study also has strengths. Physical activity was objectively measured using accelerometers, which is considered a more reliable and valid assessment than questionnaires (Segura-Jiménez, et al., 2014). The relatively large sample size, representative of the southern Spanish population of women with fibromyalgia is also a

strength (Segura-Jiménez, et al., 2015). We also corroborated the fibromyalgia diagnosis according to the 1990 ACR FM criteria.

## **CONCLUSIONS**

In a large sample of women with fibromyalgia, a global measure of physical activity (i.e., number of steps) was associated with more positive psychology resources (i.e., positive affect, satisfaction with life, optimism and emotional repair). This association seemed to be specifically driven by light physical activity. If this finding is corroborated in experimental research, gentle physical activity interventions of light intensity may help to improve deficits in positive psychological resources often experienced by women with fibromyalgia.

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### 7.3. STUDY 3 – Effects of land- and water-based exercise on positive psychology resources in women with fibromyalgia: the Al-Ándalus quasi- experimental study

### **Study 3: Effects Of Land- And Water-Based Exercise On Positive Psychology Resources In Women With Fibromyalgia: The Al-Ándalus Quasi-Experimental Study**

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#### **ABSTRACT**

**Objective:** the aims of this study were to assess (i) the effects of 24-weeks of land- and water-based exercise on positive psychology resources (e.g., positive affect, life satisfaction, emotional repair and optimism) in women with fibromyalgia and (ii) the persistence of the changes in these outcomes after 12 weeks of follow-up. **Methods:** 250 women with fibromyalgia ( $50.8 \pm 7.6$  years old) were assigned to one of three groups: the land-based exercise group (n=83), the water-based exercise group (n=85) or the control group (n=82). Participants themselves reported their (i) subjective well-being using the Positive and Negative Affect Schedule and Satisfaction with Life Scale, (ii) dispositional optimism through the Life Orientation Test-Revised, and (iii) emotional repair according to the Trait Meta-Mood Scale. **Results:** per-protocol analyses showed that after 24 weeks of intervention, the water-based exercise group improved positive affect compared to the control group (MDs ranging from 0.2 to 4.9, Cohen's  $d= 0.3$ ). No more statistical differences between groups were found. When we analyse the per-protocol differences between groups for changes after exercise cessation (week 36), no differences were found between groups. **Conclusions:** no effects of the physical exercise intervention on positive psychology resources were observed. As an exception, participants who engaged in water-based exercise improved their positive affect in comparison to those in the control

group but such enhancement was not sustained after a 12-week follow-up period of physical exercise cessation.

## **KEYWORDS**

Fibromyalgia; exercise; programme; affect; life satisfaction; subjective well-being; dispositional optimism; emotional intelligence; resilience (psychological); vulnerability (psychological).

## **INTRODUCTION**

Fibromyalgia is characterised by chronic widespread pain of unknown aetiology (Häuser et al., 2015). The definition of fibromyalgia has been updated over the years and currently involves the presence of pain and additional symptoms, such as stiffness, fatigue, restless sleep and cognitive difficulties (Jahan, Nanji, Qidwai, & Qasim, 2012; Wolfe et al., 2010, 1990). The worldwide prevalence of fibromyalgia is around 2%, being more common in women than in men (Queiroz, 2013; Wolfe, Walitt, Perrot, Rasker, & Ha, 2018). Women with fibromyalgia often experience poor mental health, e.g., the prevalence of depression and anxiety is high in people with fibromyalgia; namely, 43% and 30% respectively (Kleykamp et al., 2021).

Traditionally, the literature in fibromyalgia has primarily focused on negative psychology resources (e.g., anxiety and depression) (Seligman & Csikszentmihalyi, 2000) omitting the study of positive psychology resources (e.g., positive affect and satisfaction with life). We have recently demonstrated that, in comparison to age- and sex-matched peers, women with fibromyalgia have deficits in positive psychology resources (Arrayás-Grajera, et al., 2021) which may hamper their adaptation to living with this chronic disease (Zautra, Johnson, & Davis, 2005a). Although physical exercise is the only therapy

supported by “strong” evidence (Macfarlane et al., 2017), past literature has not examined the effects of physical exercise on positive psychology resources. Additionally, the setting in which physical exercise is performed may influence the outcomes. Particularly, it is unclear whether land-based exercise or water-based exercise is more advisable in fibromyalgia (Estévez-López et al., 2021). Also, the long-term effects of physical exercise in fibromyalgia are unknown because it is often omitted the study of the persistence of the changes in outcomes after physical exercise cessation (Estévez-López et al., 2021). Thus, to address these questions is of clinical interest.

Therefore, this study aimed to assess (i) the effects of 24-week of land- and water-based exercise on positive psychology resources (e.g., positive affect, life satisfaction, emotional repair and optimism) in women with fibromyalgia and (ii) the persistence of the changes in these outcomes 12 weeks follow-up period after physical exercise cessation. These are secondary analyses derived from the al-Ándalus trial, designed to primarily evaluate the efficacy of land and water-based exercise in improving the overall impact of fibromyalgia (primary outcome measure) (Carbonell-Baeza et al., 2012).

## **METHODS**

### **Study design**

The present study reports secondary outcomes of the al-Ándalus quasi-experimental study, which was approved by the Medical Ethics Committee of Hospital Virgen de las Nieves in Granada, Spain (registration number: 15/11/2013-N72). The ethical guidelines of the declaration of Helsinki were followed. This study was pre-registered in ClinicalTrials.gov (NCT01490281). All participants had to provide a written informed consent. More information on the design and procedures of the al-Ándalus quasi-experimental study is provided elsewhere.(Carbonell-Baeza et al., 2012)

### **Sample recruitment and follow-up**

In this multicentre study, participants were recruited from local fibromyalgia patient associations in seven provinces of Andalusia in southern Spain. Each of these provinces hosted a designated centre for recruitment purposes. A comprehensive outreach strategy, including email, postal communication, phone contact and web-based advertising, was employed to recruit potential participants. The assessments were conducted at baseline, at the end of the exercise intervention (24 weeks) and 12 weeks after physical exercise cessation. The measurements were performed at the local fibromyalgia patient associations, Universities or sport facilities. Assessments took place on 3 consecutive days. On the first day, the inclusion criteria were confirmed (e.g., the Physical Activity Readiness Questionnaire (PAR-Q) and Mini Mental State Examination (MMSE) were interviewed), the anthropometry and body composition were assessed and sociodemographic and clinical data were self-reported. On the second day, participants completed the Positive and Negative Affect Schedule (PANAS), Satisfaction with Life Scale (SWLS), Life Orientation Test Revised (LOT-R) and emotional repair subscale of the Trait Meta-Mood Scale (TMMS-ER) at home without supervision. On the third day, the participants returned the questionnaires to the research team, who reviewed all of them, and potential doubts were resolved. Next, a GT3X+ triaxial accelerometer was given to the patients to wear on the hip for 9 days, and a sleep diary. After 9 days, the patients returned the accelerometer and sleep diary.

### **Inclusion and exclusion criteria**

Before starting the study, all potential participants underwent a detailed screening process. Inclusion criteria required that individuals met the following: (i) to be 35-65

years old, (ii) to be previously diagnosed with fibromyalgia by a rheumatologist and meeting the American College of Rheumatology (ACR) criteria (Wolfe et al., 1990) (iii) answer “no” to all questions on the PAR-Q,(Cardinal, Esters, & Cardinal, 1996) (iv) not to be engaged in regular physical activity (>20 min on >3 days/week) in the past 3 months, (v) be able to communicate in Spanish, and (vi) be able to walk without assistance. Exclusion criteria were (i) being men, (ii) to have an acute or terminal illness, (iii) unstable medical condition, (iv) severe dementia (MMSE <10),(Folstein, Folstein, & McHugh, 1975) (v) refusal to comply with study conditions or to be randomly assigned to the training or control group, and (vi) presence of neuromuscular disease or drugs affecting neuromuscular function.

### **Allocation and blinding**

Although this study was initially designed as a randomised controlled trial, randomisation was not always possible because of difficulties in accessing pools that maintained a suitable temperature (~30°C) at some study settings. Thus, randomisation (computer-generated random sequence) was limited to 1 province (32.4% of participants), whereas participants in the other provinces were allocated to the exercise group (i.e., land-based or water-based exercise) or control group depending on the possibility of accessing appropriate facilities. Because of the nature of the intervention (physical exercise), it was not possible to blind participants. Assessors were not blinded to group allocation during the evaluations.

### **Intervention**

Regardless of which group they belonged to, all the participants continued with their usual care during the study.

The interventions were performed in different waves from 2011 to 2013, between November and May. The land-based and water-based intervention groups followed the same protocol: 3 days/week of training (45-60 min per session) for a 24-week period. The intervention included exercises aiming to improve cardiovascular endurance, muscle strength, and joint range of motion. The exercise interventions met the minimum training standards of the American College of Sports Medicine (ACSM) (Garber et al., 2011) and each session was supervised by an exercise monitor.

Each session lasted 45-60 minutes and included a warm-up (8-10 minutes), conditioning (muscle-strengthening and aerobic exercises, 15-25 minutes each), and a cool-down (10 minutes). The warm-up comprised mobility exercises and global movements. Muscle-strengthening exercises progressed from 1 set of 4 exercises with 12 repetitions (week 1) to 3 sets of 10 exercises with 16 repetitions (week 24). Intensity was adjusted using the perceived exertion scale (RPE, Borg scale: 6-20 points), (Borg, 1982) starting at 6-11 (week 1) and reaching 13-17 (week 24). Aerobic exercises lasted 15-25 minutes, and intensity ranged from 40%-50% of heart rate reserve (week 1) to 65%-80% of heart rate reserve (week 24). Cool down included stretching and relaxation.

Exercise progression started with an increase in volume and then the load was intensified. Identical protocols were used in both settings to compare the interventions, but the water-based exercise intervention was carried out in a chest-high (~120 cm) warm (~30°C) pool.

#### *Usual care group (control)*

Participants allocated to the usual care (control) group, where usual care conditions were maintained, received general information about fibromyalgia and generic tips on the positive effects of physical activity. Information leaflets describing the benefits of

physical activity and general guidelines on how to increase daily physical activity levels were provided. After the follow-up assessment, these participants were offered to participate in the exercise interventions, not for research purposes.

## **Measurements**

***Sociodemographic and clinical data*** (e.g., sex, age and time since diagnosis) were collected through a self-reported questionnaire. Moreover, weight (kg) was measured with a bioimpedance device (InBody R20, Seoul, Korea), height (m) was measured using a stadiometer (Seca 22, Hamburg, Germany), and body mass index (BMI) was calculated (kg/m<sup>2</sup>).

***Positive and negative affect***: The PANAS (Watson, Clark, & Tellegen, 1988) is a 20-item questionnaire designed to measure positive and negative affectivity. The questionnaire includes 10 positive and 10 negative emotional states that should be answered on a 5-point Likert scale. The negative and positive subscales represent two relatively independent scales. Higher scores reflect higher positive or negative affect.

***Satisfaction with life***: The SWLS (Diener, Emmons, Larsen, & Griffin, 1985) was designed to assess global life satisfaction. The SWLS consists of five items with a 7-point Likert-scale from "strongly disagree" to "strongly agree". Higher scores reflect better satisfaction with life.

***Emotional repair***: The Trait Meta Mood Scale – Emotion Regulation (TMMS-ER) (Fernandez-Berrocal, Extremera, & Ramos, 2004) consists of 8 items assessing how well individuals regulate their moods and repair negative emotional experiences (e.g., "when I become upset, I remind myself of all the pleasures in life"). Participants rate their responses using a 5-point Likert type scale, with 1 = "strongly disagree" to 5 = "strongly agree". Higher scores reflect better emotional repair.

**Optimism:** The Life Orientation Test-Revised (LOT-R) (Scheier, Carver, & Bridges, 1994) is a 10-item scale that assesses people expectations about their future and their general sense of optimism. It is comprised of 3 positively worded (e.g., "I'm always optimistic about my future"), 3 negatively worded items (e.g., "I hardly ever expect things to go my way") and the other 4 are filler questions. Each item is rated on a 5-point Likert type scale ranging from one ("strongly disagree") to five ("strongly agree"). Higher scores reflect better dispositional optimism.

### **Sample Size**

The sample size of this study was initially calculated to detect a clinically relevant change in fibromyalgia severity (primary outcome) measured using the total score of Fibromyalgia Impact Questionnaire (FIQ). Accordingly, we target on requiring a total of 135 participants (45 in each group)(Carbonell-Baeza et al., 2012).

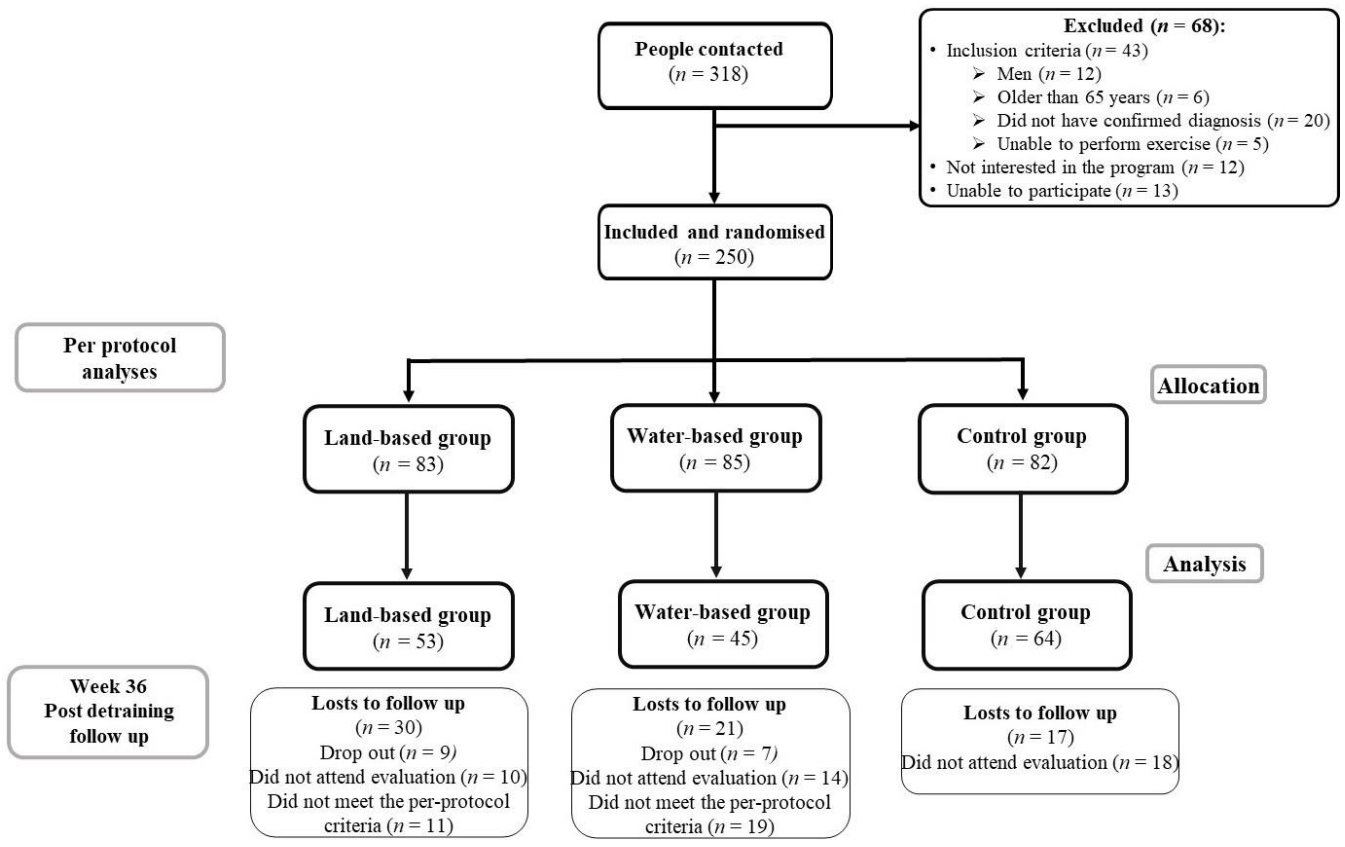
### **Statistical Analysis**

The normal distribution of the data was assumed due to the relatively large sample size. Descriptive characteristics of the sample are presented as mean and standard deviation (SD) or frequency and percentage when appropriate. Baseline characteristics between groups were compared through the Student's t test (for continuous variables) and the Chi square test (for categorical variables). To examine differences between groups we conducted a repeated measures ANCOVA with group as the independent variable, scores on positive psychology resources as the dependent variable (i.e., baseline assessment, the 24-week post-intervention assessment and 12-week follow-up) and age, fat percentage, pain levels, light physical activity and moderate physical activity as the confounders. Cohen's d was used to calculate the standardised effect size and was interpreted as small

(>0.2), medium (>0.5) or large ( $\geq 0.8$ ). The main effects of the exercise intervention were tested with the per-protocol approach, including only those participants attending at least 70% of the sessions. Multiple imputation methodology was used for imputing missing values at weeks 24 and 36. All analyses were performed using Statistical Package for Social Sciences (SPSS, IBM Corporation version 25.0; Armonk, NY) and the level of significance was set at  $p < 0.05$  (two-tailed).

## **RESULTS**

From the initial 318 potential participants who were contacted, a total of 250 met the inclusion criteria, provided written informed consent and were included in the study. Next, they were then assigned to one of three groups: the land-based exercise group ( $n=83$ ), the water-based exercise group ( $n=85$ ) or the control group ( $n=82$ ). Figure 1 shows the flowchart of the participants in this study. During the trial, the mean attendance was 83% for the land-based exercise group and 79% for the water-based exercise group. A total of 65% in the land-based group and 54% in the water-based group attended at least 70% of the sessions. No significant differences between groups at baseline were found in the variables ( $p > 0.05$ ), except for educational level ( $p > 0.01$ ). Table 1 shows the baseline characteristics of the participants in the study.



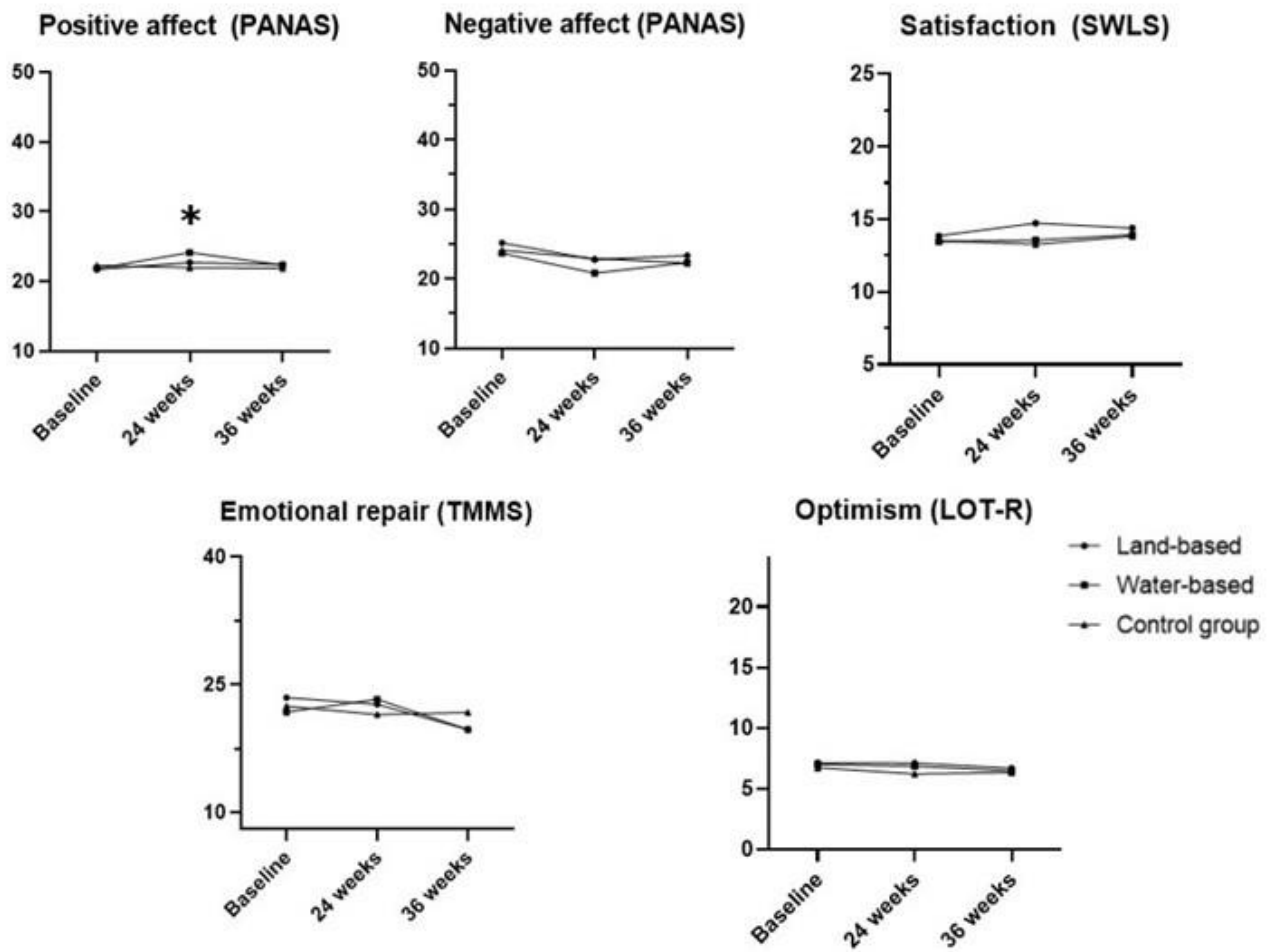
**Figure 1.** Consort flowchart of the sample recruited for this study.

**Table 1.** Baseline characteristics of the participants.

	All (n=250)		Land-based (n=83)		Water-based (n=85)		Control (n=82)		<i>p-value</i>
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Age	50.8	7.6	49.8	7.2	52.3	8.2	50.4	7.2	0.07
Body Mass Index (kg/m <sup>2</sup> )	28.6	5.6	27.7	5.2	29.5	5.6	28.6	5.9	0.11
Missing data <i>n</i> (%)	2 (1)		0 (0)		2 (2.4)		0 (0)		
Positive affect (PANAS 10-50)	22.1	6.6	21.6	6.8	22.4	6.3	22.8	6.9	0.75
Missing data <i>n</i> (%)	2 (0.8)		1 (1.2)		1 (1.2)		0 (0)		
Negative affect (PANAS 10-50)	24.5	8.3	26.1	9.3	23.3	7.2	24.1	8.1	0.08
Missing data <i>n</i> (%)	2 (0,8)		1 (1,2)		1 (1,2)		0 (0)		
Life satisfaction (SWLS 5-25)	13.6	4.7	13.4	5.0	14.0	4.7	13.5	4.3	0.69
Missing data <i>n</i> (%)	2 (0.8)		1 (1.2)		1 (1.2)		0 (0)		
Emotional repair (TMMS 8-40)	22.2	7.3	22.5	7.5	21.6	6.5	22.5	7.8	0.67
Missing data <i>n</i> (%)	2 (0.8)		1 (1.2)		1 (1.2)		0 (0)		
Optimism (LOT-R 0-24)	6.8	2.7	7.0	2.5	6.7	2.7	6.7	2.9	0.70
Missing data <i>n</i> (%)	2 (0.8)		1 (1.2)		1 (1.2)		0 (0)		
	<i>n</i>	%	<i>n</i>	%	<i>N</i>	%	<i>N</i>	%	<i>P-value</i>
Educational level									
University	31	12	16	18	3	4	12	15	<b>&gt;0.01</b>
Non-university	218	87	67	81	81	95	70	85	
Missing data	1	1	0	0	1	1	0	0	
Marital status									
Married	184	74	63	76	63	75	58	71	0.74
Not married/Single/Separated	65	26	20	24	21	25	24	29	
Time from diagnosis									
Less than 1 year	20	8	6	6	6	7	8	10	0.77
From 1 to 5 years	95	38	34	42	34	40	27	33	
More than 5 years	120	52	43	49	43	51	46	56	
Missing data	6	2	3	3	2	2	1	1	
Time since first symptoms									
Less than 1 year	24	10	6	7	10	12	8	10	0.88
From 1 to 5 years	106	42	35	42	37	44	34	42	
More than 5 years	113	45	39	47	36	42	38	47	
Missing data	7	3	3	4	2	2	2	2	

PANAS= Positive Affect and Negative Affect Scale; SWLS= Satisfaction with Life Scale; LOT-R=Revised Life Orientation Test; TMMS= Trait Meta-Mood Scale;

Figure 2 shows the evolution of the means in the outcomes (positive affect, negative affect, satisfaction with life, emotional repair and optimism) for each intervention group at each assessment point: baseline, post-exercise program (week 24) and 12 weeks after exercise cessation in per-protocol analyses.



**Figure 2.** Means of positive and negative affect, satisfaction with life, emotional repair and optimism variables at baseline, at week 24 (after exercise intervention program) and at week 36 (12 weeks after exercise cessation) for each intervention group in per-protocol analyses. PANAS= Positive Affect and Negative Affect Scale; SWLS= Satisfaction with Life Scale; LOT-R=Revised Life Orientation Test; TMMS= Trait Meta-Mood Scale; \*Significant differences between mean change of water vs control group.

Table 2 shows the per-protocol analyses assessing the differences in the values of the outcomes between groups after the 24 weeks of intervention. The water-based exercise group improved positive affect compared to the control group (MDs ranging from 0.2 to 4.9, Cohen's  $d=0.3$ ). No more statistical differences between groups were found.

**Table 2.** Differences in positive and negative affect, satisfaction with life, emotional repair and optimism between groups after 24 weeks of water or land-based exercise: per-protocol analyses.

	Water vs Control					Land vs Control					Water vs Land					
	Mean difference	SE	(95% CI)		<i>P</i>	<i>d</i>	Mean difference	SE	(95% CI)		<i>P</i>	Mean difference	SE	(95% CI)		<i>P</i>
Positive affect (PANAS)	<b>2.56</b>	<b>0.99</b>	<b>0.17</b>	<b>4.93</b>	<b>0.03</b>	<b>0.3</b>	1.46	0.93	-0.80	3.71	0.36	1.10	1.07	-1.48	3.68	0.91
Negative affect (PANAS)	-1.74	1.18	-4.59	1.11	0.42		-1.24	1.12	-3.94	1.47	0.81	-0.51	1.28	-3.60	2.58	0.99
Life satisfaction (SWLS)	0.40	0.67	-1.21	2.01	0.99		1.35	0.63	-0.18	2.87	0.10	-0.95	0.72	-2.69	0.80	0.57
Emotional repair (TMMS)	2.64	1.19	-0.23	5.51	0.08		0.36	1.13	-2.36	3.08	0.99	2.28	1.29	-0.83	5.39	0.24
Optimism (LOT-R)	0.45	0.41	-0.54	1.45	0.83		0.46	0.39	-0.49	1.41	0.72	-0.011	0.45	-1.09	1.07	0.99

NOTE. Data are presented as estimated mean difference between groups, SE, and 95% CI. *P* values obtained from post-hoc Bonferroni corrections from the repeated-measures Ancova. Abbreviations: PANAS= Positive Affect and Negative Affect Scale; SWLS= Satisfaction with Life Scale; LOT-R=Revised Life Orientation Test; TMMS= Trait Meta-Mood Scale..

Table 3 shows the per-protocol analyses assessing the differences between groups for changes after exercise cessation (week 36). However, we did not find statistical significant differences between groups.

**Table 3.** Differences in positive and negative affect, satisfaction with life, emotional repair and optimism between groups 12 weeks after water or land-based exercise cessation: per-protocol analyses.

	Water vs Control					Land vs Control					Water vs Land				
	Mean difference	SE	(95% CI)		<i>P</i>	Mean difference	SE	(95% CI)		<i>P</i>	Mean difference	SE	(95% CI)		<i>P</i>
Positive affect (PANAS)	0.90	1.20	-1.99	3.80	0.99	1.171	1.13	-1.57	3.91	0.99	-0.27	1.30	-3.40	2.87	0.99
Negative affect (PANAS)	0.40	1.30	-2.74	3.54	0.99	-0.034	1.23	-3.01	2.94	0.99	0.44	1.41	-2.97	3.85	0.99
Life satisfaction (SWLS)	0.06	0.65	-1.50	1.63	0.99	0.16	0.61	-1.33	1.64	0.99	-0.09	0.70	-1.79	1.60	0.99
Emotional repair (TMMS)	-1.21	1.25	-4.24	1.82	0.99	-0.54	1.19	-3.42	2.33	0.99	-0.67	1.36	-3.95	2.62	0.99
Optimism (LOT-R)	-0.09	0.49	-1.27	1.10	0.99	-0.06	0.46	-1.18	1.06	0.99	-0.03	0.53	-1.30	1.25	0.99

NOTE. Data are presented as estimated mean difference between groups, SE, and 95% CI. P values obtained from post-hoc Bonferroni corrections from the repeated-measures Ancova. Abbreviations: PANAS= Positive Affect and Negative Affect Scale; SWLS= Satisfaction with Life Scale; LOT-R=Revised Life Orientation Test; TMMS= Trait Meta-Mood Scale.

## **DISCUSSION**

This study aimed at examining (i) the effects of 24-weeks of land- and water-based exercise on positive psychology resources in women with fibromyalgia and (ii) the persistence of the changes in these outcomes 12 weeks after physical exercise cessation. In general, we observed no effects of the interventions. As an exception, the water-based exercise group showed an improvement in positive affect compared to the control group at the end of the exercise intervention (week 24), which was not maintained after a 12-weeks period of physical exercise cessation (week 36).

Previous literature demonstrated that physical exercise has positive effects on negative psychology resources such as, for instance, depression (Andrade et al., 2020; Kundakci et al., 2022; Tomas-Carus et al., 2007) (sample size = 22 patients with fibromyalgia and exercise duration = 12 weeks; sample size = 2013 (35 studies in a systematic review and meta-analysis); sample size = 17 patients with fibromyalgia and exercise duration = 12 weeks respectively) and anxiety (McDowell, Cook, & Herring, 2017; Tomas-Carus et al., 2007) (sample size = 298 patients with fibromyalgia and exercise duration = ranged between 8 and 32 weeks (meta-analysis); sample size = 17 patients with fibromyalgia and exercise duration = 12 weeks respectively). In the present study, however, we observed that women with fibromyalgia did not improve their satisfaction with life, emotional repair and dispositional optimism when engaging in a physical exercise programme. Thus, our intervention seems not to be effective for improving positive psychology resources in women with fibromyalgia. Accordingly, we speculate that the design of our physical exercise intervention was not optimal. Particularly, the intervention was not specifically designed for improving positive psychology resources because the primary outcome of the intervention was fibromyalgia severity. In this line, a recent systematic review has highlighted that exercise intervention targeting self-esteem, self-concept, and

self-efficacy may result in better mental health (Nguyen Ho et al., 2023). However, our intervention did not pay attention to any of these psychological mechanisms. Thus, future interventions should be designed as outcome-specific instead of designing “fix-all” exercise interventions (Estévez-López et al., 2021).

A promising approach for promoting self-esteem, self-concept, and self-efficacy in relation to physical exercise in women with fibromyalgia may be to tackle cognitive barriers (e.g., fear of pain or fear of movement) that may prevent them from comfortably engage in physical exercise (Nijs et al., 2013; Turk, Robinson, & Burwinkle, 2004; Vancampfort et al., 2022). In this line, we have recently suggested that women with fibromyalgia may benefit from having access to a brief prehabilitation intervention, a combination of education and behaviour change, before engaging in physical exercise or activity (Courel-Ibáñez et al., 2023). Our rationale is that such a prehabilitation approach may promote positive feelings for movement helping to overcome fears, which in turn may result in higher adherence to and better effects of the physical exercise intervention (Courel-Ibáñez et al., 2023). Another approach may be to focus on improving the overall health status of women with fibromyalgia through practicing activities of daily living (Henriksson et al., 1992; White, Harth, & Teasell, 1995), which refers to people’s beliefs about their own capacity (Bandura, 1999). This is strongly related with better results of recovery (Beal, Stuifbergen, & Brown, 2009; Oliver & Cronan, 2005) and may in turn increase functional status and self-efficacy (Law, Mok, Yau, & Fong, 2022).

The present study shows that water-based exercise may help to improve positive affect in women with fibromyalgia. Interestingly, positive affect is a key factor of adaptation to fibromyalgia (Munguía-Izquierdo et al., 2021; Sturgeon & Zautra, 2013; Zautra, Johnson, & Davis, 2005b). Although experimental research is scarce, our finding is in line with systematic reviews and meta-analyses that have concluded that to engage in physical

activity has benefits in positive affect across the lifespan including children, adolescents and adults (Rodriguez-Ayllon et al., 2019; Wiese, Kuykendall, & Tay, 2018) . Thus, if our finding is replicated in an independent sample, we extend the benefits of physical exercise for positive affect from the general population to women with fibromyalgia.

Some limitations of the present study need to be mentioned. First, our sample was composed of women recruited mostly through local fibromyalgia associations in southern Spain. Thus, our findings may not be generalisable to men or women from other regions or cultures. Second, it is possible that the study sample may have a higher health status than the general population of women with fibromyalgia as they were willing to participate in a physical exercise intervention. This study has also strengths. We included a control group, two physical exercise settings (land and water) and a 12-week post-physical exercise cessation assessment.

## **CONCLUSIONS**

In general, we observed no effects of the physical exercise intervention on positive psychology resources. As an exception, participants who engaged in water-based exercise improved their positive affect in comparison to those in the control group but such enhancement was not sustained after a 12-week period of physical exercise cessation. Future studies should analyse if other physical exercise intervention designed to target self-esteem, self-concept and self-efficacy could increase positive psychology resources.

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# **8. GENERAL DISCUSSION**

## 8. GENERAL DISCUSSION

The rationale of this thesis is provided in the general introduction. Briefly, fibromyalgia, is characterised by widespread pain and imposes a substantial societal and individual burden. While extensive research has examined the negative aspects of mental health in fibromyalgia, there is a paucity of studies addressing positive psychology resources, including subjective well-being, dispositional optimism and emotional repair. The relationship between physical activity and positive psychology resources in fibromyalgia remains inadequately elucidated, as does the determination of optimal physical activity intensity for individuals with this condition. Furthermore, the impact of land-based versus water-based exercise, as well as the long-term effects of exercise cessation, require in-depth investigation. A more comprehensive understanding of these associations holds potential implications for enhanced fibromyalgia management and overall well-being. Therefore, overall aim of this Doctoral Thesis was to improve positive psychology resources in people with fibromyalgia.

8.1. Women with fibromyalgia experience deficits in positive psychology resources [Study I]

Positive affect has received much attention in women with fibromyalgia as it is a key factor in adaptation to the disease (Estévez-López et al., 2015; Goubert & Trompetter, 2017; Holmes, 2017; León-Vega & Arias-Congrains, 2012; van Middendorp et al., 2008; Zautra, Johnson, & Davis, 2005). Indeed, Zautra et al., (2005) and Hassett et al., (2008) underlined that, in women with fibromyalgia, positive affect is more deteriorated than in women without fibromyalgia (healthy peers) or women with other rheumatic conditions (e.g., osteoarthritis). We observed similar finding in southern Spanish women with fibromyalgia. Importantly, previous case–control studies did not examine others positive

psychology resources. For the first time, we have shown that women with fibromyalgia do not only experience deficits in positive affect but also in life satisfaction, dispositional optimism and emotional repair. This finding is in line with several previous studies on chronic musculoskeletal pain (Anke, Damsgård, & Røe, 2013; Björnsdóttir, Jónsson, & Valdimarsdóttir, 2014; Boonstra, Reneman, Stewart, Post, & Schiphorst Preuper, 2013; González, Ramírez-Maestre, & Herrero, 2007; McNamee & Mendolia, 2014; Ramírez-Maestre, Esteve, & López, 2012). Previous studies concluded that more favourable levels of positive affect (Hassett et al., 2008; van Middendorp et al., 2008; Zautra et al., 2005), satisfaction with life (Raak, Hurtig, & Wahren, 2003), emotional repair (Luque-Reca et al., 2019) and dispositional optimism (Jansen, Linder, Ekholm, & Ekholm, 2011) are associated with lower pain (Zautra et al., 2005), fatigue (Zautra, Fasman, Parish, & Davis, 2007) and fibromyalgia severity (Estévez-López et al., 2015). Therefore, positive psychology resources are considered key factors of adaptation to fibromyalgia and deficits in positive affect, dispositional optimism and emotional repair may be clinically relevant.

## 8.2. Light physical activity is associated with positive psychology resources [Study II]

Traditional health promotion focuses on Moderate to Vigorous Physical Activity but emerging evidence suggests that light physical activity may benefit health, especially for people who are inactive or unfit (Batacan Jr, Duncan, Dalbo, Tucker, & Fenning, 2015; Chastin et al., 2019). Our group has previously shown that women with fibromyalgia who do more light physical activity have less fibromyalgia symptoms (Segura-Jiménez et al., 2017) and more health-related quality of life (Gavilán-Carrera, 2019). The findings of the present Doctoral Thesis confirm a cross-sectional association of objectively measured

light physical activity with positive psychology resources. Indeed, we found that this association was remarkably robust for all the positive psychology resources examined; namely, positive affect, satisfaction with life, optimism and emotional repair. Interestingly, we found no robust independent associations of Moderate to Vigorous Physical Activity with any positive psychology resource. This finding is in line with a recent study from our team showing that Moderate to Vigorous Physical Activity is not associated with depressive symptoms and state anxiety in women with fibromyalgia (Gavilán-Carrera et al., 2022).

8.3. Our physical exercise intervention did not improve positive psychology resources [Study III]

Physical exercise is the only therapy supported by “strong” evidence for fibromyalgia (Macfarlane et al., 2017). However, past literature has not examined the effects of physical exercise on positive psychology resources. Thus, we investigated the impact of a 24-week land- and water-based exercise intervention on positive psychology resources in women with fibromyalgia, as well as the persistence of these changes after 12 weeks of follow-up. The overall findings showed no significant effects of the interventions on positive psychology resources, except for the water-based exercise group, which demonstrated a temporary improvement in positive affect at the end of the exercise program (week 24), but this improvement was not maintained after the 12-week period of exercise cessation (week 36). While previous research has indicated positive effects of physical exercise on negative psychology resources, such as depression and anxiety, we did not find improvements in satisfaction with life, emotional repair or dispositional optimism among women with fibromyalgia engaging in the exercise intervention. We speculate that future interventions should be designed with a focus on specific

psychological mechanisms, such as self-esteem, self-concept and self-efficacy, to promote better mental health outcomes (Nguyen Ho et al., 2023). Additionally, addressing cognitive barriers (e.g., fears) related to physical exercise and designing a programme that is meaningful for women with fibromyalgia preferences and needs may enhance adherence and effectiveness (Courel-Ibáñez et al., 2023; Estévez-López et al., 2021). Our findings suggest water-based exercise may improve positive affect in women with fibromyalgia, which is crucial for adaptation to the disease. However, further research is needed to validate these findings in larger and more diverse populations.

# 9. CONCLUSIONS

## 9. CONCLUSIONS

The **general conclusion** of this Doctoral Thesis is that women with fibromyalgia exhibit deficits in positive psychology resources. Although higher levels of light physical activity were robustly associated with more positive psychology resources, a physical exercise intervention did not consistently enhance these resources.

The **specific conclusion** of each study is as follows:

- In comparison to age- and sex-matched peers, women with fibromyalgia showed lower positive psychology resources [**Study I**].
- In women with fibromyalgia, to engage more in light physical activity was associated with better positive psychology resources [**Study II**].
- A physical exercise intervention, regardless of land- or water-based, had no effects on positive psychology resources in women with fibromyalgia. The only exception was that positive affect increased in those who engaged in water-based exercise but this benefit was not maintained after 12 weeks of follow-up [**Study III**].

# **10. CONCLUSIONES**

## 10. CONCLUSIONES

La **conclusión general** de esta Tesis Doctoral es que las mujeres con fibromialgia presentan déficits en recursos de psicología positiva. Aunque niveles más altos de actividad física ligera estuvieron consistentemente asociados con mayores recursos de psicología positiva, una intervención de ejercicio físico no mejoró de manera consistente dichos recursos.

Las **conclusiones específicas** de cada estudio son las siguientes:

- En comparación con mujeres sin fibromialgia de la misma edad, las mujeres con fibromialgia mostraron peores recursos de psicología positiva [**Estudio I**].
- En mujeres con fibromialgia, realizar más actividad física ligera se asoció con mejores recursos de psicología positiva [**Estudio II**].
- Una intervención de ejercicio físico, ya sea en seco o en agua, no tuvo efectos significativos en los recursos de psicología positiva en mujeres con fibromialgia. La única excepción fue un aumento en el afecto positivo en aquellas que participaron en ejercicio acuático, pero este beneficio no se mantuvo tras 12 semanas de seguimiento al finalizar la intervención [**Estudio III**].

# **11. LIMITATIONS AND STRENGTHS**

## 11. LIMITATIONS AND STRENGTHS OF THE DOCTORAL THESIS

In the Table 2, a summary of the main limitations and strengths related to the studies of this doctoral thesis is shown.

**Table 2.** Limitations and strengths of the Doctoral Thesis studies

LIMITATIONS	STRENGTHS
<ul style="list-style-type: none"> <li>- All the studies were conducted only in women and the findings are not generalisable to men.</li> </ul>	<ul style="list-style-type: none"> <li>- We included a large sample.</li> </ul>
<ul style="list-style-type: none"> <li>- All the studies were cross-sectional designed. Thus, it precludes to determine the causality of the associations under study.</li> </ul>	<ul style="list-style-type: none"> <li>- We did a comprehensive assessment of the affective-, cognitive- and personality-related aspects of positive psychology.</li> </ul>
<ul style="list-style-type: none"> <li>- Additionally, a group of people with a chronic disease similar to fibromyalgia (e.g., chronic fatigue syndrome or bowel syndrome) was not included. Thus, it is unknown whether our findings are specific to fibromyalgia or generalisable to other similar diseases.</li> </ul>	<ul style="list-style-type: none"> <li>- We focused in corroborate that cases meet the diagnosis of fibromyalgia by a physical examination and controls did not meet so.</li> </ul>
<ul style="list-style-type: none"> <li>- The exercise intervention programme was not specifically designed for improving positive psychology resources which may explain some results.</li> </ul>	<ul style="list-style-type: none"> <li>- Physical activity was objectively measured using accelerometers, which is considered a more reliable and valid assessment than questionnaires.</li> <li>- In the third study we included a control group, two physical exercise settings (land and water) and a 12-week follow-up.</li> </ul>

# **12. MAIN CONTRIBUTIONS AND FUTURE RESEARCH DIRECTIONS**

## 12. MAIN CONTRIBUTIONS AND FUTURE RESEARCH DIRECTIONS OF THE DOCTORAL THESIS

In the Table 3, a summary of the main contributions and future research directions related to the studies of the doctoral thesis is shown.

**Table 3.** Main contribution of the doctoral thesis and future research directions.

MAIN CONTRIBUTION	FUTURE RESEARCH DIRECTIONS
<ul style="list-style-type: none"> <li>- Our first study is the first case-control study analysing levels of emotional repair and optimism in fibromyalgia and it demonstrates that women with the disease also have deficits in cognitive- and personality-related aspects of positive psychology</li> <li>- In our second study, we found a remarkably robust pattern of independent associations showing that a global measure of physical activity was associated with more positive psychology resources.</li> <li>- In the same study, the results suggest that women with fibromyalgia should be encouraged to increase their level of activity to avoid the first tertile of physical activity.</li> <li>- These results manifests a clinical relevance of the relationship established between physical activity, and positive psychology in patients with fibromyalgia, since it can be said that carrying out any physical activity, even if it is light, can increase the presence of positive psychology resources.</li> </ul>	<ul style="list-style-type: none"> <li>- Future longitudinal research including women and men as well as another disease control group is of interest.</li> <li>- Future intervention research are required.</li> <li>- Future studies should analyse if other physical exercise intervention designed to target self-esteem, self-concept and self-efficacy could increase positive psychology resources</li> </ul>

# **13. REFERENCES**

### 13. REFERENCES

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<https://doi.org/10.1037/0022-006X.73.2.212>

# **14. SHORT CV**

## **14. SHORT CV**

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#### 14.1. Academic training

- PhD STUDENT IN OFFICIAL DOCTORAL PROGRAM IN PHYSICAL EDUCATION AND SPORTS. Faculty of Education, Psychology and Sports Sciences, University of Huelva. Date: 2016-2023.
- MÁSTER DEGREE IN PHYSICAL EDUCATION AND SPORTS. Faculty of Education, Psychology and Sports Sciences, University of Huelva. Date: 2010-2011.
- GRADUATE DEGREE IN PHYSICAL ACTIVITY AND SPORTS SCIENCE. Faculty of health, physical activity and sports sciences. Catholic University of Murcia. Date: 2004-2007.
- GRADUATE DEGREE IN PHYSICAL EDUCATION. Faculty of education sciences. University of Huelva. 2001-2004.
- RESEARCH STAY (3 months). Sports subdepartment. Higher School of Education of the Polytechnic Institute of Beja (Portugal). Date: 02/02/2014 to 30/04/14.
- RESEARCH STAY (3 months). Sports subdepartment. Higher School of Education of the Polytechnic Institute of Beja (Portugal). Date: 02/02/2015 to 30/04/15.

- SCHOLARSHIPS. Collaborating student in the monitoring and evaluation of postgraduate courses developed in the European higher education area. Vice-rector for Academic Organization and Teaching Staff. University of Huelva. Date: 2012-2013.
- INTERVENTION PROGRAM. Physical activity monitor in special populations (Fibromyalgia). Intervention program of the project “Physical activity in women with fibromyalgia: effects on the degree of pain, health and quality of life”. Research group: CTS-545. Date: December'11 to June'12.
- EVALUATION STAFF. Research staff participating in the local evaluations of patients with fibromyalgia belonging to the Al-Ándalus project. Date: 2011-2012 (Cross-sectional study; pre-post-re-test), 2013-2014 (2-year follow-up; pre-post-re-test), 2016-2017 (5-year follow-up; pre-post-re-test)

#### 14.2. Research Projects

- Physical activity in women with fibromyalgia: effects on pain, health and quality of life. DEP2010-15639 (DEPO subprogramme). Plan Nacional I+D+I 2008-2011. Ministry of Science and Innovation. Date: 01/01/2011 to 31/12/2013 (36 months).
- Longitudinal follow-up and genetic modulation in fibromyalgia. The effects of exercise and hidroterapy in pain, health status and quality of life. DEP2013-40908-R. Ministry of Economy and Competitiveness. State research, development and innovation program oriented to the challenges of society, modality 1, "research challenges", I+D+I projects. Date: 01/01/2015 to 31/12/2017 (36 months).

### 14.3. University Teaching

More than two recognized trienniums of teaching experience that I summarize in the following table (table 5).

**Table 5.** Overview of the university teaching.

UNIVERSITY	FACULTY	DEPARTAMENT	ÁREA	POSITION	DATE	DEDICATION
University of Huelva	Education sciences	Physical education, music and plastic arts	Body expression didactics	Interim substitute teacher	October'15 to February'17	Full time
University of Seville	Education sciences	Physical education and sport	Body expression didactics	Interim substitute teacher	February'17 to July'17	Full time
University of Seville	Education sciences	Physical education and sport	Body expression didactics	Interim substitute teacher	November'17 to January'18	Full time
University of Huelva	Education, psychology and sports sciences	Integrated didactics	Body expression didactics	Interim substitute teacher	April'18 to September'18	Part time (6+6)
University of Seville	Education sciences	Theory and history of education and social pedagogy	Physical and sports education	Interim substitute teacher	September'18 to July'19	Full time
University of Seville	Education sciences	Human motor skills and sports performance	Physical and sports education	Interim substitute teacher	July'19 to March'21	Full time
University of Seville	Education sciences	Human motor skills and sports performance	Body expression didactics	Interim substitute teacher	April'21 to August'22	Full time
University of Seville	Education sciences	Physical and sports education	Body expression didactics	Interim substitute teacher	September'22 to October'22	Full time
University of Huelva	Education, psychology and sports sciences	Integrated didactics	Body expression didactics	Interim substitute teacher	October'22 to actually	Full time

#### 14.4. Publications related to the doctoral thesis

- Écija, C., Catala, P., Gutiérrez, L., **Arrayás-Grajera, M.J.** & Peñacoba, C. The Influence of the Fear of Negative Evaluation on Activity Avoidance in Fibromyalgia: Exploring Pain Acceptance and Positive Affect as Resilience Variables. *Clinical Nursing Research*, 2023, 1-12. DOI: 10.1177/10547738221122670.
- **Arrayás-Grajera, M.J.**, Tornero-Quiñones, I., Gavilán-Carrera, B., Luque-Reca, O., Peñacoba-Puente, C., Sierra-Robles, A., Carbonell-Baeza, A., & Estévez-López, F. Fibromyalgia: Evidence for Deficits in Positive Psychology Resources. A Case-Control Study from the Al-Ándalus Project. *International Journal of Environmental Research and Public Health*, 2021, 18(22), 12021.
- Estévez-López, F., Pulido-Martos, M., Armitage, C.J., Wearden, A., Álvarez-Gallardo, I.C., **Arrayás-Grajera, M.J.**, Girela-Rejón, M.J., Carbonell-Baeza, A., Aparicio, V.A., Geenen, R., Delgado-Fernández, M., Segura-Jiménez, V. Factor structure of the Positive and Negative Affect Schedule (PANAS) in adult women with fibromyalgia from Southern Spain: the al-Ándalus project. *Peerj*, 2016, 4:e1822; DOI 10.7717/peerj.1822.
- Estévez-López, F., Gray, C.M., Segura Jiménez, V., Soriano-Maldonado, A., Álvarez-Gallardo, I.C., **Arrayás-Grajera, M.J.**, Carbonell-Baeza, A., Aparicio, V.A., Delgado-Fernández, M. y Pulido-Martos, M. Do overall physical fitness and subjective well-being help patients cope with fibromyalgia severity? Abstract publicado en: *Rev Andal Med Deporte*. 2015; 08(1):29. DOI: 10.1016/j.ramd.2014.10.024.
- Estevez-Lopez, F., Gray, C.M., Segura-Jimenez, V., Soriano-Maldonado, A., Alvarez-Gallardo, I.C., **Arrayas-Grajera, M.J.**, Carbonell-Baeza, A., Aparicio, V.A., Delgado-Fernandez, M. y Pulido-Martos, M. Independent and combined association

of overall physical fitness and subjective well-being with fibromyalgia severity: the al-Ándalus Project. *Quality of Life Research*, Published online: 18 January 2015. DOI 10.1007/s11136-015-0917-7

- Pulido-Martos M; Estévez-López F; Armitage C; Wearden A; Álvarez-Gallardo IC; Segura-Jiménez V; **Arrayás-Grajera MJ**; Girela-Rejón MJ; Carbonell-Baeza A; Aparicio VA; Delgado-Fernández M. The Factor Structure of the Spanish Version of the PANAS in women with Fibromyalgia. The al-Andalus project. En Elosua, P. (Editor). Global and local challenges for best practices in assessment. The 9th International Test Commission. Book of Abstract. San Sebastián (España). Julio de 2014.

# **15. ANNEXES**

## 15. ANNEXES

### 15.1. Land- and water-based exercise intervention.

Carbonell-Baeza et al. *BMC Musculoskeletal Disorders* 2012, **13**:18  
<http://www.biomedcentral.com/1471-2474/13/18>



#### STUDY PROTOCOL

#### Open Access

## Land- and water-based exercise intervention in women with fibromyalgia: the *al-andalus* physical activity randomised controlled trial

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#### Abstract

**Background:** The *al-Andalus* physical activity intervention study is a randomised control trial to investigate the effectiveness of a land- and water-based exercise intervention for reducing the overall impact of fibromyalgia (primary outcome), and for improving tenderness and pain-related measures, body composition, functional capacity, physical activity and sedentary behaviour, fatigue, sleep quality, health-related quality of life, and cognitive function (secondary outcomes) in women with fibromyalgia.

**Methods/Design:** One hundred eighty women with fibromyalgia (age range: 35-65 years) will be recruited from local associations of fibromyalgia patients in *Andalucía* (Southern Spain). Patients will be randomly assigned to a usual care (control) group (n = 60), a water-based exercise intervention group (n = 60) or a land-based exercise intervention group (n = 60). Participants in the usual care group will receive general physical activity guidelines and participants allocated in the intervention groups will attend three non-consecutive training sessions (60 min each) per week during 24 weeks. Both exercise interventions will consist of aerobic, muscular strength and flexibility exercises. We will also study the effect of a detraining period (i.e., 12 weeks with no exercise intervention) on the studied variables.

**Discussion:** Our study attempts to reduce the impact of fibromyalgia and improve patients' health status by implementing two types of exercise interventions. Results from this study will help to assess the efficacy of exercise interventions for the treatment of fibromyalgia. If the interventions would be effective, this study will provide low-cost and feasible alternatives for health professionals in the management of fibromyalgia. Results from the *al-Andalus* physical activity intervention will help to better understand the potential of regular physical activity for improving the well-being of women with fibromyalgia.

**Trial registration:** ClinicalTrials.gov ID: NCT01490281

#### Background

Fibromyalgia is becoming a common syndrome in Western European countries since a point prevalence of 2.9% would translate to approximately 6 million people with fibromyalgia [1]. The prevalence of fibromyalgia in

Spain is ~2.4%, and is more common in women (~4.2%) than in men (~0.2%) [2].

Fibromyalgia is considered a disorder of pain regulation [3], as indicated by an increased sensitivity to painful stimuli (hyperalgesia) and lowered pain threshold (allodynia) [4]. Additionally to pain, fibromyalgia symptoms typically include fatigue, stiffness, non-restorative sleep patterns, and memory and cognitive difficulties [5-7]. Other common symptoms are low back pain, recurrent headaches, muscle-spasm, and balance

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problems [5]. The prevalence of comorbidities among patients diagnosed with fibromyalgia is very high [8], which increases patients' needs for appropriate medical management and results in higher healthcare resource utilization compared with persons without fibromyalgia [9].

Fibromyalgia has an important impact on the patients' health-related quality of life [10,11], since it limits activities of daily life such as walking or raising and transporting objects [11,12]. In general, functional capacity is decreased in adults with fibromyalgia [13-18] and is similar to that of healthy elderly [16,19]. Jones et al. [19] reported that women with fibromyalgia have difficulties for staying physically independent.

Exercise therapy is relatively economical, easily accessible and widely used in clinical practice as a strategy for pain management. Several reviews concerning the effect of exercise in fibromyalgia patients concluded that: i) there is moderate evidence that aerobic exercise produces important benefits in physical function, pain and tender points [20,21]; ii) there is limited evidence that strength training improves pain, global wellbeing, physical function, tender points and depression [22]; and iii) there is not enough evidence regarding the health-related effects of flexibility exercises [22]. A recent meta-analysis [23] concluded that exercise (aerobic, strength training or both) improves global wellbeing, assessed by the fibromyalgia impact questionnaire (FIQ) in women with fibromyalgia. The Ottawa Panel supports the use of aerobic exercise interventions and strengthening exercises for the overall management of fibromyalgia [24,25].

Exercise therapy in fibromyalgia patients has usually focused on either pool or land-based exercises. A recent meta-analysis [26] indicated that there is no evidence that water-based aerobic exercise produces superior results compared to similarly intense land-based exercise. Others narrative reviews however suggested slight additional benefits for water-based aerobic exercise on reducing pain and improving depressive symptoms [27], sleep quality and mood [20]. Jentoff et al. [28] compared the effect of a 20-week pool-based exercise and a land-based exercise intervention (twice a week) on symptoms, self-efficacy, self-reported physical impairment, and physical capacity in a group of fibromyalgia patients. They observed significant improvements in cardiovascular capacity and walking time in both exercise groups. The pool-exercise group also improved self-reported physical impairment, number of days feeling good, pain, anxiety, and depression. To our knowledge, the study by Jentoff et al. [28] is the only available study investigating the possible additional beneficial effects of exercising in a warm-water pool (compared to land-based) in fibromyalgia patients. More studies comparing the effectiveness

of a water-based exercise program with a land-based exercise intervention on a broader range of physical and psychological outcomes and with longer intervention period, higher frequency, and larger samples are needed.

It is of public health and clinical relevance to better understand whether the benefits of land-based exercise are similar to those observed with exercise undertaken in water, owing to the low availability of pools with an appropriate water temperature for these patients, ideally between 30 and 33°C.

### Objectives

The primary objective of the *al-Andalus* physical activity randomised controlled trial (RCT) is to investigate the effectiveness of two types of exercise interventions (water- and land-based aerobic-strength training vs. a control group) on the overall impact of fibromyalgia (primary outcome), and on tenderness and pain-related measures, body composition, functional capacity, physical activity and sedentary behaviour, fatigue, sleep quality, health-related quality of life and cognitive function (secondary outcomes) in women aged 35-65 years with fibromyalgia. The intervention groups will train 3 days/week (60 min per session) for a 24-week period. We will also study the effect of a detraining period (i.e., 12 weeks with no exercise intervention) on the studied variables.

### Presentation of the hypothesis

We hypothesised that: (i) a 24-weeks exercise intervention training (either water- or land-based) would be effective for reducing the impact of fibromyalgia (primary outcome), and improving tenderness and pain-related measures, body composition, functional capacity, physical activity and sedentary behaviour, fatigue, sleep quality, health-related quality of life and cognitive function (secondary outcomes) in women with fibromyalgia; (ii) a 24-weeks land-based aerobic-strength intervention training could be as effective as a water-based intervention; and (iii) the exercise training-induced gains would be partially retained in the intervention groups after the detraining period such that their physical status will still be better than that of the control group at this time point.

### Testing the hypothesis

The present study is a RCT (ClinicalTrials.gov ID: NCT01490281). The Medical Ethics Committee of *Hospital Virgen de las Nieves* (Granada, Spain) approved the study design, study protocols and informed consent procedure. All participants have to provide a written informed consent. After baseline measurements, they will be randomly allocated to the usual care (control), land-based training or water-based group. The

participants will be followed for 24 weeks during the training interventions and after 12 weeks of training cessation. All the baseline and follow-up examinations will be performed in the same setting (local association of fibromyalgia patients) and by the same investigators. The study will be performed following the ethical guidelines of the Declaration of Helsinki, last modified in 2000.

#### Participants and selection criteria

Women with fibromyalgia will be recruited from the local associations of fibromyalgia patients in *Andalucía* (Southern Spain). Before starting the study, a screening will be performed of all candidates. The inclusion and exclusion criteria for the study are shown in Table 1.

#### Sample size

The required sample size was determined for the primary outcome variable, i.e. overall score of Fibromyalgia Impact Questionnaire (FIQ) [30]. According to previous research [31], a clinically relevant change is a 15-20% reduction in the total FIQ score (which equals to a ~10-15 points reduction). Assuming an unilateral alternative (i.e. the intervention reduces impact of fibromyalgia), we can detect differences of at least 15% with a power of 95% and  $\alpha$  of 0.05 with two groups (intervention and usual care group) of 45 participants, with a mean in the FIQ of ~70 and a standard deviation of ~20 points. Assuming a maximum lost of follow-up of 30%, we will recruit a total of 60 women with fibromyalgia for each group. Since we will develop two types of interventions (land and water-based), we will recruit a total of 180 women with fibromyalgia (i.e., two intervention groups and one usual care group of 60 persons each). Figure 1 shows the flow diagram of the study participants

#### Randomisation and blinding

The participant randomisation assignment will follow an allocation concealment process, that is, the researcher in charge of randomly assigning participants will not know in advance which treatment the next person would receive and will not participate in assessment. Assessment staff will be blinded to participant randomisation assignment. Participants will be explicitly informed on the group to which they will be assigned as well as on the study hypotheses and will be reminded not to discuss their randomisation assignments with assessment staff. It will not be possible to conceal the group assignment from the staff involved in the training.

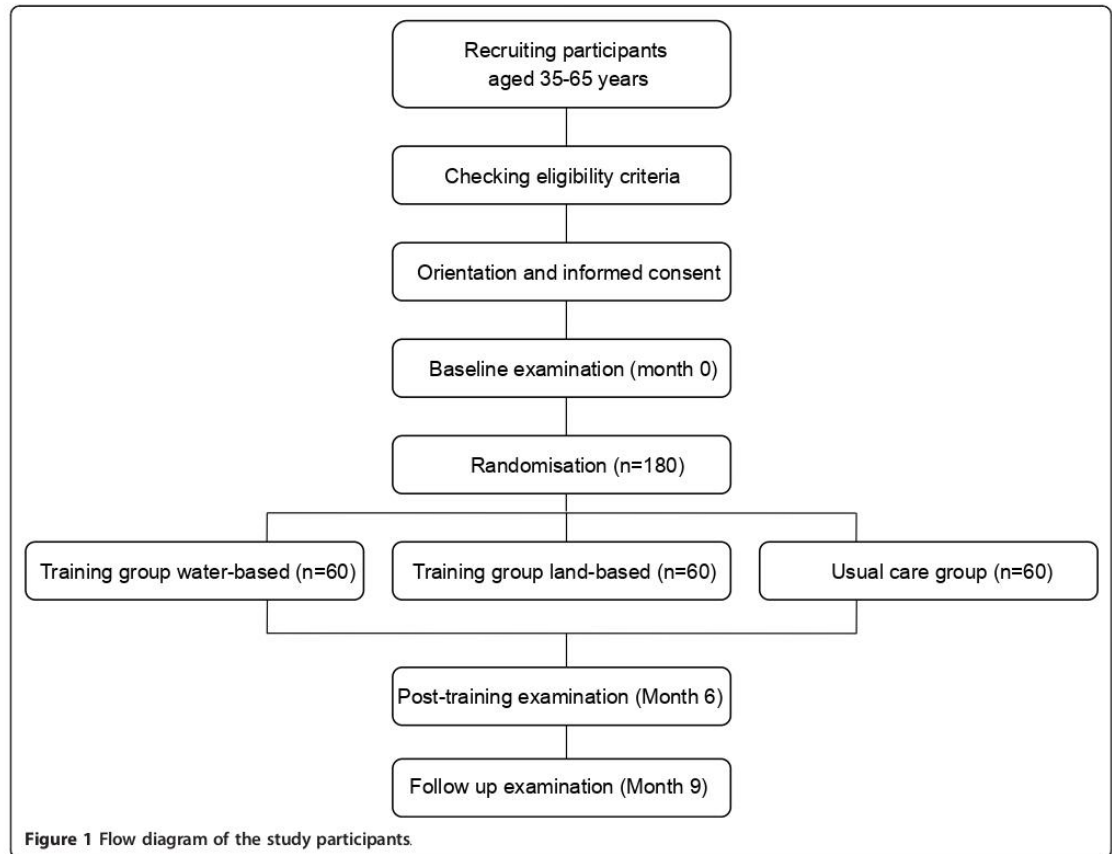
#### Statistical analysis

For between groups comparisons at baseline (usual care vs water-based intervention vs land-based intervention), we will analyse continuous variables with one-way analysis of variance or the non-parametric method of Kruskal-Wallis, and Chi-square tests (or exact techniques if needed). We will use analysis of covariance (ANCOVA) to assess the training effects on the primary and secondary study outcomes (or the rank-transform ANCOVA). Age and baseline level of each outcome variable will be entered as covariates. For each outcome variable we will report the effect size and the level of significance corresponding to the main group (between-subjects), time (within-subjects) and interaction (group  $\times$  time) effects.

We will adjust multiple comparisons for mass significance [32]. We will also examine the differences between drop-outs and participants who remain in the study. We will analyse the data according to the intention-to-treat principle [33]. We will handle missing data due to drop-outs or non-compliance using multiple imputation methods. To fully appreciate the potential

**Table 1 Inclusion and exclusion criteria in the *al-Andalus* physical activity trial**

Inclusion criteria	Exclusion criteria
- Age: 35-65 years.	- Acute or terminal illness.
- To be diagnosed with fibromyalgia by a rheumatologist and meeting the American College of Rheumatology criteria: widespread pain for more than 3 months, and pain with 4 kg/cm of pressure reported for 11 or more of 18 tender points [6].	- Myocardial infarction in the past 3 months.
- Not to have other severe somatic or psychiatric disorders, or other diseases that prevent physical loading (Answer "no" to all questions on the Physical Activity Readiness Questionnaire-PAR-Q [29]).	- Unstable cardiovascular disease or other medical condition.
- Not to be engaged in regular physical activity > 20 min on > 3 days/week in the past 3 months.	- Upper or lower extremity fracture in the past 3 months.
- Planning to stay in the same Association during the study.	- Unwillingness to either complete the study requirements or to be randomised into control or training group.
- Able to ambulate without assistance.	- Severe dementia (MMSE < 10)
- Able to communicate.	- Presence of neuromuscular disease or drugs affecting neuromuscular function.
- Informed consent: Must be capable and willing to provide consent.	- To be engaged in other physical or psychological treatment.



influence of missing responses, we will perform sensitivity analysis. In all analyses, we will study the effect of the regression towards the mean.

#### Interventions

The interventions will be performed in waves so that each wave will have between 10 and 12 participants in the intervention groups, and 10-12 in the usual care group. The land-based and water-based intervention groups will train 3 days/week (60 min per session) for a 24-week period. The intervention will involve exercises for improving cardiovascular endurance, muscle strength, and joint range of motion. The exercise interventions will meet the minimum training standards of the American College of Sports Medicine [34]. The exercise sessions will be carefully supervised by an exercise monitor.

The exercises will involve all major muscle groups. During the first weeks, the main part of the sessions will focus on teaching the patients how to perform the exercises. Each session will include 10 min of warm-up with

slow walks and mobility exercises, followed by 35-40 min of aerobic exercises, developed progressively at intensity sufficient to achieve 50% (at the beginning of the intervention) and ~80% (the last month of the intervention) of predicted maximum heart rate ( $209 - 0.73 \times \text{age}$ ), and resistance strength training. Finally, each session will end with 10 min of cooling down with low-intensity, flexibility and relaxation exercises.

Heart rate will be assessed with a heart rate monitor (Polar Electro OY, Finland) in order to control the intensity of the sessions. One third of the patients in the intervention group will wear heart rate monitors in 1/3 of the sessions, both randomly selected. We will also monitor the rate of perceived exertion (RPE) using the Borg's conventional (6-20 point) scale [35]. Intensity (expressed as RPE) will range from 12 to 14. These RPE values correspond to a subjective perceived exertion of "light" and "somewhat hard" respectively. Overexertion will be checked by the "Talk test", that is, during exercise sessions participants will be able to maintain a conversation without getting breathlessness [36].

#### **Land-based intervention**

The land-based exercise intervention group will train in the exercise training facilities of the local association of fibromyalgia, or in the closer exercise centre. Cardiovascular exercises will incorporate walking at different speeds and continuous and rhythmic activities that affects large muscle groups and aerobic dance. Resistance strength training will include 1-3 set of 8-12 repetitions. The strengthening exercises will include biceps curls, arm extensions, arm side lifts, shoulder elevations, lateral leg elevations, stands up from seated position, lunge, sideways lunge and step-up/step-down. The load will be gradually increased as the strength of each person improves. We will use body weight at the start of the program and barbells (0.5-2 kg per exercise). Flexibility will be developed by static stretching at the end of the warm-up and cool-down periods.

#### **Water-based intervention**

The water-based exercise intervention group will train in a chest-high warm (~30°C) pool. A modified version of the land-based intervention, adapted to the restrictions and peculiarities imposed by water, will be used. The training intensity and the muscle groups activated will be as similar as possible in the two groups.

The cardiovascular exercises will include bicycling simulation (with the floater between legs), walking around the pool, continuous and rhythmic activities that affects large muscle groups and aerobic dance. The strength exercises will be performed at slow pace using water and aquatic materials as resistance. Flexibility exercises will consist of static stretching at the end of the warm-up and cool-down, as in the land-based intervention.

#### **Usual care group (control)**

Participants randomly assigned to the usual care (control) group will receive general advices from the exercise monitor about the positive effects of physical activity. We will prepare informative pamphlets describing the benefits of physical activity and general guidelines about how to increase the daily physical activity levels.

#### **Participant retention and adherence**

To maximize adherence, several strategies will be implemented including music in all sessions, individualized attention at the intervention sessions, telephone calls following missed sessions, and the control of patients' pain rate before and after each session. Make-up sessions will be allowed in case of missing sessions (due to illness or any other reason).

#### **Primary outcomes measures**

*Fibromyalgia Impact Questionnaire* (FIQ) is a self-administered questionnaire, comprising 10 subscales of disabilities and symptoms (physical function, work missed

day, job ability, feel good, pain, fatigue, sleep, stiffness, anxiety and depression) and has been validated for Spanish fibromyalgia patients [30]. The total scores range from 0 to 100, with a higher score indicating greater effect of the condition on the person's life.

#### **Secondary outcomes measures**

##### ***Tenderness and pain related measures***

We will assess 18 *tender points* according to the American College of Rheumatology criteria for classification of fibromyalgia using a standard pressure algometer (FPK 20; Effegi, Alfonsine, Italy). The *tender point count*, total count of positive tender points, will be recorded for each participant. The *algometer score* will be calculated as the sum of the minimum pain-pressure values obtained for each tender point.

*The Visual analogic scale for pain* is a simple assessment tool consisting of a 10 cm line with 0 on one end, representing no pain, and 10 on the other, representing the worst pain ever experienced, which a patient marks to indicate the severity of her pain in the present moment. This scale will also be administered before and after each session during the intervention, to assess the acute effect of exercise on pain.

*The Pain Catastrophizing Scale* [37,38] will be used to assess three factors: rumination, magnification and helplessness associated to pain. It includes 13 items measured on a 5-point Likert scale ranging from 0 (not at all) to 4 (all the time). Higher scores indicate a greater tendency to catastrophize pain symptoms.

*The Chronic Pain Self-Efficacy Scale* [39,40], is a scale that measures efficacy expectations for coping with pain. It contains 22 items grouped into 3 subscales: self efficacy for pain management, self efficacy for coping with symptoms, and self efficacy for physical function. The scores are obtained by means of a Likert scale with a range of 0-10, where higher scores indicate better self efficacy.

##### ***Body composition***

Weight and height will be measured, body mass index [weight (kg)/height(m<sup>2</sup>)] will be calculated, and skeletal muscle mass, total body water and fat free mass will be estimated with bioelectrical impedance analysis (InBody R20; Biospace, Gateshead, UK).

##### ***Functional capacity***

Participants' functional capacity will be assessed by field-based fitness tests following the standardised Functional Senior Fitness Test Battery [41]. This battery assesses muscular strength, flexibility, balance and aerobic capacity by means of the following tests:

***Lower body muscular strength*** The "30-s chair stand test" involves counting the number of times within 30 s that an individual can rise to a full stand from a seated position with back straight and feet flat on the floor,

without pushing off with the arms. The patients will perform one trial after familiarization [41].

**Upper body muscular strength** The “Arm curl test” involves determining a number of times a hand weight (2.3 kg for women) can be curled through a full range of motion in 30 s [41]. Additionally, handgrip strength will be measured using a digital dynamometer (TKK 5101 Grip-D; Takey, Tokyo, Japan) as described elsewhere [42]. Patients will perform (alternately with both hands) the test twice allowing a 1-min rest period between measures. The best value of 2 trials for each hand will be chosen and the average of both hands will be used in the analyses.

**Lower body flexibility** In the “chair sit and reach test”, the patient seated with one leg extended, slowly bends forward sliding the hands down the extended leg in an attempt to touch (or pass) the toes. The number of centimeters short of reaching the toe (minus score) or reaching beyond it (plus score) will be recorded [41]. Two trials with each leg will be measured and the best value of each leg will be registered, and the average of both legs will be used in the analyses.

**Upper body flexibility** The “back scratch test”, a measure of overall shoulder range of motion, involves measuring the distance between (or overlap of) the middle fingers behind the back with a ruler [41]. Participants will perform this test twice, alternately with both hands, and the best value will be registered. The average of both hands will be used in the analyses.

**Motor agility/dynamic balance** The “8 ft up and go test” involves standing up from a chair, walking 8 ft to and around a cone, and returning to the chair in the shortest possible time [41]. The best time of two trials will be recorded and used in the analyses.

**Cardiorespiratory fitness** We will use the “6-min walk test”. This test involves determining the maximum distance (meters) that can be walked in 6 min along a 45.7 m rectangular course [41,43].

*The International Fitness Scale* [44] is composed of five Likert-scale questions asking about the perceived patients’ overall fitness, cardio-respiratory fitness, muscular fitness, speed-agility and flexibility in comparison with their friends’ physical fitness (“very poor”, “poor”, “average”, “good” and “very good”).

**Physical activity and sedentary behaviour**

Physical activity and sedentary behaviour will be objectively (i.e. accelerometry) and subjectively (i.e. questionnaires) assessed:

**Accelerometry** Women will be asked to wear a tri-axial accelerometer (ActiGraph GT3X+, Pensacola, Florida, US) for 8 consecutive days, starting the same day they receive the monitor, and will returned the accelerometers to the researcher 9 days later. Participants will be instructed to wear the accelerometer on their lower

back attached by an elastic belt during waking as well as sleeping hours. For security reasons, participants will be asked to take them off while bathing.

We will exclude from the analyses bouts of 60 continuous minutes of 0 activity intensity counts, considering these periods as non-wearing time. Monitor wearing time will be calculated by subtracting the non-wear time and the sleeping time (recorded through a diary) from the total registered time for the entire day (typically 1,440 min). A recording of more than 20,000 counts per minute will be considered as a potential malfunction of the accelerometer and the value will be excluded from the analyses. The first day of recording will not be included in the analysis. A total of 7 days of recording with a minimum of ten or more hours of registration per day will be necessary to be included in the study. Physical activity levels will be shown as follows: (i) average physical activity, expressed as mean counts per minute. It is a measure of overall physical activity. We will calculate mean counts per minute by dividing the sum of total counts per epoch for a valid day by the number of minutes of wear time in that day across all valid days. We will also calculate the time engaged in light, lifestyle, moderate, and moderate and vigorous intensity physical activity based upon a standardized cut-off of 100-759, 760-1,951, 1,952-5,724, and at least 1,952 counts per minute, respectively. Sedentary time will be calculated as the amount of time accumulated below 100 counts per minute during periods of wear time.

*The Leisure time physical activity instrument* [45,46] is composed of 4 items with 3 activity levels: light, moderate, and vigorous (a short description of each category will be presented). Patients will be asked to recall the average number of hours a week during the previous 4 weeks that they had spent engaged in a particular type of physical activity and at what activity level. The scale will be simplified into the following 3 levels: (1) 0.5-1.5 h a week, (2) 2-4 h a week, and (3) more than 4 h a week, and the patient will be asked to provide answers in hours. The number of hours indicated by the patient for each intensity category will be summed to obtain the leisure time physical activity level for 1 week.

*The Physical activity at homework or workplace instrument* [45,46] is composed of 7 items with 3 categories for work performed at home (light, moderate and heavy activity) and 4 categories for employment (sedentary, light, moderate and heavy activity). The hours for each category will be summed to obtain the total score.

*The Sedentary Behavior Questionnaire* [47] consisted of reports of time spent in 9 sedentary behaviors (watching television, sitting while playing computer/video games, sitting while listening to music, sitting and talking on the phone, doing paperwork or office work, sitting and reading, playing a musical instrument, doing

arts and crafts, sitting and driving/riding in a car, bus, or train).

The short version of the *ALPHA Environmental questionnaire* [48,49] will be used to assess the environmental perceptions physical activity. The questionnaire will provide information about types of residences in the neighborhood, distances to local facilities, walking or cycle infrastructure in the neighborhood, cycling and walking network, neighborhood safety, home and work/study environment mode of active travel.

#### **Fatigue**

*The Multidimensional Fatigue Inventory* [50], that will be used to measure fatigue severity, comprises five subscales: general fatigue, physical fatigue, mental fatigue, reduced activity, and reduced motivation [2]. Each subscale includes four items with five-point Likert scales. General fatigue includes general statements about fatigue and decreased functioning and is designed to encompass both physical and psychological aspects of fatigue. Physical fatigue concerns physical sensations related to fatigue. Mental fatigue pertains to cognitive functioning, including difficulty concentrating. Reduced activity refers to the influence of physical and psychological factors on the level of activity. Reduced motivation relates to lack of motivation for starting any activity. Scores on each subscale range from 4 to 20, with higher scores indicating greater fatigue.

#### **Sleep quality**

*The Pittsburgh Sleep Quality Index* [51] will be used to assess sleep quality and disturbances over a 1-month time interval. Nineteen individual items generate seven "component" scores: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. The sum of scores for these seven components yields one global score. This test has been used in previous studies in fibromyalgia patients [52,53].

#### **Health-related quality of life**

We will determine patients' quality of life with the *Short-Form Health Survey 36* (SF-36) [54]. The SF-36 is a generic instrument for assessing health-related quality of life. It contains 36 items grouped into 8 dimensions: physical functioning, physical role, body pain, general health, vitality, social functioning, emotional role, and mental health. The scores range from 0 to 100 in every dimension, where higher scores indicate better health.

*The Beck Depression Inventory-II* [55,56] will be used to assess depression severity. It contains 21 items and the range of score is 0-63 with higher score indicating greater depression.

*The State Trait Anxiety Inventory-I* [57] will be used to assess the level of current anxiety. It is a 20-item self-administered questionnaire; the range of score is 20-80, with higher scores indicating a greater state of anxiety.

Positive health will be assessed by means of the following questionnaire:

*The Trait Meta-Mood Scale* [58], is comprised of three subscales and we will use only one of them, the mood repair scale (8 items), that assesses how well individuals regulate their moods and repair negative emotional experiences (e.g. "when I become upset, I remind myself of all the pleasures in life"). Participants rate their responses using a 5-point Likert type scale, with 1 = "strongly disagree" to 5 = "strongly agree".

*The Positive and Negative Affectivity Schedule* [59,60] is a 20-item questionnaire designed to measure positive and negative affectivity. The questionnaire includes 10 positive and 10 negative emotional states that should be answered on a 5-point Likert scale. The negative and positive subscales represent two relatively independent scales.

*The Satisfaction With Life Scale* [61,62] designed to assess global life satisfaction. The SWLS consists of five items with a 7-point Likert-scale from "strongly disagree" to "strongly agree". Higher scores reflect greater subjective well-being.

*The Life Orientation Test Revised* [63,64], is a 10-item scale that assesses subjects' expectations about their future and their general sense of optimism. It is comprised of 3 positively worded (e.g., "I'm always optimistic about my future"), 3 negatively worded items (e.g. "I hardly ever expect things to go my way") and the other 4 are filler questions. Each item is rated on a five-point Likert type scale ranging from one ("strongly disagree") to five ("strongly agree"). The higher the score obtained in the test, the higher the level of dispositional optimism is and vice-versa.

#### **Cognitive function**

*The Mini Mental State Examination* (MMSE) [65] will be used to evaluate cognitive capacity and severity of dementia for the exclusion criteria. The MMSE is a brief cognitive screening test. The MMSE asks questions that assess five areas of cognitive functioning: orientation, immediate memory, attention/concentration, delayed recall and language.

*The Paced Auditory Serial Addition Task* [66] will be used to measure sustained and divided attention, auditory information processing speed, and stimulus competition filtering skill. In this study, it will be administered only at the slowest presentation rate of 2.4 s. The score is the number of correct responses over 60 trials.

*The Rey Auditory Verbal Learning Test* [67] measures immediate free recall, delayed free recall, delayed recognition, and verbal learning. This is a multiple-trial verbal list learning test and will be given on an individual basis.

**Patient global impression of change**

We will also assess the patients' perception of change after the exercise interventions with *Patient Global Impression of Improvement scale* [68]. This is a scale used by patients to report their overall assessment of change during a clinical trial that uses a 7-point rating scale with the options "very much improved", "much improved", "minimally improved", "no change", "minimally worse", "much worse" and "very much worse".

**Assessment**

The outcomes will be assessed just before the intervention (baseline), after 24 weeks of exercise interventions (post-intervention) and after 12 weeks of training cessation (detraining). The assessments of the primary and secondary outcomes will be performed on two separate days in order to prevent fatigue in the patients. The patients will complete some questionnaires at home between day 1 and 2. The study assessment schedule is shown in Table 2.

**Table 2 Study Assessment Schedule**

Assessment	Screening	Baseline	Intervention	Post-intervention (24 weeks)	Detraining (12 weeks)
- Informed Consent	X				
<i>Day 1 testing</i>					
- Sociodemographic data	X			X	X
- Mini Mental State Examination	X				
- Physical Activity Readiness Questionnaire-PAR-Q	X				
- Beck Depression Inventory-II	X			X	X
- Tender points	X			X	X
- Visual analogic scale for pain		X	X	X	X
<i>Questionnaires to complete at home between day 1 and 2</i>					
- Fibromyalgia Impact Questionnaire		X		X	X
- Short-Form Health Survey 36		X		X	X
- State Trait Anxiety Inventory-I		X		X	X
- Trait Meta-Mood Scale		X		X	X
- Positive and Negative Affectivity Schedule		X		X	X
- Satisfaction With Life Scale		X		X	X
- Life Orientation Test Revised		X		X	X
- Pittsburgh Sleep Quality Index		X		X	X
- Multidimensional Fatigue Inventory		X		X	X
- ALPHA Environmental questionnaire		X		X	X
- Sedentary Behavior Questionnaire		X		X	X
- Physical activity at homework or workplace instrument		X		X	X
- Leisure time physical activity instrument		X		X	X
- International Fitness Scale		X		X	X
- Chronic Pain Self-Efficacy Scale		X		X	X
- Pain Catastrophizing Scale		X		X	X
<i>Day 2 testing</i>					
- Paced Auditory Serial Addition Task		X		X	X
- Rey Auditory Verbal Learning Test		X		X	X
- Body composition		X		X	X
- Chair sit and reach test		X		X	X
- Back scratch test		X		X	X
- Arm curl test		X		X	X
- 30-s chair stand test		X		X	X
- 8 ft up and go test		X		X	X
- Handgrip strength		X		X	X
- 6-min walk test		X		X	X
- Accelerometry (1 week)		X		X	X
- Patient Global Impression of Improvement scale				X	

### Familiarization and reliability assessment

Before the start of the study all patients will have a familiarization period with all the functional capacity tests, consisting of two ~50-min sessions. Each session will be preceded by a warm-up and will end with a cool-down of the same activities and duration used during the training period. Each familiarization session will consist of 2-3 sets of 1-3 repetitions of the exercises. We will also assess test-retest reliability (2-weeks apart) of the study functional capacity tests in a sub-sample. The tests will be performed by trained and qualified researchers.

### Assessment of side effects

We will record adverse effects or health problems attributable to the testing sessions or intervention sessions, including muscle pain, fatigue, and general aches and pains by self-report during the study period. An independent researcher will be in charge of auditing all assessment staff to record all these events in the participants over the study period.

### Implications of the hypothesis

The *al-Andalus* physical activity RCT will investigate the effects of 24-week land- and water-based exercise interventions on disease impact, tenderness, body composition, functional capacity, quality of life and cognitive function in female patients with fibromyalgia. Both exercise interventions will include aerobic, strengthening and flexibility exercises. We will also assess the effect of a 3-month detraining period on the study primary and secondary outcomes. To our knowledge, this is the largest study specifically designed to compare the effect of a water-based and land-based exercise interventions on fibromyalgia patients. Our study attempts to reduce impact of fibromyalgia and improve patients' health status and quality of life by implementing two types of exercise interventions. Results from this study will help to better assess the potential of exercise interventions in the treatment of fibromyalgia. If the interventions proved to be effective and safe, this study would provide low-cost and feasible alternatives for health professionals in the management of fibromyalgia.

### Abbreviations

ANCOVA: Analysis of covariance; FIQ: Fibromyalgia impact questionnaire; MMSE: Mini Mental State Examination; PAR-Q: Physical Activity Readiness Questionnaire; RCT: Randomised controlled trial; RPE: Rate of perceived exertion; SF-36: Short-form 36 items.

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### Authors' contributions

ACB, JRR, VAA and MDF conceived the study, and participated in its design. ACB, JRR and VAA drafted the manuscript. FBO, DM, VS, AR, FE, BS, AJC, AS, PL, MP, PF, UP, PC, MJG, PT and AL participated in the study design and critically revised the manuscript. ICA, DC and BS participated in the study design, critically revised the manuscript, supervised and design the exercise interventions. PF participated in the study design and provided statistical support. All authors read and approved the final manuscript.

### Competing interests

The authors declare that they have no competing interests.

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## 15.2. Positive and negative affect schedule (PANAS).

Indicate the extent you have felt this way over the past week.		Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
PANAS 1	Interested	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
PANAS 2	Distressed	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
PANAS 3	Excited	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
PANAS 4	Upset	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
PANAS 5	Strong	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
PANAS 6	Guilty	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
PANAS 7	Scared	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
PANAS 8	Hostile	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
PANAS 9	Enthusiastic	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
PANAS 10	Proud	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
PANAS 11	Irritable	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
PANAS 12	Alert	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
PANAS 13	Ashamed	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
PANAS 14	Inspired	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
PANAS 15	Nervous	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
PANAS 16	Determined	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
PANAS 17	Attentive	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
PANAS 18	Jittery	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
PANAS 19	Active	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
PANAS 20	Afraid	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

### Scoring:

**Positive Affect Score:** Add the scores on items 1, 3, 5, 9, 10, 12, 14, 16, 17, and 19. Scores can range from 10 – 50, with higher scores representing higher levels of positive affect.  
Mean Scores: 33.3 (SD±7.2)

**Negative Affect Score:** Add the scores on items 2, 4, 6, 7, 8, 11, 13, 15, 18, and 20. Scores can range from 10 – 50, with lower scores representing lower levels of negative affect.  
Mean Score: 17.4 (SD ± 6.2)

**Your scores** on the PANAS: Positive: \_\_\_\_\_ Negative: \_\_\_\_\_

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of personality and social psychology*, 54(6), 1063.

### 15.3. Satisfaction with life scale (SWLS).

#### Reference:

Diener, E., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The Satisfaction with Life Scale. *Journal of Personality Assessment*, 49, 71-75.

#### Description of Measure:

A 5-item scale designed to measure global cognitive judgments of one's life satisfaction (not a measure of either positive or negative affect).

Participants indicate how much they agree or disagree with each of the 5 items using a 7-point scale that ranges from 7 strongly agree to 1 strongly disagree.

#### Scale:

*Instructions:* Below are five statements that you may agree or disagree with. Using the 1 - 7 scale below, indicate your agreement with each item by placing the appropriate number on the line preceding that item. Please be open and honest in your responding.

- 7 - Strongly agree
- 6 - Agree
- 5 - Slightly agree
- 4 - Neither agree nor disagree
- 3 - Slightly disagree
- 2 - Disagree
- 1 - Strongly disagree

\_\_\_ In most ways my life is close to my ideal.

\_\_\_ The conditions of my life are excellent.

\_\_\_ I am satisfied with my life.

\_\_\_ So far I have gotten the important things I want in life.

\_\_\_ If I could live my life over, I would change almost nothing.

#### Scoring:

Though scoring should be kept continuous (sum up scores on each item), here are some cut-offs to be used as benchmarks.

- 31 - 35 Extremely satisfied
- 26 - 30 Satisfied
- 21 - 25 Slightly satisfied
- 20 Neutral
- 15 - 19 Slightly dissatisfied
- 10 - 14 Dissatisfied
- 5 - 9 Extremely dissatisfied

## 15.4. Life Orientation Test – Revised (LOT-R)

### Instructions:

Please answer the following questions about yourself by indicating the extent of your agreement using the following scale:

- [0] = strongly disagree
- [1] = disagree
- [2] = neutral
- [3] = agree
- [4] = strongly agree

Be as honest as you can throughout, and try not to let your responses to one question influence your response to other questions. There are no right or wrong answers.

- \_\_\_\_\_ 1. In uncertain times, I usually expect the best.
- \_\_\_\_\_ 2. It's easy for me to relax.
- \_\_\_\_\_ 3. If something can go wrong for me, it will.
- \_\_\_\_\_ 4. I'm always optimistic about my future.
- \_\_\_\_\_ 5. I enjoy my friends a lot.
- \_\_\_\_\_ 6. It's important for me to keep busy.
- \_\_\_\_\_ 7. I hardly ever expect things to go my way.
- \_\_\_\_\_ 8. I don't get upset too easily.
- \_\_\_\_\_ 9. I rarely count on good things happening to me.
- \_\_\_\_\_ 10. Overall, I expect more good things to happen to me than bad.

### Scoring:

1. Reverse code items 3, 7, and 9 prior to scoring (0=4) (1=3) (2=2) (3=1) (4=0).
2. Sum items 1, 3, 4, 7, 9, and 10 to obtain an overall score.

*Note* Items 2, 5, 6, and 8 are filler items only. They are not scored as part of the revised scale.

The revised scale was constructed in order to eliminate two items from the original scale, which dealt more with coping style than with positive expectations for future outcomes. The correlation between the revised scale and the original scale is .95.

### Reference:

Scheier, M.F., Carver C.S., and Bridges, M.W. (1994). Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem): A re-evaluation of the Life Orientation Test. *Journal of Personality and Social Psychology*, **67**, 1063-1078.

## 15.5. Trait Meta Mood Scale – Emotional Repair (TMMS-ER)

The Trait Meta-Mood Scale, is comprised of 3 subscales and we will use only one of them, the emotional repair (8 items; from 17 to 24), that assesses how well individuals regulate their moods and repair negative emotional experiences (e.g. “when I become upset, I remind myself of all the pleasures in life”). Participants rate their responses using a 5-point Likert type scale, with 1 = “strongly disagree” to 5 = “strongly agree”.

1	I pay a lot of attention to my feelings.	1	2	3	4	5
2	I am usually very conscious of what I feel.	1	2	3	4	5
3	I usually spend time thinking about my emotions.	1	2	3	4	5
4	I think my emotions and state of mind deserve to be paid attention to.	1	2	3	4	5
5	I allow my feelings to affect my thoughts.	1	2	3	4	5
6	I constantly think about my state of mind.	1	2	3	4	5
7	I often think about my feelings.	1	2	3	4	5
8	I pay a lot of attention to the way I feel.	1	2	3	4	5
9	My feelings are clear to me.	1	2	3	4	5
10	I can usually define my feelings.	1	2	3	4	5
11	I nearly always know how I feel.	1	2	3	4	5
12	I usually know how I feel about people.	1	2	3	4	5
13	I often become aware of my feelings in different situations.	1	2	3	4	5
14	I can always say how I feel.	1	2	3	4	5
15	I can sometimes say which emotions I am experiencing.	1	2	3	4	5
16	I can manage to understand my feelings.	1	2	3	4	5
17	I usually have an optimistic outlook, although I sometimes feel sad.	1	2	3	4	5
18	Even when I feel sad, I try to think about pleasant things.	1	2	3	4	5
19	When I am sad, I think about all life’s pleasures.	1	2	3	4	5
20	I try to have positive thoughts even when I feel bad.	1	2	3	4	5
21	If I think about things too much and end up complicating them, I try to calm myself down.	1	2	3	4	5
22	I am concerned about having a good state of mind.	1	2	3	4	5
23	I have a lot of energy when I feel happy.	1	2	3	4	5
24	When I am angry, I try to change my state of mind.	1	2	3	4	5

### Evaluation of the subscale of the emotional repair:

Puntuaciones <i>Hombres</i>	Puntuaciones <i>Mujeres</i>
Debe mejorar su regulación < 23	Debe mejorar su regulación < 23
Adecuada regulación 24 a 35	Adecuada regulación 24 a 34
Excelente regulación > 36	Excelente regulación > 35

**Reference:** Fernandez-Berrocal, P., Extremera, N., & Ramos, N. (2004). Validity and Reliability of the Spanish Modified Version of the Trait Meta-Mood Scale. *Psychological Reports*, 94(3), 751-755. <https://doi.org/10.2466/pr0.94.3.751-755>



Article

## Fibromyalgia: Evidence for Deficits in Positive Psychology Resources. A Case-Control Study from the Al-Ándalus Project

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**Abstract:** Positive psychology is the study of positive subjective experience and individual traits. Identifying deficits in positive psychology regarding fibromyalgia may inform targets for management. Therefore, the aim of the present case-control study was to compare the levels of positive affect, negative affect, satisfaction with life, optimism and emotional repair in a large sample of women with fibromyalgia (cases) and age-matched peers without fibromyalgia (controls). This case-control study included 437 women with fibromyalgia (51.6 ± 7.1 years old) and 206 age-matched women without fibromyalgia (50.6 ± 7.2 years old). Participants self-reported their levels of (i) subjective well-being on the Positive and Negative Affect Schedule and the Satisfaction with Life Scale, (ii) dispositional optimism on the Life Orientation Test-Revised and (iii) emotional repair on the Trait Meta-Mood Scale. Women with fibromyalgia showed lower levels of positive affect, satisfaction with life, optimism and emotional repair and higher levels of negative affect. Large effect sizes were found for positive affect, negative affect and satisfaction with life (all, Cohen's  $d \geq 0.80$ ) and small-to-moderate for emotional repair and optimism (both, Cohen's  $d \geq 0.50$ ). Women with fibromyalgia experience deficits of positive psychology resources. Thus, developing tailored therapies for fibromyalgia focusing on reducing deficits in positive psychology resources may be of clinical interest, though this remains to be corroborated in future research.

**Keywords:** chronic pain; emotional intelligence; fibromyalgia; persistent physical symptoms; resilience (psychological); subjective well-being; vulnerability (psychological)

### 1. Introduction

Fibromyalgia is a chronic disease characterised by widespread musculoskeletal pain and additional physical and psychological symptoms that usually include fatigue, poor

sleep quality, stiffness, depression, anxiety and cognitive difficulties [1,2]. As a consequence, people with fibromyalgia report substantial functional limitations, which may lead to high health resource use and lost productivity, resulting in significantly higher costs [3,4]. In fibromyalgia, the exclusive focus on negative aspects has traditionally dominated [5]. However, positive psychology has been defined as the scientific study of positive experiences and positive individual traits [6], which refers to people's ability to maintain positive functioning in the face of adversity and challenges [7,8].

In fibromyalgia, previous case-control research has extensively focused on the affective sources, such as positive and negative affect [9–11], which are the emotional components of subjective well-being, i.e., people's evaluations of their lives [12]. In comparison to peers without fibromyalgia, those with the disease have reduced levels of positive affect and increased levels of negative affect [9–11]. However, scarce attention has been paid to the cognitive-, emotional- and personality-related aspects of positive psychology despite the fact that they may play a key role in adaptation to chronic pain [13]. Satisfaction with life is the cognitive component of subjective well-being, i.e., the cognitive evaluation of one's life [12,14]. It has been observed that satisfaction with life is low in people with chronic pain [15,16]. Dispositional optimism (herein after referred to as optimism) is the generalised expectancy that good things will happen in the future and bad things will be minimal [17]. In the general population, higher optimism is related to better health [18–20]. In fibromyalgia, higher optimism is associated with less perceived barriers to goal attainment during disease flares [21,22]. Emotional repair is the ability that people have to regulate their emotional states themselves [23], enhancing the positive states and minimising those which are negative. In people with chronic pain, higher emotional repair is associated with lower pain [24]. Collectively, it seems that satisfaction with life, optimism and emotional repair may play a role in adaptation to fibromyalgia. However, previous case-control studies have not comprehensively characterised the levels of affective, cognitive and personality aspects of positive psychology in fibromyalgia. Addressing this gap in the knowledge may help to develop tailored therapies focused on reducing fibromyalgia deficits in positive psychology and, consequently, the severity of the disease.

Therefore, the aim of the present case-control study was to compare the levels of positive affect, negative affect, satisfaction with life, optimism and emotional repair in a large sample of women with fibromyalgia (cases) and age-matched women without fibromyalgia (controls). On the basis of the previous evidence, the hypothesis of the present study was that, in comparison to controls, women with the disease would have more unfavourable scores in all of these positive psychology resources.

## 2. Materials and Methods

### 2.1. Participants

Participants from the eight provinces of Andalusia (southern Spain) were recruited for the present case-control study through local fibromyalgia associations via e-mail, letter, telephone or university press. Additionally, participants with fibromyalgia (cases) were asked to recruit non-fibromyalgia (control) participants with a similar age and socio-demographic characteristics to conduct comparisons between groups. All potential participants ( $n = 960$ ) gave their written informed consent after receiving detailed information about the study aims and procedures before taking part in the study. The inclusion criteria for participants with fibromyalgia were: (1) to be an adult woman (aged 18 to 65 years old); (2) to have a medical diagnosis of fibromyalgia from a rheumatologist (participants were requested to provide their medical records to confirm their diagnosis); and (3) to meet the 1990 American College of Rheumatology (ACR) fibromyalgia criteria [25,26]. The inclusion criteria for control participants were: (1) to be an adult woman (aged 18 to 65 years old); and (2) not to meet the 1990 ACR fibromyalgia criteria [25]. Additionally, fibromyalgia or control participants with either acute/terminal illness (such as cancer, stroke, recent cardiopathy, severe coronary disease, schizophrenia or any other disabling injury) or severe cognitive impairment, as defined by a score of less than ten on the Mini-Mental State Examination

(MMSE) [27,28], were excluded. All tests were performed by the same trained group of researchers to reduce inter-examiner error. The study was reviewed and approved by the Ethics Committee of the “Hospital Virgen de las Nieves” (Granada, Spain), registration number: 15/11/2013-N72. The ethical guidelines of the Declaration of Helsinki (modified in 2000) were followed.

## 2.2. Measures

The MMSE [27,28] was used as a screening test to determine whether a participant experienced severe cognitive impairment (i.e., an exclusion criterion). The MMSE assesses five areas of cognitive function: orientation, immediate memory, attention/concentration, delayed recall and language.

Socio-demographic data were recorded using a self-report questionnaire in which participants indicated their date of birth, marital status (i.e., married, single, separated, divorced and widowed), education level (i.e., unfinished studies, primary studies, secondary studies and university studies), time since fibromyalgia diagnosis (<1 year, 1–5 years and >5 years) and time since first symptoms until fibromyalgia diagnosis (<1 year, 1–5 years and >5 years).

A physical examination of tender points according to the 1990 ACR fibromyalgia criteria [25,26] was performed using a standard pressure algometer (FPK 20; Wagner Instruments, Greenwich, CT, USA). This examination was performed by fully trained researchers. Those participants who (i) reported widespread musculoskeletal pain for at least 3 months and (ii) reported pain at a pressure of  $\leq 4$  kg/cm<sup>2</sup> in at least 11 tender points were classified as meeting the 1990 ACR fibromyalgia criteria.

The Positive and Negative Affect Schedule (PANAS) [29–31] is a 20-item questionnaire with a 5-point Likert scale (from 1 = “very slightly or not at all” to 5 = “extremely”) that assesses two subscales, positive and negative affect. The scores of the PANAS range from 10 to 50, where higher scores reflect greater positive affect or negative affect. We used the trait time-frame version of the PANAS, i.e., “in general” directions. The 2-factor structure of the PANAS has shown satisfactory psychometric properties in fibromyalgia [31]. In the present study, Cronbach’s alpha was 0.91 for positive affect and 0.91 for negative affect.

The Satisfaction with Life Scale (SWLS) [32,33] is a 5-item questionnaire with a 7-point Likert scale (from 1 = “strongly disagree” to 7 = “strongly agree”). The score of the SWLS ranges from 5 to 35, where a higher score reflects greater satisfaction with life. In the present study, Cronbach’s alpha for satisfaction with life was 0.86.

The Life Orientation Test-Revised (LOT-R) [17,34–36] is a 10-item questionnaire with a 5-point Likert scale (from 0 = “strongly disagree” to 4 = “strongly agree”). LOT-R is composed of three positively worded items (e.g., “I’m always optimistic about my future”), three negatively worded items (e.g., “I hardly ever expect things to go my way”) and four fillers that are not considered in the LOT-R score. The score of the LOT-R ranges from 0 to 24, where a higher score reflects greater dispositional optimism. In the present study, Cronbach’s alpha for optimism was 0.70.

The emotional repair scale of the Trait Meta-Mood Scale (TMMS-ER) [37,38] is an 8-item questionnaire with a 5-point Likert scale (from 1 = “strongly disagree” to 5 = “strongly agree”). The score of the emotional repair scale of the TMMS ranges from 8 to 40, where a higher score reflects the perceived ability to enhance positive emotional states and minimise negative ones. In the present study, Cronbach’s alpha for emotional repair was 0.90.

## 2.3. Procedure

Assessments took place over three consecutive days. On day 1, the MMSE was conducted, socio-demographic data were collected and a tender point examination was conducted. On day 2, participants filled out the PANAS, SWLS, LOT-R and TMMS-ER questionnaires at home without supervision. On day 3, participants returned the questionnaires to the research team who reviewed all of them, and potential doubts were resolved.

#### 2.4. Statistical Analysis

Descriptive statistics include means and standard deviations for continuous variables as well as frequencies and percentages for categorical variables. Internal consistency of the instruments was assessed by Cronbach's  $\alpha$  coefficient with acceptable values  $\geq 0.70$  [39]. Before main analyses, *t*-test and chi-square test analysis (in continuous and categorical variables, respectively) were used to identify differences between groups (i.e., participants with and without fibromyalgia) in the potential socio-demographic confounders; namely age, marital status and education level. Statistical differences in education level between women with and without fibromyalgia were found and, thus, it was included as a covariate in all the analyses.

Multivariate analysis of covariance (MANCOVA) was conducted to compare the mean scores of fibromyalgia and non-fibromyalgia groups on positive psychology resources. In MANCOVA, the group was entered as the independent variable; all the positive psychology resources were entered as dependent variables and education level was entered as a covariate. The effect size was calculated using Cohen's *d* (standardised mean differences) to compare all the positive psychology variables. Cohen's *d* values were interpreted as small ( $\sim 0.2$ ), medium ( $\sim 0.5$ ) or large ( $\sim 0.8$ ) effects [40].

All analyses were performed using Statistical Package for Social Sciences (IBM SPSS Statistics for Windows, version 26.0; Armonk, NY, USA), and the level of statistical significance was set at  $\alpha = 0.05$  (two-tailed).

### 3. Results

Figure 1 shows the flowchart of the participants. Table 1 shows the characteristics of the 643 participants (437 women with fibromyalgia and 206 non-fibromyalgia women).

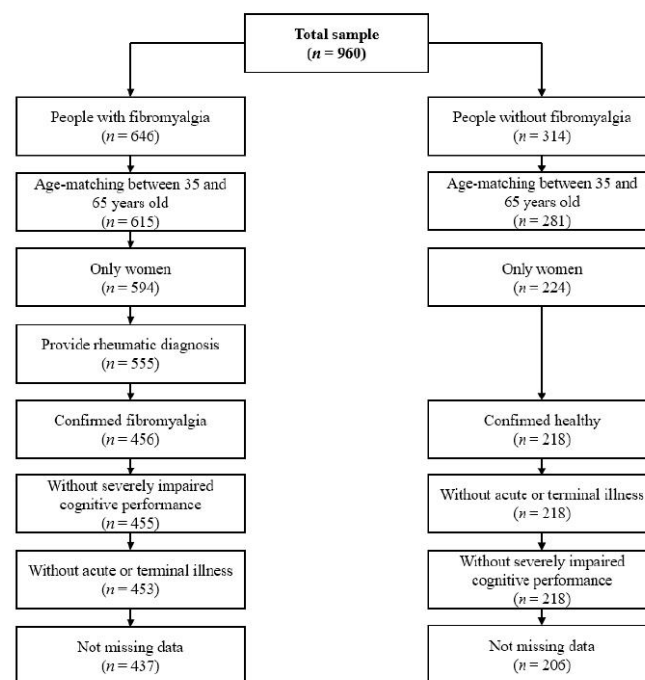
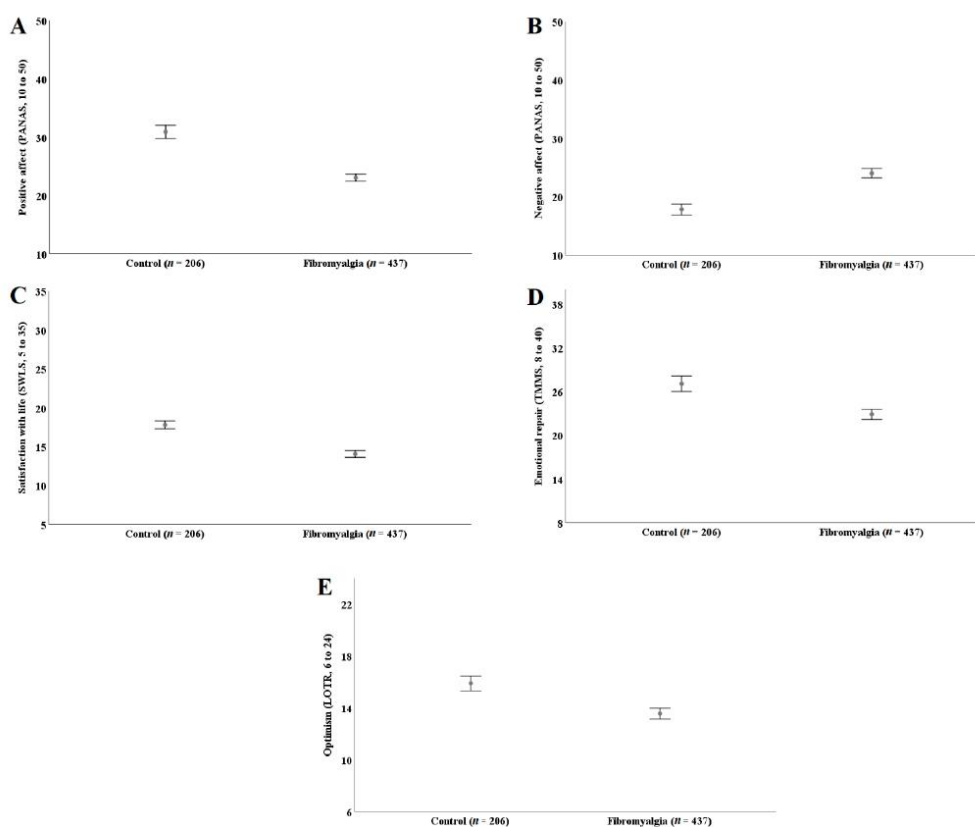


Figure 1. Flowchart of the participants.

A significant effect of the group emerged on positive psychology resources ( $V = 0.241$ ,  $F(5, 636) = 40.43$ ,  $p < 0.001$ ) adjusting for age and education level. Figure 2 (panel A to E) shows that women with fibromyalgia have lower levels of positive affect ( $F(1, 640) = 154.47$ , panel A), satisfaction with life ( $F(1, 640) = 100.23$ , panel C), emotional repair ( $F(1, 640) = 40.33$ , panel D) and optimism ( $F(1, 640) = 36.78$ , panel E), and higher levels of negative affect ( $F(1, 640) = 82.59$ , panel B) compared to women without fibromyalgia (all  $p$ 's  $< 0.001$ ). The effect sizes were medium (0.56 for emotional repair and 0.53 for optimism) and large (1.07 for positive affect,  $-0.79$  for negative affect and 0.87 for satisfaction with life).



**Figure 2.** Panel (A–E): Levels of positive affect, negative affect, satisfaction with life, emotional repair and optimism in women with and without fibromyalgia. PANAS: Positive and Negative Affect Schedule. SWLS: Satisfaction with Life Scale. TMMS: Trait Meta-Mood Scale. LOT-R: Life Orientation Test-Revised.

**Table 1.** Characteristics of the participants (*n* = 643).

Characteristics	Fibromyalgia ( <i>n</i> = 437)	Control ( <i>n</i> = 206)	<i>p</i> -Value
Age, mean (SD)	51.6 (7.1)	50.6 (7.2)	0.081
Education level, <i>n</i> (%)			0.004
Unfinished studies	40 (9.2)	11 (5.3)	
Primary studies	210 (48.1)	81 (39.3)	
Secondary studies	126 (28.8)	65 (31.6)	
Tertiary studies	61 (14.0)	49 (23.8)	
Marital status, <i>n</i> (%)			0.700
Married	332 (76.0)	149 (72.3)	
Single	34 (7.8)	21 (10.2)	
Separated/divorced	50 (11.4)	26 (12.6)	
Widow	21 (4.8)	9 (4.4)	
Missing data	0 (0)	1 (0.5)	
Time since fibromyalgia diagnosis, <i>n</i> (%)			
<1 year	28 (6.6)		
1–5 years	147 (34.6)		
>5 years	250 (58.8)		
Missing data	12 (2.7)		
Time since first symptoms until fibromyalgia diagnosis, <i>n</i> (%)			
<1 year	41 (9.6)		
1–5 years	181 (42.6)		
>5 years	203 (47.8)		
Missing data	12 (2.7)		

#### 4. Discussion

The aim of the present study was to compare the levels of positive affect, negative affect, satisfaction with life, emotional repair and optimism between women with fibromyalgia and age-matched peers without fibromyalgia (cases and controls, respectively). As we hypothesised, women with fibromyalgia experienced deficits in positive psychology resources. Large effect sizes were found for three components of subjective well-being (namely positive affect, negative affect and satisfaction with life; all, Cohen's  $d \geq 0.80$ ). Effect size ranged from small to medium for emotional repair and optimism. The comprehensive characterisation of the positive psychology of women with fibromyalgia provided in the present study may inform the development of tailored therapies for this disease. For instance, therapies targeted at improving positive affect may be a priority in fibromyalgia in order to improve the markedly high deficits observed in these resources of positive psychology.

In the present study, women with fibromyalgia experienced lower positive affect and higher negative affect than women without fibromyalgia, which concurs with previous findings from smaller samples [10,41–45]. Indeed, Zautra et al. [9] and Hassett et al. [11] underlined that, in women with fibromyalgia, positive affect and negative affect are more deteriorated than in women without fibromyalgia (healthy peers) or women with other rheumatic conditions (e.g., osteoarthritis). Previous case–control studies did not analyse satisfaction with life, which is the cognitive component of subjective well-being. The present findings confirmed that, in comparison to peers without fibromyalgia, women with the disease have lower levels of satisfaction with life. This finding is in line with several previous studies on chronic musculoskeletal pain [15,46–48]. Thus, it seems that fibromyalgia, similarly to other chronic pain conditions, imposes a burden on levels of subjective well-being in general and, particularly, on positive affect.

To the best of our knowledge, this is the first case–control study analysing levels of emotional repair and optimism in fibromyalgia, and it demonstrates that women with the disease also have deficits in cognitive- and personality-related aspects of positive psychology. Reduced levels in emotional repair [24] and optimism [49] have been previously observed in other populations with chronic pain. Thus, our findings extend previous observations from other chronic pain populations to fibromyalgia.

Previous studies concluded that more favourable levels of positive and negative affect [9–11], satisfaction with life [50], emotional repair [51] and optimism [22] are associated with better adaptation to fibromyalgia (e.g., reduced pain [45], fatigue [52] and disease severity [44]). Therefore, they are considered resources of adaptation to fibromyalgia. As a group, women with fibromyalgia showed the largest deficit in positive affect and large deficits in negative affect and satisfaction with life. Thus, therapies may focus on enhancing subjective well-being as a priority when aiming to increase positive psychology. The results of different studies collected in a previous meta-analysis revealed that positive psychology interventions do indeed significantly enhance well-being [53]. It is also important to note that fibromyalgia is a heterogeneous population [54] and that decisions about the aims of any therapy should be defined by a process of shared decision making with the person who has the disease [55,56].

Some limitations of the present study need to be mentioned. This study was conducted only on women and the findings are not generalisable to men. The study was designed cross-sectionally. Thus, it precludes the possibility of determining the causality of the associations under study. Additionally, a group of people with a chronic disease similar to fibromyalgia (e.g., chronic fatigue syndrome or bowel syndrome) was not included. Thus, it is unknown whether our findings are specific to fibromyalgia or generalisable to other similar diseases. Future longitudinal research including women and men as well as another disease control group is of interest. The strengths of the present study were the inclusion of (i) a large sample, (ii) a comprehensive assessment of the affective-, cognitive- and personality-related aspects of positive psychology and (iii) a corroboration by the research team that cases met the diagnosis of fibromyalgia by a physical examination and controls did not.

## 5. Conclusions

Women with fibromyalgia have lower values of positive affect, satisfaction with life, emotional repair and optimism, and higher values of negative affect than women without fibromyalgia. Large effect sizes were found for positive affect, negative affect and satisfaction with life. Thus, developing tailored therapies for fibromyalgia focusing on reducing deficits in positive psychology resources may be of clinical interest, though this remains to be corroborated in future research.

**Author Contributions:** Conceptualization, M.J.A.-G., I.T.-Q., A.C.-B. and F.E.-L.; methodology, M.J.A.-G., I.T.-Q., B.G.-C., O.L.-R., C.P.-P., Á.S.-R., A.C.-B. and F.E.-L.; software, M.J.A.-G. and F.E.-L.; formal analysis, M.J.A.-G., I.T.-Q., A.C.-B. and F.E.-L.; investigation, M.J.A.-G., I.T.-Q., B.G.-C., O.L.-R., C.P.-P., Á.S.-R., A.C.-B. and F.E.-L.; writing—original draft preparation, M.J.A.-G., I.T.-Q., A.C.-B. and F.E.-L.; writing—review and editing, M.J.A.-G., I.T.-Q., B.G.-C., O.L.-R., C.P.-P., Á.S.-R., A.C.-B. and F.E.-L.; visualisation, M.J.A.-G., I.T.-Q., A.C.-B. and F.E.-L.; supervision, I.T.-Q., A.C.-B. and F.E.-L.; project administration, B.G.-C., A.C.-B. and F.E.-L.; funding acquisition, B.G.-C., Á.S.-R., A.C.-B. and F.E.-L. All authors have read and agreed to the published version of the manuscript.

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**Institutional Review Board Statement:** The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethics Committee of the Hospital Virgen de las Nieves (Granada, Spain); registration number: 15/11/2013-N72.

**Informed Consent Statement:** Informed consent was obtained from all participants involved in the study.

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