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PHYSICAL FITNESS ASSESSMENT AND ITS ASSOCIATION WITH QUALITY OF LIFE IN PEOPLE WITH FIBROMYALGIA

EVALUACIÓN DE LA CONDICIÓN FÍSICA Y SU RELACIÓN CON LA CALIDAD DE VIDA EN PERSONAS CON FIBROMIALGIA

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INMACULADA C. ÁLVAREZ GALLARDO

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DEPARTAMENTO DE EDUCACIÓN FÍSICA Y DEPORTIVA
FACULTAD DE CIENCIAS DEL DEPORTE
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INMACULADA C. ÁLVAREZ GALLARDO

Directores de la Tesis Doctoral [Doctoral Thesis Supervisors]

Ana Carbonell Baeza
PhD
Profesora Contratada Doctora
Universidad de Cádiz

Manuel Delgado Fernández
PhD
Catedrático de Universidad
Universidad de Granada

Francisco B. Ortega Porcel
PhD
Investigador Ramón y Cajal
Universidad de Granada

Miembros del Tribunal [Doctoral Thesis Comittee]

Manuel J. Castillo Garzón
PhD
Catedrático de Universidad
Universidad de Granada

Palma Chillón Garzón
PhD
Profesora Titular
Universidad de Granada

Borja Sañudo Corrales
PhD
Profesor Contratado Doctor
Universidad de Sevilla

Luis Gracia Marco
PhD
Lecturer in Paediatric Exercise and Health
University of Exeter
United Kingdom

David Jiménez Pavón
PhD
Investigador Ramón y Cajal
Universidad de Cádiz

Granada, 11 de diciembre de 2015

Prof. Dra. Dña. Ana Carbonell Baeza
Profesora Contratada Doctora

Dpto. Didáctica de la Educación Física
Plástica y Musical
Facultad de Ciencias de la Educación
Universidad de Cádiz

ANA CARBONELL BAEZA, PROFESORA CONTRATADA DOCTORA DE LA UNIVERSIDAD DE CÁDIZ

CERTIFICA:

Que la Tesis Doctoral titulada "Evaluación de la condición física y su relación con la calidad de vida en personas con fibromialgia" que presenta Dña. **Inmaculada C. Álvarez Gallardo** al superior juicio del Tribunal que designe la Universidad de Granada, ha sido realizado bajo mi dirección durante los años 2011-2015, siendo expresión de la capacidad técnica e interpretativa de su autor en condiciones tan aventajadas que le hacen merecedora del Título de Doctora, siempre y cuando así lo considere el citado Tribunal.

Fdo. Ana Carbonell Baeza

En Granada, 14 de octubre de 2015

Prof. Dr. D. Manuel Delgado Fernández
Catedrático de Universidad

Dpto. de Educación Física y Deportiva
Facultad de Ciencias del Deporte
Universidad de Granada

MANUEL DELGADO FERNÁNDEZ, CATEDRÁTICO DE LA UNIVERSIDAD DE GRANADA

CERTIFICA:

Que la Tesis Doctoral titulada "Evaluación de la condición física y su relación con la calidad de vida en personas con fibromialgia" que presenta Dña. **Inmaculada C. Álvarez Gallardo** al superior juicio del Tribunal que designe la Universidad de Granada, ha sido realizado bajo mi dirección durante los años 2011-2015, siendo expresión de la capacidad técnica e interpretativa de su autor en condiciones tan aventajadas que le hacen merecedora del Título de Doctor, siempre y cuando así lo considere el citado Tribunal.

Fdo. Manuel Delgado Fernández

En Granada, 14 de octubre de 2015

Prof. Dr. D. Francisco B. Ortega Porcel
Investigador Ramón y Cajal

Dpto. de Educación Física y Deportiva
Facultad de Ciencias del Deporte
Universidad de Granada

FRANCISCO B. ORTEGA PORCEL, INVESTIGADOR RAMÓN Y CAJAL DE LA UNIVERSIDAD DE GRANADA

CERTIFICA:

Que la Tesis Doctoral titulada "Evaluación de la condición física y su relación con la calidad de vida en personas con fibromialgia" que presenta Dña. **Inmaculada C. Álvarez Gallardo** al superior juicio del Tribunal que designe la Universidad de Granada, ha sido realizado bajo mi dirección durante los años 2011-2015, siendo expresión de la capacidad técnica e interpretativa de su autor en condiciones tan aventajadas que le hacen merecedora del Título de Doctor, siempre y cuando así lo considere el citado Tribunal.

Fdo. Francisco B. Otega Porcel

En Granada, 14 de octubre de 2015

La doctoranda Dña. INMACULADA C. ÁLVAREZ GALLARDO y los directores de la tesis Dña. ANA CARBONELL BAEZA, D. MANUEL DELGADO FERNÁNDEZ y D. FRANCISCO B. ORTEGA PORCEL:

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Directores de la Tesis

Fdo. Ana Carbonell Baeza

Fdo. Manuel Delgado Fernández

Fdo. Francisco B. Ortega Porcel

Doctorando

Fdo. Inmaculada C. Álvarez Gallardo

En Granada, a 14 de octubre de 2015.

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Abbreviations

ACR, American College of Rheumatology

ACT, arm curl test

ANCOVA, analysis of covariance

ANOVA, analysis of variance

BCCG, Box-Cox Cole and Green

BCPE, Box-Cox power exponential

BMI, body mass index

BST, back scratch test

CI, confidence interval

CRF, cardiorespiratory fitness

CSR, chair sit-and-reach test

CST, 30-s chair stand test

FIQ, Fibromyalgia Impact Questionnaire

FLEX, flexibility

FM, fibromyalgia

GAMLSS, Generalized Additive Model for Location, Scale and Shape

ICC, Intraclass Correlation Coefficient

IFIS, International FItness Scale

HRQoL, health-related quality of life

MCS, mental component scale of the Short Form-36 Health Survey

MDC, minimal detectable change

MMSE, Mini Mental State Examination

MS, muscular strength

MWT, six minutes walk test

NO, normal

NS, not significant

PCS, physical component scale of the Short Form-36 Health Survey

RPE, rating of perceived exertion

SD, standard deviation

SE, standard error

SEM, standard error of measurement

SF-36, Short Form-36 Health Survey

SP-AG, speed-agility

SS, symptom severity

VAS, visual analog scale

WPI, Widespread Pain Index

RESUMEN

La fibromialgia es una enfermedad de etiología desconocida que se caracteriza por la presencia de dolor musculo-esquelético crónico generalizado y una elevada comorbilidad. Todo ello afecta notablemente la función física y la calidad de vida relacionada con la salud de la persona que la padece. Los niveles de condición física parecen estar muy relacionados con la sintomatología y severidad de la enfermedad, incluso algunos test de condición física han demostrado ser discriminatorios para su diagnóstico.

El objetivo general de esta Tesis Doctoral ha sido analizar la validez, fiabilidad y viabilidad de instrumentos de valoración de la condición física en mujeres con fibromialgia, así como aportar valores de referencia de condición física y comparar dichos valores con los de sujetos controles de la misma edad. Además, se examinó la asociación de la condición física con la calidad de vida en esta población. Para responder a estos objetivos se desarrollaron 4 estudios a partir de los datos recogidos en un proyecto piloto y un proyecto principal de investigación (proyecto al-Ándalus).

El estudio I se llevó a cabo con 100 mujeres con fibromialgia que participaron en el proyecto piloto. El estudio II, se llevó a cabo con 101 mujeres con fibromialgia del proyecto piloto (apartado de análisis de fiabilidad), más 413 mujeres con fibromialgia y 195 controles del proyecto principal al-Ándalus (apartado análisis de validez). En el estudio III participaron 489 personas con fibromialgia (21 hombres) y 415 controles (55 hombres), y para el estudio IV 466 mujeres con fibromialgia, todos ellos/as pertenecientes al proyecto principal al-Ándalus. Se evaluó la condición física mediante la batería Senior Fitness Test y dinamometría manual. La condición física auto-reportada se midió por medio del International FItness Scale (IFIS) y la calidad de vida relacionada con la salud mediante el Cuestionario de Salud SF-36.

Los principales hallazgos y conclusiones de esta Tesis Doctoral fueron: i) La batería de condición física Senior Fitness Test, y la prueba de fuerza de dinamometría manual presentan una buena fiabilidad para medir la condición física de mujeres con fibromialgia. Estas pruebas han mostrado una alta viabilidad, siendo rápidas y fáciles de

administrar; ii) IFIS puede ser una herramienta útil para identificar mujeres con fibromialgia con muy baja condición física y distinguirlas de las que tienen mayores niveles de condición física. Además, IFIS ha demostrado moderada fiabilidad en mujeres con fibromialgia; iii) Los niveles de condición física de personas con fibromialgia de Andalucía son muy bajos en comparación con personas sanas de la misma edad; iv) Mayores niveles de condición física se asocian de forma consistente a una mayor calidad de vida en mujeres con fibromialgia. La fuerza muscular se asocia independientemente con el componente físico, y la flexibilidad y la condición física cardiorrespiratoria con el componente mental de calidad de vida.

Los resultados de esta Tesis Doctoral han ayudado a incrementar el conocimiento acerca de herramientas válidas y fiables para medir condición física en personas con fibromialgia, así como ha aportado valores de referencia por grupos de edad de condición física de una muestra geográficamente representativa del sur de España. Los resultados sugieren también que una mejor condición física podría contribuir a mejorar la calidad de vida en mujeres con fibromialgia. Estudios de intervención futuros confirmarán o contrastarán estos resultados, aumentando el conocimiento acerca del potencial preventivo y terapéutico del ejercicio físico y la condición física en esta población.

ABSTRACT

Fibromyalgia is a disorder of unknown etiology, characterized by widespread chronic pain and multiple comorbidities. Fibromyalgia has a larger impact on the physical function and health-related quality of life (HRQoL) of those with the condition. Physical fitness seems to be closely related to symptomatology and fibromyalgia severity. Indeed some physical fitness tests have been demonstrated to discriminate between the presence or absence of fibromyalgia.

The overall objective of the present Doctoral Thesis has been to analyse the validity, reliability and feasibility of instruments to assess physical fitness in women with fibromyalgia, as well as to provide age-specific reference values of physical fitness and to compare them with age-matched controls. Additionally, the association of physical fitness with HRQoL was assessed in this population. To address these aims, four studies were conducted in the context of a Pilot project and the main research project (the al-Ándalus project).

Study I was carried out with 100 women with fibromyalgia that participated in the Pilot project. Study II was performed with 101 women with fibromyalgia of the Pilot project (reliability sub-study), plus 415 women with fibromyalgia and 195 control participants of the al-Ándalus project (validity sub-study). Study III involved 489 people with fibromyalgia (including 21 men) and 415 controls (including 55 men), and Study IV included 466 women with fibromyalgia, all belonging to the al-Ándalus project (main project). Physical fitness was assessed with the Senior Fitness Test battery and handgrip test. Self-reported physical fitness was measured with the International FItness Scale (IFIS) and HRQoL was measured with the 36-item Short-Form Health Survey.

The main findings and conclusions of this Doctoral Thesis were: i) The Senior Fitness Test battery, and the handgrip test demonstrated good reliability in the measurement of physical fitness in women with fibromyalgia. These tests were quick and easy to administer, and as such feasible to use with this population; ii) The IFIS was demonstrated to be a useful tool to identify women with fibromyalgia who had very low physical fitness and distinguish them from those with higher physical fitness levels.

Furthermore, the IFIS has demonstrated moderate test-retest reliability in women with fibromyalgia; iii) Physical fitness levels of people with fibromyalgia from Andalusia are very low in comparison with age-matched healthy controls; iv) High physical fitness was consistently associated with better HRQoL in women with fibromyalgia. Muscle strength was independently associated with the physical component of HRQoL, whereas flexibility and cardiorespiratory fitness were independently associated with the mental component.

The results of this Doctoral Thesis have provided valid, reliable and feasible tools to measure physical fitness in people with fibromyalgia, as well as, age-specific reference values of physical fitness of a geographically representative sample of the south of Spain. Results also suggest that a better physical fitness could contribute to a better HRQoL in women with fibromyalgia. Future intervention studies, based on the results of this Doctoral Thesis, will increase the knowledge about the preventive and therapeutic value of exercise and physical fitness in this population.

I

INTRODUCTION

INTRODUCTION

1. Fibromyalgia: definition, epidemiology, burden for the health care system and diagnosis.

1.1. Definition and etiology

Fibromyalgia is a chronic disease characterized by widespread musculoskeletal pain, as well as the presence of multiple sites of tenderness[1]. Fibromyalgia is considered a disorder of pain regulation[2], indicated by an increased sensitivity to painful stimuli (hiperalgesia) and lower pain threshold (allodynia)[3]. Although pain is the main symptom, fibromyalgia has been defined as a complex multidimensional disorder[4], and there are others important no-pain symptoms, such as fatigue, stiffness, cognitive problems, depression and anxiety between other complains[4,5]. The presence of widespread pain and the high prevalence of comorbidities, restrict activities of daily living of people that suffer it and have a massive impact on the patient´s illness perception[6] and quality of life[7–9].

The cause of fibromyalgia is still unknown[10]. The increased pain sensitivity in fibromyalgia is not limited to mechanical stimuli, and also includes electrical, heat and cold stimuli[11,12]. Accumulating evidence suggest that abnormal central pain processing could explain the increased pain sensitivity, since central nervous system sensory processing shows abnormalities in this population[3,13,14]. Although the pathophysiology of fibromyalgia still remains unclear, recent studies indicate that genetics and environmental factors play a key role in the etiology of the disease[15]. A genome-wide linkage study reported that siblings of patients with fibromyalgia have a 13-fold increased risk of developing the condition compared with the general population and a single region of chromosome 17 was linked to fibromyalgia[16].

1.2. Prevalence and burden

The prevalence of fibromyalgia in the general population ranges from 2 to 8%[17]. In Spain, the prevalence of fibromyalgia is ~2.4%, being more frequent in rural (~4.1%) than in urban settings (~1.7%)[18]. The clinical manifestation of fibromyalgia appears between the 40s and 50s, and is more common in women (~4.2%) than in men (~0.2%)[18]. Recent studies have suggested the inclusion of the new preliminary fibromyalgia criteria[19,20] for diagnosis, and this might lead to a greater proportion of men diagnosed. Due to the low proportion of men diagnosed with fibromyalgia, studies have mainly focused in women.

Fibromyalgia is currently a burden for the health care system[21], with significant direct and indirect medical care costs[22,23]. In Spain, after controlling for age and sex, a study[23] revealed that fibromyalgia patients incurred 614€ more in average annual health care (direct) costs and 4,397€ more indirect costs in comparison with the reference group, totalling an extra annual average cost of 5,011€ per patient. Furthermore, both, direct and indirect costs have been significantly correlated to disease severity, the degree of functional disability, the presence of depressive symptoms, the existence of comorbidities, and a younger patient age[24]. Therefore, it is important to find modifiable factors that may be associated with more favourable profile in relation to core fibromyalgia symptoms and quality of life in this population. An up-to-date study has shown that treated patients with fibromyalgia in daily practice improve their clinical symptoms and reduce the costs of the illness[24].

1.3. Diagnosis

The main problem in fibromyalgia is the absence of a gold standard or criteria for the diagnosis to the disease[19]. In 1990, the American College of Rheumatology (ACR) reported the first fibromyalgia diagnosis criteria[1]. The diagnosis was mostly based on the identification of tender points. The 1990 ACR criteria for the diagnosis of fibromyalgia considers: widespread pain for at least 3 months and pain with ≤4 kg/cm^2 of pressure for 11 or more of 18 tender points[1].

As time passed, objections to the 1990 ACR criteria developed, being the bases that the presence of different tender points cannot be an objective assessment of whole body pain[25]. Furthermore, fibromyalgia has been defined as a complex multidimensional pain disorder[4,19] with the inclusion of other non-pain symptoms, such as fatigue, stiffness, depression and cognitive problems among other complaints[4,5].

Twenty years later to the 1990 ACR, Wolfe et al[19] proposed the ACR new preliminary diagnostic criteria for fibromyalgia. The objective of this new criteria was to simplified clinical diagnosis avoiding the requirement of tender points examination[19]. The 2010 ACR criteria was modified in 2011 to allow complete self administration[20]. This modified 2010 ACR criteria eliminated the physicians´ subject assessment thus making it a self-administered questionnaire suitable for epidemiological studies[20]. The 2010 ACR criteria and the modified 2010 ACR criteria have been validated in different languages[26–28] and have shown its validity in Spanish population[29]. The coexistence of both, 1990 and 2010 ACR criteria (meeting one of the two), might be a better option that using the modified 2010 ACR criteria alone[29], and their combination might be potentially useful to identify subgroups of fibromyalgia patients[30].

The modified 2010 ACR diagnostic criteria are composed by two scales: a) The Widespread Pain Index (WPI) is a measure of the number of painful body regions. The patients are asked to indicate in which of 19 body areas they had pain during the week before. The minimum total score of WPI is 0 and the maximum total score is 19. B) The Symptom Severity (SS) score is a measure of symptomatology: patients are asked to indicate the severity of fatigue, trouble thinking or remembering and walking up tires (unrefreshed) over the previous week; and to answer whether (or not) they have had pain or cramps in the lower abdomen, depression or headache during the previous 6 months. The minimum total score of SS is 0 and the maximum total score is 12. This preliminary diagnostic criteria establish 3 conditions: i) WPI ≥7, and SS ≥ 5, or WPI between 3-6 and SS ≥ 9; ii) Symptoms have been present at a similar level for at least 3 months; iii) The patients do not have a disorder that would otherwise explain the pain.

2. Physical fitness and fibromyalgia

Physical fitness has been defined as a set of attributes related to a person's ability to perform physical activities that require cardiorespiratory fitness, endurance, strength or flexibility and is determined by a combination of regular activity and genetically inherited factors[31]. The fitness components studied in the present Doctoral Thesis are flexibility, muscular strength, speed-agility and cardiorespiratory fitness. From a conceptual point of view, flexibility is a health-related component of fitness that relates to the range of motion available at a joint[32]; Muscular strength is a health-related component of fitness that relates to the amount of external force that a muscle can exert[32]; Speed-agility is a component of fitness that implicates the ability of an individual to rapidly change the position of the entire body in space with speed and accuracy[32]; Cardiorespiratory fitness is a health-related component of physical fitness that reflects the overall capacity of the cardiovascular and respiratory systems and the ability of an individual to perform prolonged exercise[32].

Physical fitness has been consistently identified as a powerful predictor of morbidity and mortality[33–35] in the general population, regardless of physical activity[36], age, smoking, adiposity and other disease risk factors[37]. Physical fitness is inversely associated in different populations with the risk for cardiovascular diseases[38,39], back pain[40], low bone mineral density[41], metabolic syndrome[42], or psychiatric conditions[43,44] (among others).

In fibromyalgia, physical fitness is decreased compared to that of age-matched healthy peers[45–47] and is similar to that of healthy older adults[46,48]. Overall, patients with chronic pain usually reduce their physical activity levels, resulting in deconditioned fitness status[49,50]. On the other hand, higher levels of physical fitness have been related to lower levels of pain[51], fibromyalgia severity[52,53] and better quality of life in people with fibromyalgia[54–56]. Furthermore, exercise programs that improve physical fitness have proved to be effective in the management of the illness[57–60]. It is therefore plausible that physical fitness plays an important role with regards to fibromyalgia symptomatology and might be considered a relevant marker of health in this illness.

Due to the importance of physical fitness in fibromyalgia, simple, practical, valid and reliable tools can be helpful in the clinical examination and evaluation of patients. Physical fitness can be assessed through performance based tests or self-reported measures. In this context, many researchers have recommended that both performance-based and self-report functional measures can be used to assess physical fitness[61–66].

The Senior Fitness Test battery[67] and the handgrip strength test[68] have been previously used in fibromyalgia patients[50,69–73], but its reliability in fibromyalgia is unknown. Reliability is a characteristic that need to be assured for any measurement tool[74]. A reliable test is considered when an individual performs a test on two or more occasions under the same conditions and close proximity in time and obtains similar results[75]. It is important, then, to study the reliability of those physical fitness tests in women with fibromyalgia (Study I).

On the other hand, laboratory or performance-based fitness test are not always practical or possible to conduct in clinical settings or in large surveys and epidemiological studies. A cheap and quick tool to estimate physical fitness would be helpful in fibromyalgia. Additionally, a discrepancy between self-reported disability and clinically observed disability has been reported in people with fibromyalgia[76]. Therefore, even when performance-based fitness testing is feasible, a complementary tool to assess self-reported fitness levels might provide useful and complementary information. The International FItness Scale (IFIS) is a self-reported measure of physical fitness that could easily be implemented in patients with fibromyalgia. This scale has been validated in children[77], adolescents[78] and in young adults[79]. The symptoms and comorbidities found in people with fibromyalgia (e.g. pain, chronic fatigue, non-restorative sleep, depression or cognitive impairment) could influence the accuracy of self-reported physical fitness. Therefore, it is important to know if IFIS is valid and reliable in women with fibromyalgia (Study II).

Moreover, recent studies suggest that fitness testing could be used as a complementary tool in the diagnosis[80] and monitoring[70] of fibromyalgia. In this context, it is of clinical interest to provide normative values of different components of physical fitness. A better characterization and complete description of physical fitness in people with fibromyalgia (Study III) will improve the knowledge of the disease and the prescription of individualized exercise doses[81]. In the last years, reference data of physical fitness have been provided in healthy adults[82], adolescents[83] and children[84], while to the better of our knowledge, only a previous study worldwide with a relatively small sample size has reported reference values for women with fibromyalgia[50].

3. Physical fitness and health-related quality of life in people with fibromyalgia

Health-related quality of life (HRQoL) in people with fibromyalgia is deteriorated due to the wide impact of this illness in those who suffer it[8,9]. Different types of interventions are used in the management of fibromyalgia (i.e. pharmacological, exercise, educational, psychological or alternative therapies)[10]. There is strong evidence that regular exercise substantially improves HRQoL in populations with serious diseases such as cancer[85], chronic obstructive pulmonary disease[86], as well as in other health conditions, as for example, in postmenopausal women with overweight or obesity[87]. In fibromyalgia, most improvements of exercise interventions focused on cardiorespiratory fitness were found for HRQoL and pain relief[58]. Furthermore, exercise interventions focused on muscular strength found also most improvements on HRQoL (between others)[59]. Exercise interventions for the management of fibromyalgia rarely focused on flexibility or speed-agility and there is a lack in the literature about the effects of these exercise programs in HRQoL. However, multi-component exercise programs that includes these physical fitness components obtained improvements in physical fitness, symptomatology and HRQoL[88,89]. In exercise programs for fibromyalgia, it is essential to understand and evaluate all aspects of people with fibromyalgia, including health-related physical fitness parameters. Identifying which physical fitness components are associated with HRQoL in people with fibromyalgia may contribute to the development of more specific therapeutic strategies[90]. Moreover, although physical fitness has been related with HRQoL in people with fibromyalgia, studies have generally focused on the association of a single component of physical fitness with HRQoL separately. For the above mentioned, it is important to improve understanding of the associations of overall physical fitness and HRQoL and it is needed a comprehensive characterization of the independent and combined association of different components of physical fitness (flexibility, muscular strength, speed-agility and cardiorespiratory fitness) with HRQoL to optimize future exercise intervention studies in this population (Study IV).

A

OBJETIVOS / AIMS

OBJETIVOS

General:

El objetivo general de esta Tesis Doctoral ha sido analizar la validez, fiabilidad y viabilidad de instrumentos de valoración de la condición física en mujeres con fibromialgia, así como aportar valores de referencia de condición física por grupos de edad y comparar dichos valores con los de sujetos controles de la misma edad. Además, se examinó la asociación de la condición física con la calidad de vida en esta población.

Específicos:

- Analizar la fiabilidad y viabilidad de la batería de condición física "Senior Fitness Test" y de la prueba de fuerza de dinamometría manual en mujeres con fibromialgia. **(Estudio I)**

- Examinar la fiabilidad y validez del cuestionario "International Fitness Scale-IFIS" (condición física auto-reportada) en comparación con medidas objetivas de la condición física en mujeres con fibromialgia y en mujeres sanas. **(Estudio II)**

- Aportar valores de referencia de condición física por franjas de edad de personas con fibromialgia de una muestra geográficamente representativa del sur de España; y comparar dichos valores con los de sujetos controles de la misma edad. **(Estudio III)**

- Analizar la asociación entre los diferentes componentes de la condición física y calidad de vida relacionada con la salud en mujeres con fibromialgia. **(Estudio IV)**

AIMS

Overall:

The overall objective of the present Doctoral Thesis has been to analyse the validity, reliability and feasibility of instruments to assess physical fitness in women with fibromyalgia, as well as to provide age-specific reference values of physical fitness and to compare them with age-matched controls. Additionally, the association of physical fitness with quality of life was assessed in this population.

Specifics:

- To analyze the reliability and feasibility of the Senior Fitness Test battery and handgrip test in women with fibromyalgia. **(Study I)**

- To examine the reliability and construct validity of the International FItness Scale-IFIS (i.e. self-reported fitness) against objectively measured physical fitness in women with fibromyalgia and in healthy women. **(Study II)**

- To report age-specific physical fitness levels in people with fibromyalgia of a geographically representative sample from the south of Spain; and to compare them with age-matched controls. **(Study III)**

- To examine the associations of different physical fitness components with health-related quality of life in women with fibromyalgia. **(Study IV)**

M

MATERIAL AND METHODS

MATERIALS AND METHODS

Design and population sample size estimations

The present Doctoral Thesis belongs to the al-Ándalus project (cross-sectional study), and the Pilot project that was performed prior to the al-Ándalus project. The al-Ándalus project recruited a geographically representative sample of people with fibromyalgia from Andalusia, southern Spain. To assure geographical representativeness of the Andalusian Region (southern of Spain), a two-phase (sex and province) proportional sampling of fibromyalgia patients was planned. We used as a reference the database of Spanish Association of Rheumatology, as well as the Census of the 8 provinces of Andalusia (Andalusian population by province according Multi-territorial Information System of Andalusia -http://www.juntadeandalucia.es/institutodeestadisticaycartografia/sima/index2.htm-). The level of accuracy (*k*) was set as a fraction of the standard deviation of the population (accuracy=*k*standard deviation*). Following the common practice in clinical studies, we selected a *k* of 10-50%. Therefore, for a confidence interval of 95%, a sample consisting of 300 participants (240 women and 60 men) were needed to obtain an accuracy of 11%. The final sample was oversized in order to prevent loss of information.

Recruitment of the subjects

The Pilot project was performed with women with fibromyalgia from a local patient association in Granada, Spain. We contacted this local association and 116 potentially eligible patients responded and gave their written informed consent after receiving detailed information about the aims and study procedures in an informative session.

For the al-Ándalus project, local patient associations were contacted by e-mail, letter or telephone. Additionally, healthy volunteers (controls) were recruited via fibromyalgia participants' acquaintances, e-mail and internet advertisements, all between 2011 and 2013 (cross-sectional study of the al-Ándalus project). A total of 960 potentially eligible participants were recruited (607 participants with fibromyalgia and 353 controls). All participants were informed of the study aims and procedures and signed written informed consent to participate.

In the study III (reference values of physical fitness), we also included data from another research project conducted by our team in perimenopausal women (n = 127, used as controls), since these women were from the same geographical area and in the same age range, as well as performed exactly the same physical fitness tests carried out in the al-Ándalus project and by the same evaluators.

Inclusion criteria

Inclusion criteria to the Pilot project were: (1) to be previously diagnosed with fibromyalgia and meeting the ACR criteria: widespread pain for more than 3 months, and pain with ≤ 4 kg/cm^2 of pressure reported for 11 or more of 18 tender points for fibromyalgia classification[1]; (2) not to have acute or terminal illness (i.e. cancer, stroke, recent cardiomyopathy, severe coronary disease, and severe chronic obstructive pulmonary disease) nor severe cognitive impairment (the Mini Mental State Examination score <10)[91]; (3) to be able to ambulate and communicate; and (4) to be woman. Sample to the Pilot project was used in studies I and II (for reliability purposes).

Inclusion criteria to the al-Ándalus project for participants with fibromyalgia were the same that for the Pilot project with the exception that participants of both sexes were included. The participants from the control group had to meet the same criteria except those that were disease-specific (i.e. fibromyalgia diagnosis and to meet the 1990 ACR criteria). Sample to the al-Ándalus project was used in studies II, III and IV.

Some additional inclusion criteria were set for the studies that compose the present Doctoral Thesis: a common criterion for all studies was *to have available data for at least one of the physical fitness tests.* Furthermore, others inclusion criteria were:

- *STUDY I:* (i) To be women younger than 65 years old.

- *STUDY II:* For the reliability analyses (Pilot project sample); (i) participants had to be aged ≤65 years.

  For the validity analyses (al-Ándalus project sample); (i) participants had to be aged between 37 and 65 years, to obtain age-matched groups; (ii) should not have participated in any other assessments involving physical fitness within the last 3 months to avoid influence on self-reported fitness; (iii) to have available data for the IFIS questionnaire and (iv) to be women.
- *STUDY IV:* (i) To have available data for the Short Form-36 Health Survey (SF-36) questionnaire and (ii) to be women.

Screening of participants

Screening of participants to the Pilot project:

Six potentially eligible participants were men, two had orthopedic or musculoskeletal limitations, and five did not carry out one of the two assessments. The final sample was 103 women with fibromyalgia. One woman had 65 years old and two women were older than 65 years, therefore, the final sample for study I was 100 women (age criteria was to be younger than 65) and for reliability analyses to the study II was 101 (inclusion criteria was to be aged ≤ 65 years) women with fibromyalgia.

Screening of participants to the al-Ándalus project:

Figure 1 shows the flow chart of participants from the al-Ándalus project.

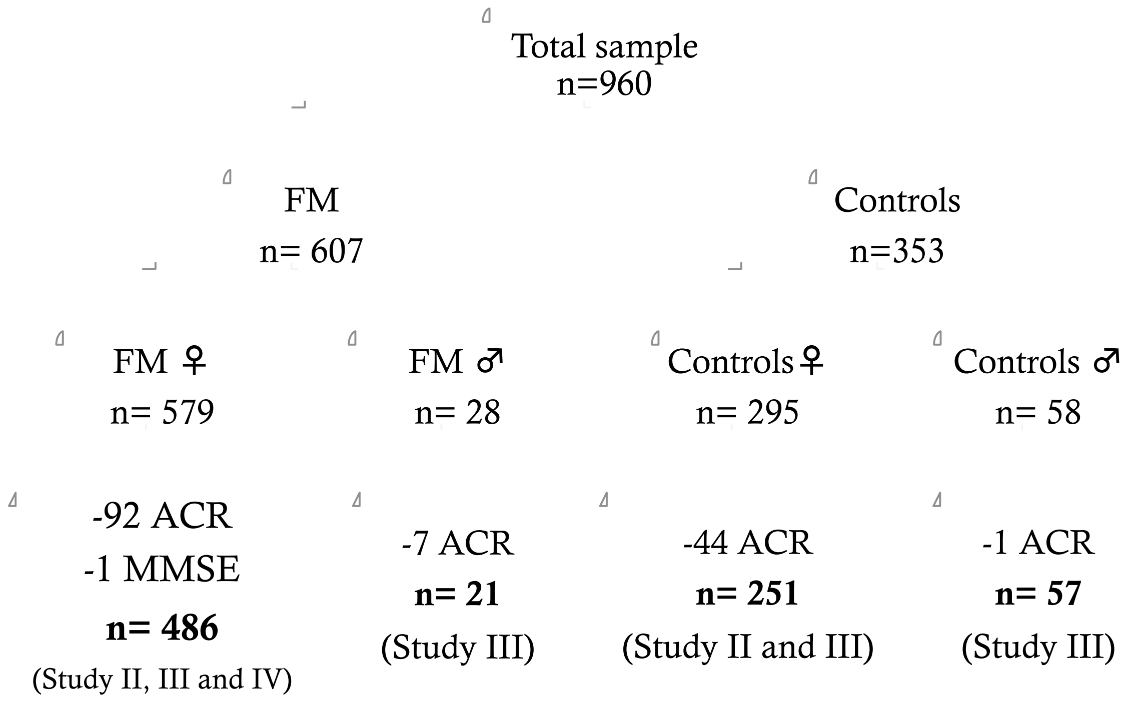

Figure 1. Flow diagram of the study participants in al-Ándalus project.
FM, fibromyalgia; ACR, American College of Rheumatology; MMSE, Mini Mental State Examination; ♀, women; ♂ men.

After inclusion criteria screening to the al-Ándalus project, the screening for the present Doctoral Thesis was:

- *STUDY II:* For validity purposes, 39 potentially eligible participants with fibromyalgia were not aged between 37-65 years, 31 participated in physical fitness assessments within the last three months, and three did not have available data for at least one of the physical fitness tests. In the control group, 55 were not aged between 37-65 years and one did not have available data for at least one of the physical fitness tests. The final sample of the Study II comprised 101 women with fibromyalgia (sample of the Pilot project) for reliability purposes and 608 women (413 with fibromyalgia and 195 controls) for validity purposes.

- *STUDY III:* One hundred twenty seven potentially eligible control women from the perimenopausal study were added to the 251 control women to the al-Ándalus project (n= 378). Eighteen women with fibromyalgia, 18 control women and two control men did not have available data for at least one of the physical fitness tests. The final sample of the Study III was 468 women and 21 men with fibromyalgia, 360 control women and 55 control men.

- *STUDY IV:* Eighteen participants did not attend the second evaluation day and were excluded because did not have data for at least one of the physical fitness tests and did not complete the SF-36 questionnaire. Additionally, two participants that attend to the second evaluation day did not complete the SF-36 questionnaire. The final sample comprised 466 women with fibromyalgia.

Ethical issues

The study was performed following the ethical guidelines of the Declaration of Helsinki, last modified in 2000. Ethics approval was obtained by the Ethics Committee of the Hospital Virgen de las Nieves (Granada, Spain) and all patients gave written informed consent.

Protocols

Protocol for the Pilot project

Three measurement conditions, separated by an interval of 14 days, were performed during appointments that took place at the local association of patients with fibromyalgia of Granada. The participants were asked not to change their medications, habitual lifestyles, or undergo any treatments during the study period. In both projects (Pilot project and al-Ándalus project), the whole evaluation process was carried out by the same team of researchers who had previously received specific training.

- **First appointment, day 1:** During the first appointment, the Mini-Mental State Examination (MMSE)[91] was applied in a private room for inclusion purposes and the diagnosis of fibromyalgia was confirmed by means of the tender point's examination[1]. The sociodemographic and personal medical records of the fibromyalgia patients were registered. In addition, the Spanish version of the FIQ[92], SF-36[93], and the IFIS[77–79] were administered.
- **Second appointment, day 7:** During the second appointment (7 days later), body composition was assessed and the IFIS was administered. After IFIS, VAS pain was assessed and physical fitness tests were performed. Furthermore, RPE was monitoring after each test.
- **Third appointment, day 14:** Seven days later to the second appointment (day 14), physical fitness assessment was performed. Prior to the physical fitness test VAS pain was assessed and RPE was monitoring after each test of physical fitness.

Table 1 presents an overview of the global assessment procedure undertaken in the Pilot project.

Table 1. General overview of the assessments carried out in the Pilot project.

Assessments	Day 1	Day 7	Day 14
MMSE	X		
Tender points (ACR criteria)	X		
Body composition		X	
Sociodemographic questionnaire	X		
FIQ	X		
IFIS	X	X	
SF-36	X		
Physical fitness		X	X

MMSE, Mini-Mental State Examination; ACR, American College of Rheumatology; FIQ, Fibromyalgia Impact Questionnaire; IFIS, International Fitness Scale; SF-36, Short Form-36 Health Survey.

General protocol for the al-Ándalus project

The evaluation process was performed on two alternate days (e.g. Monday and Wednesday) either at the University facilities or at fibromyalgia associations. The assessments were carried out either in morning or afternoon sessions, according to the participants' convenience. On day 1, the Mini-Mental State Examination (MMSE)[91] was applied in a private room for inclusion purposes and the diagnosis of fibromyalgia was confirmed by means of the tender point's examination[1], which was performed by a single trained researcher. In addition, anthropometric measurements and body composition were assessed, and a complete self-reported sociodemographic questionnaire (assessing age, marital status, educational level, occupational status, medication usage, etc.) was filled by participants. Participants were then given the IFIS[77–79] and the SF-36[93] to fill at home (day 2) and bring on the next assessment day (day 3). On the second appointment, day 3, the research team verified that the questionnaire was properly and completely filled. Thereafter, the physical fitness assessment was undertaken. **Table 2** presents an overview of the global assessment procedure undertaken in the al-Ándalus project.

Table 2. General overview of the assessments carried out in the al-Ándalus project.

Assessments	**Day 1**	**Day 2 (Home)**	**Day 3**
MMSE	X		
Tender points (ACR criteria)	X		
Body composition	X		
Sociodemographic questionnaire	X		
IFIS		X	
SF-36		X	
Physical fitness			X

MMSE, Mini-Mental State Examination; ACR, American College of Rheumatology; IFIS, International Fitness Scale, SF-36, Short Form-36 Health Survey.

Outcomes

Sociodemographic characteristics and medication usage

Participants filled a complete self-reported sociodemographic questionnaire. Age, years since clinical diagnosis, marital status, occupational status, educational level, medication usage and menopause were measured (between others). Marital status was classified in married, unmarried, separated, divorced and widowed. Educational level was classified in six categories: no studies, primary school, professional training, secondary school, university medium degree and university higher degree. Furthermore, the usage of analgesic, antidepressants, anticonvulsants, and stimulants was registered as binary variables (yes/no) to be used as control variables in subsequent analyses.

Cognitive impairment

The Spanish version[94] of the MMSE[91] was used to assess severe cognitive impairment. It consists of 30 items grouped into seven categories: orientation to place, orientation to time, registration, attention and concentration, recall, language, and visual construction. The MMSE ranges from 0 to 30. Severe cognitive impairment was considered as the MMSE score < 10[91].

Tender points examination

The 18 tender points according to the ACR criteria[1] were assessed using a standard pressure algometer (FPK 20; Wagner Instruments, Greenwich, CT, USA). The pain threshold at each tender point was determined by applying increasing pressure with the algometer perpendicular to the tissue, at a rate of ~1 kg/s. Patients were asked to say "stop" at the moment pressure became painful. The mean of two measurements at each tender point was used for the analysis. Tender point scored as positive when the patient noted pain at pressure of 4 kg/cm^2 or less. The total count of positive tender points was recorded for each participant.

Body composition and anthropometric measurements

We used a portable eight-polar tactile-electrode impedanciometer (InBody R20, Biospace, Seoul, Korea) to measure weight (kg) and body fat. The measurements were made at least two hours after the last lunch, released from clothing and metal objects and having remained standing at least 5 minutes before the assessment. Height (cm) was measured using a stadiometer (Seca 22, Hamburg, Germany). BMI was calculated as weight (kg) divided by height squared (meters). The validity and reliability of this instrument has been reported elsewhere[95].

Fibromyalgia Impact

To better describe the characteristic of the study sample in Study I, we assessed fibromyalgia severity and pain with the Spanish version[92] of the Fibromyalgia Impact Questionnaire (FIQ)[96]. It is composed of ten subscales: physical impairment, overall well-being, work missed, and a seven items (subscales) of a visual analog scale (VAS) marked in 1-cm increments on which the patient rates the work difficulty, pain, fatigue, morning tiredness, stiffness, anxiety, and depression. The FIQ score ranges from 0 to 100. A higher value indicates a higher impact of the disorder[97].

Pain visual Analogue Scale (VAS)

A 10-cm VAS[98] was used to asses pain. It 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. Previous findings suggest that baseline pain acts as an occasion setter which determines the level of physical activity the patient is willing to perform, regardless of pain increase[99].

Physical fitness

Physical fitness was assessed by means of the standardized Senior Fitness Test battery[67], and the handgrip strength test[68]. These tests are commonly used in fibromyalgia[50,69–73]. This battery of tests assesses flexibility, muscular strength, speed-agility, and cardiorespiratory fitness. To prevent fatigue, the tests were carried out alternating upper and lower body tests with one minute rest between tests in the following order: chair sit-and-reach, back scratch, handgrip, 30-s chair stand, arm curl, 8-foot up-and-go and 6-minute walk tests.

- *Lower body flexibility:* In the "*Chair sit-and-reach test*", the participant was seated with one leg extended, slowly bending forward and 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 (negative score) or reaching beyond it (positive score) was recorded[67]. The test was performed twice for each leg (alternating between legs), and the average of the best score for each leg was selected.
- *Upper body flexibility:* The "*Back scratch test*", provides a measure of the overall shoulder range of motion, as the distance between (or overlap of) the middle fingers behind the back with a ruler[67]. Participants performed the test twice (alternating between arms) and the average of the best score for each hand was used.
- *Lower body muscular strength:* The "*30-s chair stand test*" involves counting the number of times, in 30 seconds 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. Participants performed one trial after becoming familiar with the procedure[67].
- *Upper body muscular strength:* The "*Arm curl test*" involves determining the number of times a hand weight (2.3 kg for women and 3.6 kg for men) can be curled through a full range of elbow motion in 30 seconds[67]. The test was performed once with each arm and the average number of repetitions was recorded. The "*handgrip te*st" was performed with a digital dynamometer (TKK 5101 Grip-D; Takey, Tokyo, Japan) as described by Ruiz[68]. Participants performed the test twice for each hand (alternating between hands), with one minute rest between trials. The average of the best score for each hand was used.
- *Speed-agility:* The "*8-foot up-and-go test*" involves standing up from a chair, walking 8 feet (2.44m) to a cone, and returning to the chair in the shortest period of time[67]. The best time of two trials was recorded.
- *Cardiorespiratory fitness:* The *"6-minute walk test"* measures the maximum distance (in meters) that participants are able to walk in six minutes along a 45.7 m rectangular

course. This test has been shown to be a valid and reliable measure of cardiovascular fitness in women with fibromyalgia[67,100].

Rating of perceived exertion (RPE)

The RPE was monitoring using the Borg's conventional (6–20 point) scale[101]. It was therefore possible to analyse whether the baseline pain and perceived exertion were similar in both assessment appointments of the Pilot project (Study I).

Self-reported physical fitness

Self-reported fitness was assessed by means of the IFIS, previously validated in Spanish children[77], European adolescents[78] and in young Spanish adults[79]. The IFIS comprises five Likert-scale questions about self-reported fitness (available at the HELENA study Web site: http//www.helenastudy.com/IFIS). Each question has five response options (very poor, poor, average, good, and very good) about overall fitness and specific fitness components: flexibility, muscular strength, speed-agility, and cardiorespiratory fitness.

Health-related quality of life (HRQoL)

The Spanish version[93] of the Short Form-36 Health Survey[102] was used to assess HRQoL. This questionnaire is composed of 36 items that assesses eight dimensions: physical functioning, physical role, bodily pain, vitality, social functioning, emotional role, mental health, and general health. It examines two main standardized global domains of health, namely the physical and mental component scales (PCS and MCS, respectively). Each dimension and global component scores ranges from 0 (worst possible health status) to 100 (the best possible health status). Internal consistency of the SF-36 showed an alpha coefficient between .78 for the vitality dimension and .96 for the SF-36 physical role dimension[93]. The SF-36 has been demonstrated to have good reliability and validity in chronic pain patients[103].

A summary of the variables and methods utilised in the present Doctoral Thesis are presented in **table 3**.

The questionnaires used (IFIS and SF-36) in the present Doctoral Thesis are presented as Annexes (page 153).

Table 3. Summary table of the methods used in this Doctoral Thesis.
FM, fibromyalgia; IFIS, International FItness Scale; SF-36, HRQoL, Health Related

Study	Design	Project	Participants	Main variables	Methods
I	Cross-sectional	Pilot project	100 FM women	Physical fitness	Senior Fitness Test battery
II	Cross-sectional	The al-Ándalus project (sub-study 1) and Pilot project (sub-study 2)	Sub-study 1, 608 women: 413 FM /195 control Sub-study 2: 101 FM women	Physical fitness and IFIS	Senior Fitness Test battery and IFIS questionnaire
III	Cross-sectional	The al-Ándalus project	489 FM: 468 women / 21 men 415 controls: 360 women / 55 men	Physical fitness	Senior Fitness Test battery
IV	Cross-sectional	The al-Ándalus project	466 FM women	Physical fitness and HRQoL	Senior Fitness Test battery and SF-36 questionnaire

FM, fibromyalgia; IFIS, International FItness Scale; HRQoL, Health-related quality of life; SF-36, Short Form-36 Health Survey.
In Study II, reliability was analysed in Sub-study 1 and validity in Sub-study 2.

Statistical analysis

Summary statistics are presented as means (standard deviation; SD), unless otherwise indicated. The statistical analyses were performed with IBM SPSS (IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp) and in study III the *gamlss package* (version 4.3-1)[104] of the statistical software R (version 3.1.2)[105] was also used. The level of significance was set at $p<0.05$. The statistical approach undertaken to accomplish the aims of this Doctoral Thesis is presented below and is summarized in **table 4** (page 62).

Analyses conducted for Study I

A one-way repeated measures analysis of variance (ANOVA) was used to compare mean differences between measurements (test-T1 vs. retest-T2). Additionally, we performed the same analysis after adjusting for change in pain (ANCOVA, pain T2-pain T1). Cohen's *d* [106] was computed to quantify the magnitude of the difference between test and retest. The Wilcoxon signed-rank test was selected to analyze the differences in RPE and baseline pain between the two appointments. Relative reliability of the battery was determined by Intraclass Correlation Coefficient (ICC, model 2,1) and was interpreted as follows: >0.75, 0.50-0.75, and <0.50 were considered as good, moderate and poor reliability scores[107]. The standard error of measurement (SEM) provides an absolute index of reliability, and was calculated as: SEM = SD $\sqrt{(1-ICC)}$[108].

The minimal detectable change (MDC), represents the minimum detectable change necessary to exceed the measurement error of two repeated measures at a specified interval confident (CI), and was calculated for the 95% CI as MDC = SEM × 1.96 ×√2.

The agreement between the corresponding fitness variables obtained during the two successive measurements was also graphically examined by plotting the difference between each pair of measurements against their mean, according to the Bland-Altman approach[109]. The 95% limits of agreement for all the physical fitness variables were calculated as the inter trials mean difference ± 1.96 SD. The association between the difference and the magnitude of each fitness test (i.e. heteroscedasticity) was examined by regression analysis.

The feasibility of each test was calculated as the percentage of participants who were able to complete the test.

Analyses conducted for Study II

Construct validity of the IFIS in fibromyalgia:
The ability of the IFIS to correctly rank patients with fibromyalgia and healthy women into appropriate physical fitness levels was determined by means of a one-way analysis of variance (ANOVA). Post hoc group comparisons with Tukey's correction were applied to assess the differences in measured fitness across categories of self-reported fitness (evaluated with IFIS). Performance-based fitness variables were entered as dependent variables and self-reported fitness variables as fixed factors. Differences in performance-based fitness z-scores among self-reported fitness categories were analyzed by means of a one-way ANOVA and post hoc group comparisons with Tukey's correction were applied to assess the differences in performance-based fitness across categories on self-reported fitness. Before analyzes a clustered score of physical fitness (general fitness) was computed as the average of the standardized scores ([value-mean]/standard deviation [SD]) from the seven fitness tests, weighted for the number of tests assessing the same fitness component (i.e. hand grip, arm curl and 30-s chair stand tests assessed muscular strength, and back scratch and chair sit-and-reach assessed flexibility). The standardized score from each of the physical fitness tests, as well as general fitness, were entered as dependent variables in separate models, and the corresponding self-reported fitness component and overall fitness was entered into each model as fixed factors.

Reliability of the IFIS in fibromyalgia:
The t-test was used to analyze the differences between women with fibromyalgia and controls in BMI and tender points. The test-retest reliability of the IFIS was examined by means of weighted Kappa *(k)* coefficients. Weighted *k*-coefficients were calculated, which is appropriate when dealing with ordered categorical data[110] as weighted *k* accounts for strict agreement and provides weighting to adjacent categories. Linear, (instead of quadratic) weights were chosen since the distance between adjacent

categories was equally important[78]. The significance of the tests was interpreted as suggested by Sterne & Smith[111]. Cohen's weighted *k* is not available in the standard SPSS package, but command syntax is available from the 'Knowledgebase' at SPSS.com. Data for imputation into the syntax were generated from cross-tabulation.

Analyses conducted for Study III

Sex and group differences in physical fitness variables for the whole sample were tested by two-way analysis of variance (ANOVA), with fitness as dependent variable and sex and group (fibromyalgia vs. controls) as fixed factors. Additionally, one-way ANOVA was used to compare fitness levels between groups (fibromyalgia vs. controls) separately by sex and age groups (≤35, 35.1-45, 45.1-55, 55.1-65 and >65). We used standardized mean differences (Cohen´s *d*)[106] to be able compare the magnitude of the differences between fibromyalgia patients and controls across different fitness tests.

We applied the Generalized Additive Model for Location, Scale and Shape (GAMLSS)[112] to calculate percentile curves for women. GAMLSS allows the age depending modelling of the mean (μ), the coefficient of variation (σ), the skewness (ν) and the kurtosis (τ) of the underlying distribution. We used the *gamlss package* (version 4.3-1)[104] of the statistical software R (version 3.1.2)[105]. The exact procedure is described elsewhere.[112] The different models consist of different distributions and different types of functions of age (constant, linear or splines). Goodness of fit was assessed by the Bayesian Information Criterion, worm plots[113] and Q-Q plots to select a final model. For example, for the 6-minute walk test a model based on the Box-Cox Cole and Green distribution was used where μ were modelled with a linear function, log (σ) and ν both were modelled as constants. Finally, percentile curves for the 1st, 3rd, 10th, 20th, 25th, 30th, 40th, 50th, 60th, 70th, 75th, 80th, 90th, 97th, 99th percentiles were calculated based on the model that showed the best goodness of fit. In the control group there was a higher percentage of women from Granada, which was taken into account by weighting the cases corresponding to the fibromyalgia group. For men, due to the low sample size, only a linear regression model was fitted to the data.

Analyses conducted for Study IV

Generation of variables

First, the sample was segmented by age ranges (≤45, 45.1 to 52.5, 52.6 to 60 and >60 years) to create age-specific normalized scores in the next step. The score of each physical fitness test was standardized (z-score: [value-mean]/SD) to allow computing a composite score for each physical fitness component (flexibility, muscle strength, speed-agility and cardiorespiratory fitness). All the z-score were computed to be age-specific according to the age groups indicated above. Flexibility composite score was computed as the average of the age-specific z-score from the chair sit-and-reach and back scratch tests. Muscle strength composite score was computed from the chair stand, arm curl test and handgrip tests (z-score: [[handgrip + arm curl] / 2] + chair stand] / 2). Speed-agility composite score was computed from the 8-foot up-and-go test multiplied by -1 (since higher time implies lower performance). Cardiorespiratory fitness composite score was computed as the age-specific z-score from the 6-minute walk test. To obtain a clustered measure of physical fitness, a "global fitness profile" was calculated as the average of the flexibility, muscle strength, speed-agility and cardiorespiratory fitness composite z-scores.

Age-specific quintiles from the above-mentioned physical fitness composite score (flexibility, muscle strength, speed-agility, cardiorespiratory fitness and "global fitness profile") were derived. Within each age category (≤45, 45.1 to 52.5, 52.6 to 60 and >60 years), quintiles of physical fitness were calculated.

Prior to the main analyses, Pearson´s correlations were used to check whether age, marital status, educational level, total body fat percentage, occupational status, years since clinical diagnosis, and medication usage were associated with fibromyalgia HRQoL to test their role as potential confounders. Finally, occupational status, total body fat percentage and medication consumption were taken as cofounders.

Analyses conducted

The association of physical fitness with HRQoL was analysed with two complementary approaches. Firstly, multivariate linear regression assessed the individual relationship of each physical fitness test and the 'global fitness profile' with the eight dimensions and the two subscales of the SF-36, after adjusting for occupational status, total body fat percentage, analgesics, antidepressants and stimulants. As there is evidence suggesting that improving physical fitness might improve quality of life[58,59,89,114,115], each dimension or subscale of the SF-36 was treated as dependent variable, and physical fitness as independent variables in all the analyses. Secondly, we conducted one-way analysis of covariance (ANCOVA; occupational status, total body fat percentage, analgesics, antidepressants and stimulants as confounders) to assess the differences on the SF-36 PCS and the SF-36 MCS across quintiles of each physical fitness composite score and the 'global fitness profile'. These analyses provide information about the tendency (that could potentially be linear or non-linear) of HRQoL across different levels of physical fitness.

In an attempt to assess the clinical relevance of the association under study, the magnitude of the differences between extreme quintiles of the SF-36 PCS and the SF-36 MCS was assessed using standardized mean differences (Cohen´s d[106]). Values of Cohen´s *d* of 0.20-0.49 were considered small, values of 0.50-0.79 considered moderate, and values ≥ 0.80 considered large[106]. The standards for minimal clinically relevant changes are based on a moderate effect size (0.50-0.79) of Cohen´s *d*, which corresponds to at least 5-point change in scores on the 0-100 scale (5%)[116].

We also aimed to assess which physical fitness components were independently associated with the SF-36 PCS and the SF-36 MCS. We conducted a forward stepwise regression method with the SF-36 PCS and the SF-36 MCS as dependent variables. Occupational status, total body fat percentage, analgesics, antidepressants and stimulants were introduced in the first stage using the "enter" method so that they could not be excluded from the models. In the second stage, flexibility, muscle strength, speed-agility and cardiorespiratory fitness were simultaneously introducing a "forward stepwise" procedure.

Table 4. Summary table of the statistical approach used in each study included in the present Doctoral Thesis.

Study	Statistical analysis
I. Reliability and feasibility of physical fitness tests in women with fibromyalgia	Reliability: one-way repeated measures ANOVA and the same analyses adjusting for change in pain (ANCOVA). Cohen´s *d*, ICC, SEM and MDC. Bland-Altman plots. Feasibility: percentage of participants who were able to complete the test.
II. Construct validity and reliability of the International FItness Scale (IFIS) in women with fibromyalgia	Validity: one-way ANOVA and post hoc group comparisons with Tukey's correction. Reliability: weighted Kappa.
III. Reference values of physical fitness in Andalusian fibromyalgia patients	Objective 1: GAMLSS (percentile curves) for women. Linear regression model for men. Objective 2: one-way ANOVA separately by sex and age groups (≤35, 35.1-45, 45.1-55, 55.1-65 and >65) and Cohen´s *d*.
IV. Association of physical fitness with health-related quality of life in women with fibromyalgia	Objective 1: multivariate linear regression Objective 2: forward stepwise regression. The physical fitness tests were included in the model simultaneously with confounders (cofounders forced to be included). Cofounders/covariates: occupational status, % body fat, analgesics, antidepressants and stimulants.

ANOVA, analysis of variance; ANCOVA, analysis of covariance; ICC, Intraclass Correlation Coefficient; SEM, standard error of measurement; MDC, minimal detectable change; GAMLSS, Generalized Additive Model for Location, Scale and Shape; IFIS, International FItness Scale.

RESULTS

R

RESULTS

The results of each individual study comprising the present Doctoral Thesis are presented below.

STUDY I. Reliability and feasibility of physical fitness tests in women with fibromyalgia

The final sample of the Study I was 100 women with fibromyalgia from the Pilot project. Characteristics of the study participants are shown in **table 5.** The mean number of tender points was 17.3 ± 1.6 and the mean FIQ total score 69.2 ± 15.4. These data shows that the sample included in Study I was severely affected by the disease. Significant mean differences between test and retest were found in the arm curl, 30-s chair stand and 8-foot up-and-go tests (**table 6**). Pain levels differed between test and retest (5.8 ± 2.0 vs 5.1 ± 2.4; p<0.001). The results did not change after adjusting for change in pain (pain T2-pain T1) (data not shown). There was good test-retest reliability in all tests (ICCs from 0.91 to 0.96) (**table 6**).

R

There were no differences in RPEs between test and retest in any tests, except for the arm curl test (14.7 ± 2.5 vs 13.8 ± 2.5, respectively; p=0.013). The mean RPE score for the other physical fitness tests studied in test and retest were: 12.3 ± 3.0 vs 12.0 ± 2.6 for the chair sit-and-reach test; 12.7 ± 3.1 vs 12.1 ± 2.6 for the back scratch test; 11.7 ± 2.8 vs 11.5 ± 2.5 for the handgrip test; 13.3 ± 2.7 vs 12.9 ± 2.3 for the 30-s chair stand test; 11.6 ± 3.0 vs 11.0 ± 2.4 for the 8-foot up-and-go test and 13.7 ± 2.6 vs 13.2 ± 2.6 for the 6-minute walk test, respectively.

Table 5. Characteristics of the participants of Study I, *n=100*.

Variable	
Age (years)	50.6 ± 8.6
Weight (Kg)	70.4 ± 12.5
Height (cm)	158.6 ± 5.9
BMI (Kg/m^2)	28.0 ± 5.4
Number of tender points	17.3 ± 1.6
FIQ total score	69.2 ± 15.4
Menopause [a]	n (%)
Yes	34 (34.3)
No	65 (65.7)
Years since clinical diagnosis [b]	n (%)
≤ 5 years	48 (49.0)
> 5 years	50 (51.0)
Marital status	n (%)
Married	76 (76.0)
Unmarried	13 (13.0)
Separated/ Divorced/Widowed	11 (11.7)
Educational level [a]	n (%)
No studies	5 (5.1)
Primary school	41 (41.4)
Secondary school	32 (32.3)
University degree	21 (21.2)

Values are mean and standard deviation, unless otherwise stated. [a] One missing data. [b] Two missing data. SD, standard deviation; BMI, body mass index; FIQ, fibromyalgia impact questionnaire.

Table 6. Test–retest reliability of physical fitness tests in women with fibromyalgia.

	N	1st Trial (T1)*	2nd Trial (T2)*	Inter-trial difference (T2-T1)*	p	Effect size	ICC (95%CI)	SEM	MDC
Chair sit-and-reach (cm)	99	-10.09 ± 12.62	-10.26 ± 12.90	-0.17 ± 6.27	0.787		0.94 (0.90-0.96)	3.13	8.66
Back scratch (cm)	95	-10.30 ± 14.48	-9.27 ± 13.22	1.03 ± 5.22	0.058		0.96 (0.95-0.98)	2.77	7.68
Handgrip (kg)	100	16.75 ± 6.47	16.88 ± 6.58	0.17 ± 2.94	0.654		0.95 (0.92-0.97)	1.46	4.04
Arm curl (rep.)	89	13.33 ± 3.95	14.57 ± 4.12	1.24 ± 2.16	**<0.001**	0.251	0.92 (0.88-0.95)	1.14	3.16
30-s chair stand (rep.)	99	9.10 ± 2.87	10.09 ± 3.19	0.99 ± 1.70	**<0.001**	0.254	0.91 (0.87-0.94)	0.91	2.52
8-foot up-and-go (s)	99	7.31 ± 2.37	6.92 ± 2.00	-0.38 ± 1.09	**0.001**	0.111	0.93 (0.90-0.96)	0.58	1.60
6-minute walk (m)	95	473.11 ± 81.74	476.05 ± 84.59	3.51 ± 47.1	0.541		0.92 (0.87-0.94)	23.52	65.20

*Values are mean and standard deviation.
ICC, intraclass correlation coefficient; CI, confidence interval; SD, standard deviation; SEM, standard error of measurement; MDC, minimal detectable change at a 95% confidence level; rep., repetitions.

The Bland-Altman plots (**figure 2 and figure 3**) graphically shows the reliability patterns in terms of systematic errors (bias or mean inter-trial differences) and the limits of agreement for the physical fitness tests studied: chair sit-and-reach (-12.46, 12.12 cm), back scratch (-9.20, 11.26 cm), handgrip (-5.59, 5.93 kg), arm curl (-2.99, 5.47 rep), 30-s chair stand (-2.34, 4.32 rep), 8-foot up-and-go (-2.52, 1.76 s), and 6-minute walk (-87.81, 95.83 m). The heteroscedasticity analysis showed a positive association between inter-trial mean differences and inter-trial average in back scratch, 8-foot up-and-go ($R=0.46$ and $R= 0.43$, respectively, both $p<0.001$) and 30-s chair stand ($R=0.2$, $p<0.01$) tests.

All women were able to perform the handgrip test. A 99 % completed the chair sit-and-reach test, 30-s chair stand test and 8-foot up-and-go test, and 95% the back scratch test and 6-minute walk test. The lowest feasibility was observed in the arm curl test (89%). The main problem in those patients whose did not complete the arm curl test or the back scratch test was that they felt more pain during the test. During the 6-minute walk test the main problem was discomfort with the shoes.

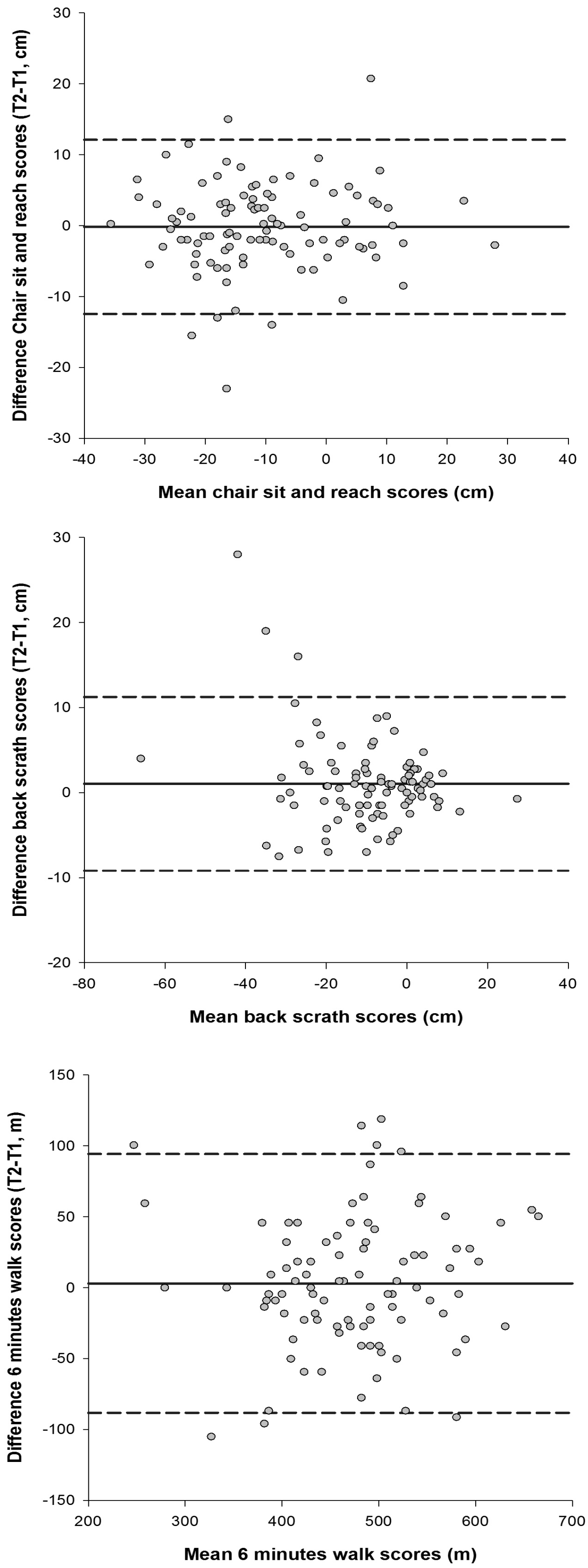

Figure 2. Bland-Alman plot of the flexibility and cardiorespiratory fitness tests. The central line represents the mean difference between the second trial (T2) and the first trial (T1); the upper and lower dotted lines represent the upper and lower 95% limits of agreement (mean differences ± 1.96 SD), respectively.

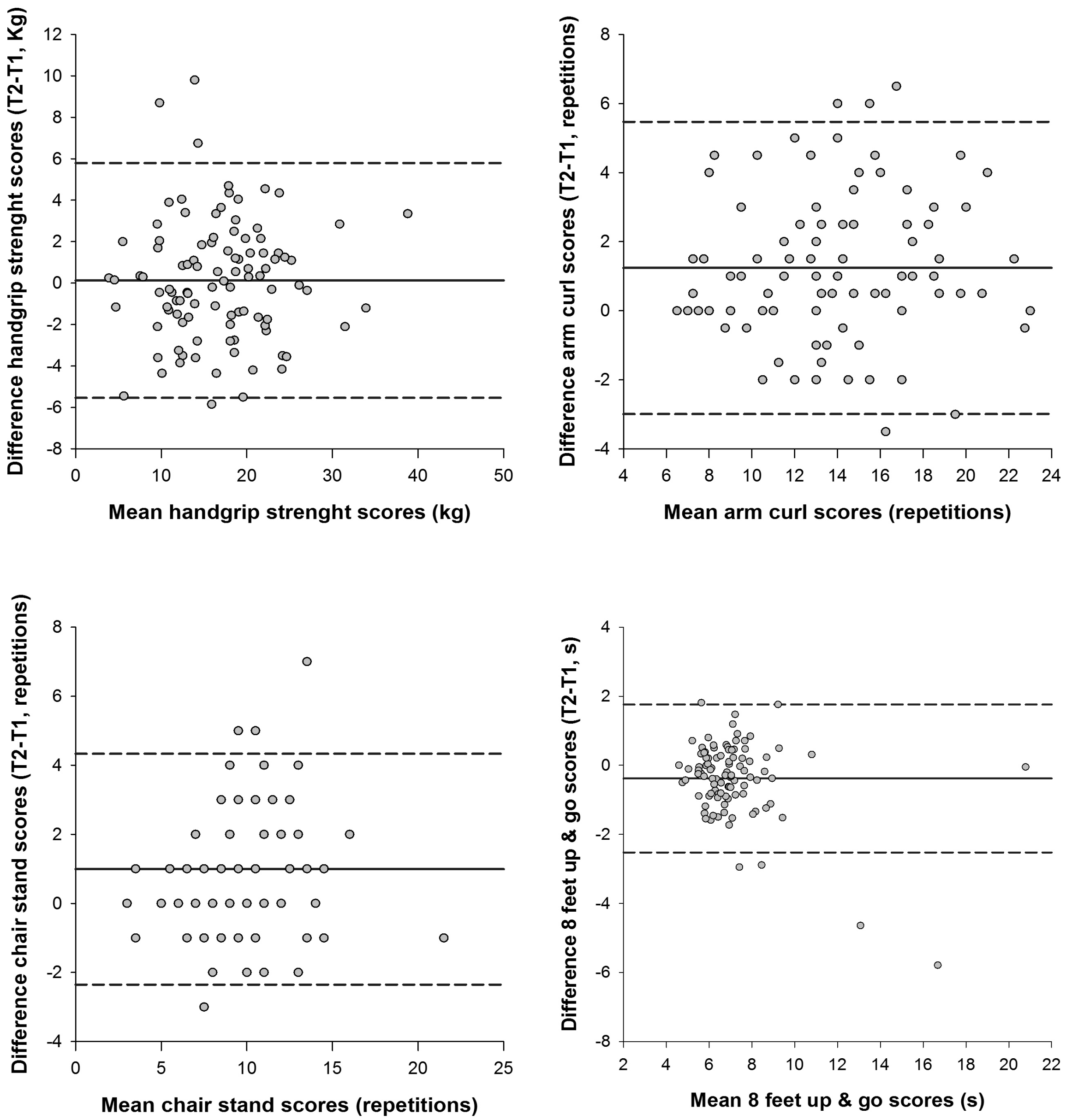

Figure 3. Bland-Altman plot of the muscular strength and speed-agility tests. The central line represents the mean difference between the second trial (T2) and the first trial (T1); the upper and lower dotted lines represent the upper and lower 95% limits of agreement (mean differences ± 1.96 SD), respectively.

STUDY II. The International FItness Scale (IFIS): construct validity and reliability in women with fibromyalgia

The final sample of the Study II comprised 608 women (413 with fibromyalgia and 195 controls) for validity purposes and 101 women with fibromyalgia for reliability purposes. The sociodemographic characteristics of the study groups are shown in **table 7**. Women with fibromyalgia had higher body mass index ($p>0.001$) than controls. Moreover, educational level ($p=0.015$) and occupational status ($p<0.001$) were statistically different between groups. No differences were found for age or marital status ($p>0.05$). The distribution of the answers of the IFIS was positively skewed, with only a small number of women with fibromyalgia reporting good and very good fitness (**figure 4**). More than half of the healthy control women, however, reported their overall fitness to be average, good or very good (**figure 4**). Controls also had a more normal distribution of responses to the IFIS than those with fibromyalgia; with most healthy participants selecting the middle categories. Chi-squared tests showed a significant difference in the distribution of answers for all fitness tests ($p<0.001$), indicating worse self-reported fitness in women with fibromyalgia compared to controls. To avoid a lack of statistical power due to the low number of participants reporting higher levels of fitness, the very good and good categories were merged into a single category (good/very good) for both groups for the validity analysis.

Table 7. Sociodemographic characteristics of the Study II groups.

	Fibromyalgia n=413		**Control** n=195		**p value**
	Mean	SD	Mean	SD	
Age (years)	52.3	7.2	51.3	6.9	0.486
Body mass index (kg/m^2)	28.6	5.4	26.7	4.3	**<0.001**
	n	%	n	%	
Marital status					0.174
Married	315	76.3	142	72.9	
Single	28	6.8	18	9.3	
Separated	14	3.4	13	6.8	
Divorced	36	8.7	12	6.3	
Widow	20	4.8	9	4.6	
Educational level					**0.015**
No studies	44	10.7	12	6.2	
Primary school	197	47.7	75	38.5	
Professional training	64	15.5	31	15.9	
Secondary school	50	12.1	33	16.9	
University medium degree	36	8.7	24	12.3	
University higher degree	22	5.3	20	10.3	
Current occupational status					**<0.001**
Working full time	64	15.5	61	31.3	
Working part time	42	10.2	21	10.8	
Home worker	136	32.9	71	36.4	
Student	4	1	2	1	
Retired/pensioner	11	2.7	6	3.1	
Retired/incapacity pension	59	14.3	5	2.6	
Sick leave	29	7	2	10	
Unemployed	68	16.5	27	13.8	

SD, standard deviation.
Differences in sociodemographic variables tested by analysis of variance or Chi-squared test when appropriate.

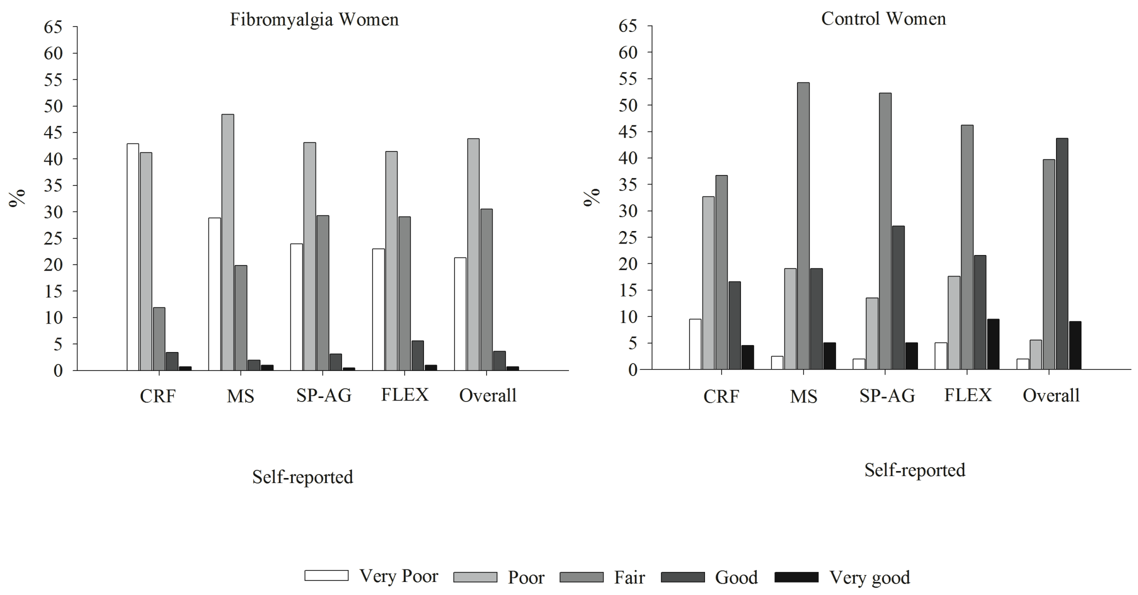

Figure 4. Distribution of the answers for the five questions of the International FItness Scale in women with fibromyalgia and controls (*n* = 608, 413 women with fibromyalgia and 195 control women). CRF, cardiorespiratory fitness; MS, muscular strength; SP-AG, speed-agility; FLEX, flexibility; Overall, overall physical fitness.

Construct validity of the IFIS in women with fibromyalgia and controls

The comparison of performance-based fitness across self-reported fitness categories in women with fibromyalgia and controls are shown in **table 8**. Overall, a linear relationship between self-reported and performance-based fitness was observed in women with fibromyalgia and controls. The post hoc analysis revealed that for all the fitness variables studied, those women with fibromyalgia reporting an average fitness had better performance-based fitness compared with those reporting very poor fitness level (all $p<0.001$, except 6-minute walk test $p<0.05$). Moreover, control women reporting good/very good fitness had better performance-based fitness compared to those reporting poor or very poor fitness level (all $p<0.001$, except back scratch test $p<0.05$). The association between self-reported and performance-based physical fitness is presented in **figures 5 and 6**. There was a linear relationship between item categories of the IFIS in both groups, in all fitness components and in overall fitness. Overall, the 6-minute walk test showed the weakest relationship between self-reported fitness and performance-based fitness in women with fibromyalgia, while flexibility tests showed the strongest relationship.

Table 8. Means (SD) of measured physical fitness by self-reported physical fitness categories in women with fibromyalgia and controls.

		Very poor (1)		Poor (2)		Average (3)		Good/ Very good (4)		p value	Pair-wise comparisons (Tukey)					
	n	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)		1-2	1-3	2-3	1-4†	2-4†	3-4†
FIBROMYALGIA																
Cardiorespiratory fitness																
6-min walk test (m)	408	472.2	88.5	483.0	87.5	516.2	78.8	499.3	85.8	**0.016**	NS	**0.010**	NS	NS	NS	NS
Muscular strength																
30-s chair stand test (rep.)	406	9.4	3.3	10.5	3.3	11.4	3.2	11.6	2.8	**<0.001**	**0.021**	**<0.001**	NS	NS	NS	NS
Arm curl test (rep.)	404	12.8	4.9	14.3	4.8	15.9	5.0	18.8	4.6	**<0.001**	**0.030**	**<0.001**	NS	**0.001**	**0.019**	NS
Handgrip test (kg)	413	17.2	6.2	19.3	6.3	21.8	5.9	20.5	10.7	**<0.001**	**0.023**	**<0.001**	**0.018**	NS	NS	NS
Speed-Agility																
8-foot up-and-go test(sec)*	409	7.8	2.9	7.3	2.7	6.1	0.9	6.7	1.9	**<0.001**	NS	**<0.001**	**<0.001**	NS	NS	NS
Flexibility										**<0.001**						
Chair sit-and-reach (cm)	413	-17.3	11.1	-12.8	10.4	-6.7	11.2	-0.3	14.1	**<0.001**	**0.007**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**0.033**
Back scratch test (cm)	413	-21.3	12.8	-14.6	12.3	-10.0	9.7	-8.5	14.8	**<0.001**	**<0.001**	**<0.001**	**0.006**	**<0.001**	NS	NS
		Very poor (1)		Poor (2)		Average (3)		Good/ Very good (4)		p value	Pair-wise comparisons (Tukey)					
	n	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)		1-2‡	1-3‡	2-3	1-4‡	2-4	3-4
CONTROL																
Cardiorespiratory fitness																
6-min walk test (m)	193	515.9	63.2	555.4	53.6	571.6	61.7	611.6	65.0	**<0.001**	NS	**0.004**	NS	**<0.001**	**<0.001**	**0.005**
Muscular strength																
30-s chair stand test (rep.)	195	11.5	4.7	13.4	2.6	15.1	2.7	15.8	3.6	**<0.001**	NS	NS	**0.019**	**0.028**	**0.001**	NS
Arm curl test (rep.)	195	16.1	5.6	19.8	4.3	22.3	4.1	24.1	3.9	**<0.001**	NS	**0.018**	**0.008**	**0.002**	**<0.001**	NS
Handgrip test(kg)	195	23.4	3.1	23.6	4.7	26.6	4.3	29.1	4.3	**<0.001**	NS	NS	**0.003**	NS	**<0.001**	**0.005**
Speed-Agility																
8-foot up-and-go test(sec)*	195	6.0	0.3	6.4	1.6	5.4	0.7	5.1	0.6	**<0.001**	NS	NS	**<0.001**	NS	**<0.001**	NS
Flexibility																
Chair sit-and-reach (cm)	195	-6.1	14.9	-3.9	10.6	2.7	9.4	7.4	9.7	**<0.001**	NS	**0.043**	**0.007**	**0.001**	**<0.001**	**0.030**
Back scratch test (cm)	195	-10.3	6.2	-6.9	7.2	-6.2	9.9	-2.2	8.0	**0.006**	NS	NS	NS	**0.040**	NS	**0.035**

* Lower score (time in seconds) indicates better performance. †There were very few subjects (range from 0.5 to 1%) in category 4 (good-very good); consequently, this group is under-represented and results should be interpreted carefully. ‡ Idem, for category 1 (very poor) in control women (range from 2 to 9.5%). NS: not significant; rep., repetitions.

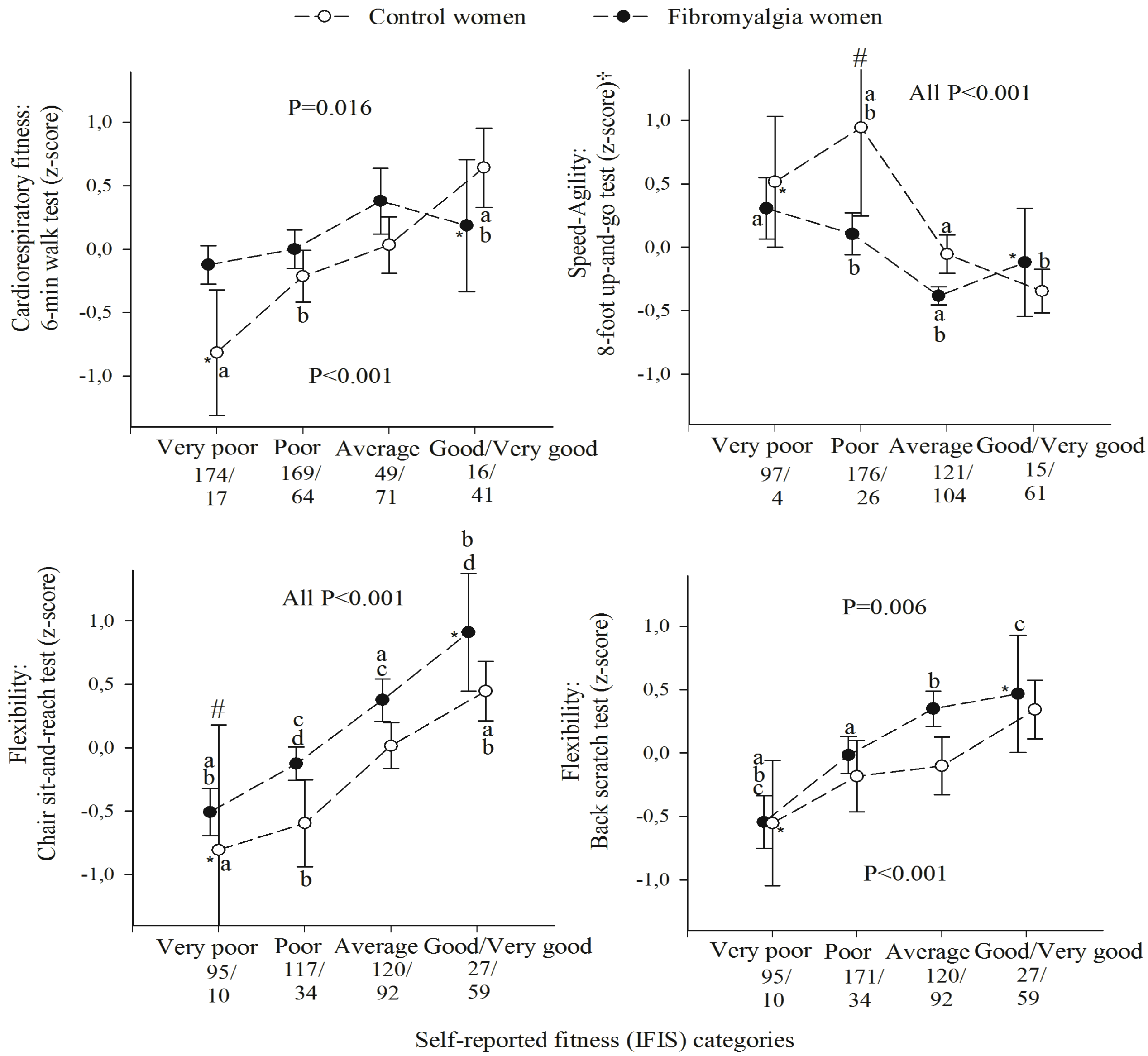

Figure 5. Comparison between self-reported fitness and measured fitness for cardiorespiratory fitness, speed-agility and flexibility.

Data represented means and 95% confidence intervals. One-way analysis of variance (ANOVA) was carried out to test whether participants reporting better fitness (IFIS) had significantly better fitness performance. Each measured fitness variable was compared with the corresponding item in IFIS.

*Results for the extreme categories, i.e. Very poor and Good/Very good, should be interpreted cautiously due to the small sample size (range from 4 to 27).

† The lower the score, the better the performance.

Confidence interval for speed agility was from -0.51 to 0.51 and for flexibility chair sit-and-reach from -0.99 to 0.99.

Common superscripts indicate significant ($p \leq 0.001$) differences between groups.

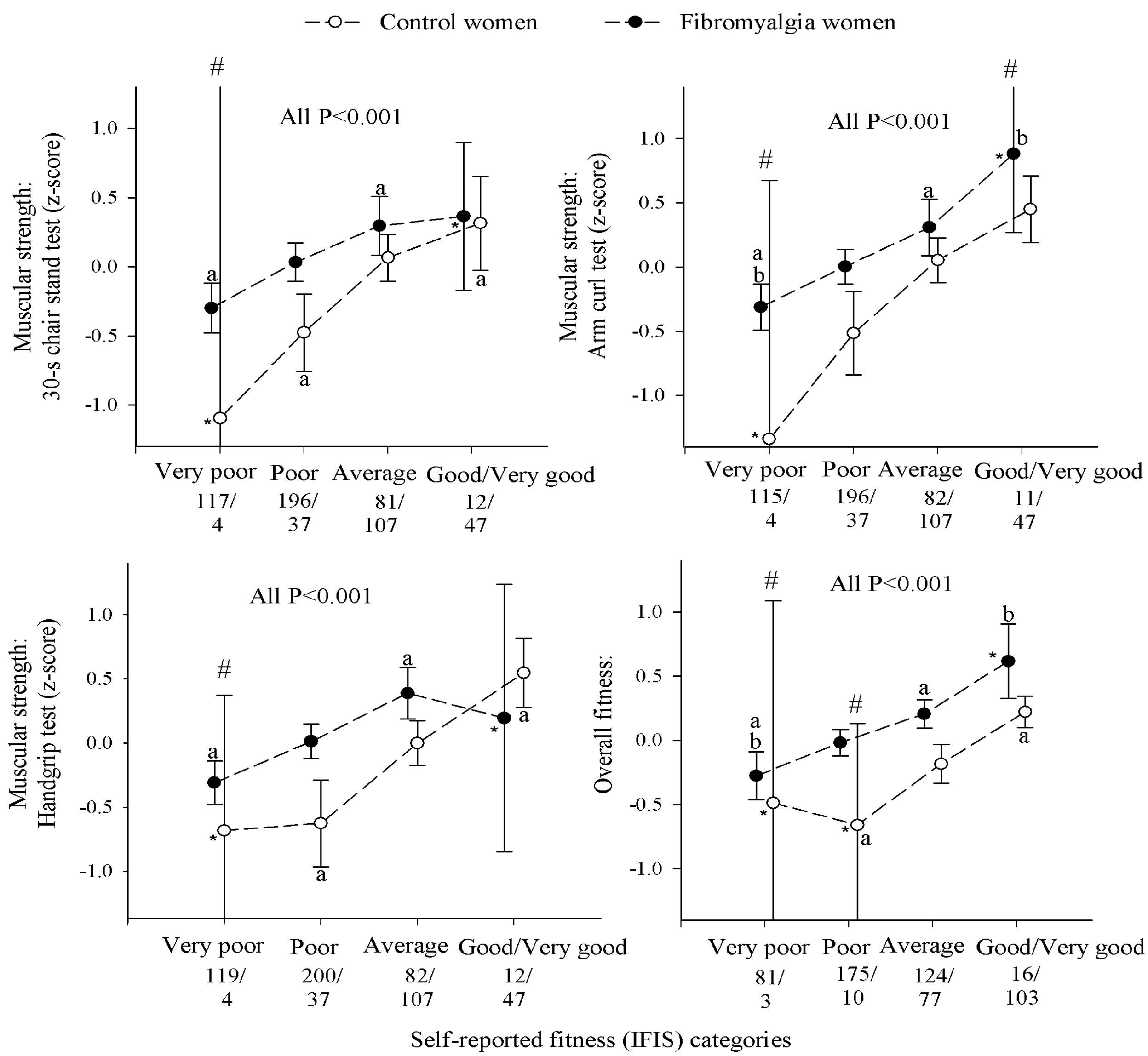

Figure 6. Comparison between self-reported fitness and measured fitness for muscular strength and overall fitness.

Data represented means and 95% confidence intervals. One-way analysis of variance (ANOVA) was represented carried out to test whether participants reporting better fitness (IFIS) had significantly better fitness performance. Each measured fitness variable was compared with the corresponding item in IFIS.

* Very poor and Good/Very good, should be interpreted cautiously due to the small sample size.

Confidence interval for 30-s chair stand test was from -2.41 to 2.41, for arm curl test from -2.01 to 2.01, for handgrip test from -1.05 to 1.05, for overall fitness (very poor) from -1.57 to 1.57 and for overall fitness (poor) from -0.78 to 0.78.

Common superscripts indicate significant ($p \leq 0.001$) differences between groups.

Reliability of the IFIS in women with fibromyalgia

The test-retest reliability statistics for the five items comprising the IFIS are displayed in **table 9**. Weighted Kappa ranged from 0.40 (muscular fitness) to 0.63 (flexibility), and the averaged weighted Kappa was 0.45.

Table 9. Test-retest reliability of the International Fitness Scale (IFIS) in women with fibromyalgia.

IFIS items	Weighted Kappa coefficients	Standard Error	95% Confidence interval
Overall fitness	0.45	0.07	(0.31-0.59)
Cardiorespiratory fitness	0.46	0.08	(0.30-0.61)
Muscular fitness	0.40	0.07	(0.25-0.55)
Speed-agility	0.46	0.07	(0.33-0.59)
Flexibility	0.63	0.07	(0.52-0.74)

STUDY III. Reference values of physical fitness in Andalusian fibromyalgia patients

The final sample comprised 828 women (468 with fibromyalgia and 360 controls) and 76 men (21 with fibromyalgia and 55 controls). The resulting models derived with GAMLSS are listed in **table 10**. **Table 11** shows the characteristics of the study participants by group and sex. No differences were found between patients with fibromyalgia and controls on age and anthropometric characteristics. Participants with fibromyalgia showed a worse performance in all physical fitness tests than controls (all, $p<0.001$). There were not sex differences in physical fitness except for upper body muscular strength (i.e., arm curl and handgrip tests, $p<0.05$ and $p<0.001$, respectively) in which men performed better than women, and for upper body flexibility, in which women performed better than men ($p<0.01$).

Table 10. Selected GAMLSS models to calculate the fitness percentile curves for women with fibromyalgia and controls.

Variable	n FM	n control	Model	Parameters			
			Distribution	*μ*	*log(σ)*	*v*	*log(τ)*
6-minutes walk test	459	354	BCCG	age	1	1	-
8-foot up-and-go test	462	359	BCCG	age	age	1	-
Chair sit-and-reach test*	468	360	BCPE	age	1	1	age
Back scratch test*	468	358	BCCG	age	age	1	-
30-s chair stand test	461	356	NO	age	1	-	-
Handgrip test**	468	358	NO	age	1	-	-
			Distribution	*log(μ)*	*log(σ)*	*v*	*log(τ)*
Arm curl test***	458	247	NO	age	1	-	-

Abbreviations: FM, fibromyalgia; NO, normal; BCPE, Box-Cox power exponential; BCCG, Box-Cox Cole and Green.
Transformation was conducted to make sure that all values are positive.
** In two cases handgrip test was below the detection limit. Therefore these values were introduced with half of the detection limit (2.5) in analysis.
*** In four cases arm curl test was zero. Therefore these values were introduced with 0.1 in analysis.

Table 11. Characteristics of the study participants by group (fibromyalgia/control) and sex of the Study III.

	Women		Men		Sex effect	Group effect
	Fibromyalgia (n=468)	Control (n=360)	Fibromyalgia (n=21)	Control (n=55)	p	p
Age	52.2 (8.0)	51.7 (8.2)	46.9 (8.4)	49.5 (11.2)	**0.001**	0.32
Weight (kg)	71.2 (13.8)	69.0 (12.2)	81.2 (13.4)	83.1 (12.5)	**<0.001**	0.93
Height (cm)	157.8 (6.0)	158.4 (6.5)	170.3 (7.2)	171.3 (6.9)	**<0.001**	0.35
BMI (kg/m^2)	28.59 (5.4)	27.5 (4.8)	28.1 (4.8)	28.2 (3.9)	0.9	0.53
6 MWT (m)	483.9 (81.7)	553.9(69.6)	531.2 (144.0)	632.8 (81.7)	**<0.001**	**<0.001**
8-foot up-and-go(s)*	6.9 (1.9)	5.6 (1.0)	6.8 (2.6)	5.1 (1.7)	0.17	**<0.001**
CSR (cm)	-11.3 (12.1)	2.2 (11.1)	-12.7 (12.6)	0.6 (10.9)	0.34	**<0.001**
BST (cm)	-14.4 (12.6)	-5.0 (9.0)	-16.6 (15.0)	-10.4 (11.8)	**0.01**	**<0.001**
30-s CST (rep)	10.3 (3.3)	14.6 (3.3)	10.1 (3.8)	15.4 (2.5)	0.5	**<0.001**
ACT (rep)	14.3 (5.0)	22.4 (4.4)	15.8 (4.2)	23.7 (5.5)	**0.03**	**<0.001**
Handgrip test (kg)	19.0 (6.5)	25.6 (5.2)	34.4 (13.0)	42.6 (6.9)	**<0.001**	**<0.001**

BMI, body max index; 6 MWT, six minutes walk test; CSR, chair sit-and-reach; BST, back scratch test; CST, 30-s chair stand test; ACT, arm curl test.
Data are shown as mean (SD). Sex and group (fibromyalgia/control) differences were analysed by two-way analysis of variance, with sex and group as fixed factors, and age, anthropometric or physical fitness measurements as dependent variables.
*Lower values indicate better performance.

Means and standard deviations of all physical fitness tests were calculated in women with fibromyalgia and controls in different age groups (**table 12**). Overall, there was a trend towards lower effect size between groups (women with fibromyalgia and controls) with greater age, that is, the differences in physical fitness tests between groups were smaller when women were older.

Table 12. Sample size, mean and standard deviation (SD) of all physical fitness tests in fibromyalgia and control women.

		Fibromyalgia			Controls			Effect size**
	AGE	N	Mean	SD	n	Mean	SD	
6-minute walk test (m)	≤35	6	-	-	14	-	-	
	35.1-45.0	91	522.1	75.2	48	605.4	63.7	1.17
	45.1-55.0	196	483.9	77.6	176	556.1	62.4	1.02
	55.1-65.0	144	462.9	82.0	104	518.3	64.3	0.74
	>65.0	22	-	-	12	-	-	
8-foot up-and-go test (s)*	≤35	6	-	-	14	-	-	
	35.1-45.0	92	6.14	1.0	48	4.97	0.6	-1.27
	45.1-55.0	197	6.93	1.9	178	5.46	0.8	-0.99
	55.1-65.0	144	7.29	2.1	105	6.05	1.3	-0.68
	>65.0	23	-	-	14	-	-	
Chair sit-and-reach test (cm)	≤35	6	-	-	14	-	-	
	35.1-45.0	92	-8.9	12.4	48	7.7	8.9	1.46
	45.1-55.0	197	-11.5	11.7	179	2.0	10.7	1.20
	55.1-65.0	150	-12.2	12.3	105	-0.1	12.1	0.99
	>65.0	23	-	-	14	-	-	
Back scratch test (cm)	≤35	6	-	-	14	-	-	
	35.1-45.0	92	-10.7	11.0	48	-1.7	8.5	0.88
	45.1-55.0	197	-13.9	12.0	178	-4.1	7.7	0.96
	55.1-65.0	150	-16.5	13.6	104	-7.9	10.2	0.70
	>65.0	23	-	-	14	-	-	
30-s chair stand test (rep)	≤35	6	-	-	14	-	-	
	35.1-45.0	92	11.57	3.3	48	17.17	3.1	1.74
	45.1-55.0	196	10.21	3.2	177	14.41	3.1	1.32
	55.1-65.0	144	9.72	3.2	103	13.37	3.0	1.17
	>65.0	23	-	-	14	-	-	
	≤35	6	-	-	14	-	-	
Arm curl test (rep)	35.1-45.0	91	15.7	5.3	46	24.4	4.0	1.76
	45.1-55.0	194	14.2	4.9	120	22.4	4.0	1.79
	55.1-65.0	144	13.5	4.6	59	20.4	4.7	1.48
	>65.0	23	-	-	8	-	-	
	≤35	6	-	-	14	-	-	
Handgrip test (kg)	35.1-45.0	92	21.2	6.5	48	27.8	4.0	1.13
	45.1-55.0	197	18.9	6.6	177	26.4	4.9	1.27
	55.1-65.0	150	18.0	6.0	105	23.3	5.5	0.91
	>65.0	23	-	-	14	-	-	

Mean and SD for extreme range of age were omitted due to the small sample in these age groups.
*Lower values indicate better performance.
**Cohen's *d.*

Differences between means of all fitness test in all age ranges between fibromyalgia and controls were $p<0.001$.

Tables 13-15 show the age-specific reference values for physical fitness in women with fibromyalgia and controls, expressed in percentiles from 1 to 99 (P_1, P_{10}, P_{20}, P_{30}, P_{40}, P_{50}, P_{60}, P_{70}, P_{80}, P_{90}, P_{99}).

Table 13. Percentiles of cardiorespiratory fitness and speed-agility calculated with GAMLSS in fibromyalgia and control women.

	Age	P_1	P_{10}	P_{20}	P_{30}	P_{40}	P_{50}	P_{60}	P_{70}	P_{80}	P_{90}	P_{99}
6-minute walk test (m)												
Fibromyalgia												
	35.1-45.0	284.2	413.1	456.2	484.7	507.6	528.0	547.5	567.6	590.1	619.7	684.3
	45.1-55.0	267.6	389.0	429.6	456.4	477.9	497.1	515.5	534.4	555.6	583.5	644.3
	55.1-65.0	251.0	364.8	402.9	428.1	448.3	466.3	483.6	501.3	521.1	547.3	604.3
Controls												
	35.1-45.0	440.5	511.2	540.5	561.4	579.1	595.6	612.0	629.4	649.7	677.7	743.2
	45.1-55.0	418.8	486.1	513.8	533.7	550.6	566.2	581.8	598.4	617.7	644.3	706.6
	55.1-65.0	397.1	460.9	487.2	506.0	522.0	536.9	551.7	567.4	585.7	610.9	670.0
8-foot up-and-go test (s)*												
Fibromyalgia												
	35.1-45.0	4.5	5.0	5.3	5.5	5.7	5.9	6.1	6.4	6.8	7.4	10.0
	45.1-55.0	4.7	5.3	5.6	5.9	6.1	6.4	6.7	7.1	7.6	8.5	13.0
	55.1-65.0	4.8	5.5	5.9	6.2	6.6	6.9	7.3	7.8	8.5	9.9	18.3
Controls												
	35.1-45.0	4.0	4.3	4.5	4.7	4.8	4.9	5.1	5.3	5.5	5.8	6.9
	45.1-55.0	4.2	4.7	4.9	5.0	5.2	5.4	5.5	5.7	6.0	6.4	7.8
	55.1-65.0	4.5	5.0	5.2	5.4	5.6	5.8	6.0	6.2	6.5	7.0	8.8

Abbreviation: GAMLSS, General Additive Model for Location Scale and Shape; m, meters; s, seconds. The values corresponded to the 1st, 10th, 20th, 30th, 40th, 50th, 60th, 70th, 80th, 90th, 99th. Percentiles values were estimated simultaneously for shown decades and the exact percentile for the mid point of the age interval is shown; for example, for the age range 35.1-45.0, percentiles for the age of 40.0 years are shown. Percentiles for extreme range of age (≤35 and >65.0) were omitted due to the small sample in these age groups.
*Lower values indicate better performance.

Table 14. Percentiles of lower-limb and upper-limb flexibility calculated with GAMLSS in fibromyalgia and control women.

	Age	P_1	P_{10}	P_{20}	P_{30}	P_{40}	P_{50}	P_{60}	P_{70}	P_{80}	P_{90}	P_{99}
Chair sit-and-reach (cm)												
Fibromyalgia												
	35.1-45.0	-31.5	-24.2	-19.8	-16.0	-12.2	-8.4	-4.5	-0.6	3.7	8.7	17.7
	45.1-55.0	-35.1	-26.0	-21.4	-17.7	-14.3	-11.0	-7.5	-3.9	0.1	5.4	16.6
	55.1-65.0	-39.1	-27.6	-22.8	-19.3	-16.3	-13.5	-10.6	-7.5	-3.7	1.8	16.1
Controls												
	35.1-45.0	-30.1	-8.5	-2.5	1.0	3.6	5.7	7.7	10.0	13.0	17.4	28.9
	45.1-55.0	-29.3	-10.8	-5.1	-1.5	1.3	3.7	6.0	8.5	11.4	15.6	25.4
	55.1-65.0	-28.5	-12.9	-7.5	-3.9	-0.9	1.7	4.2	6.8	9.8	13.6	22.1
Back scratch test (cm)												
Fibromyalgia												
	35.1-45.0	-37.8	-22.1	-17.0	-13.6	-10.9	-8.5	-6.2	-3.9	-1.3	2.1	9.5
	45.1-55.0	-49.7	-28.8	-22.4	-18.3	-15.0	-12.2	-9.5	-6.8	-3.8	0.1	8.3
	55.1-65.0	-60.9	-35.7	-27.8	-22.9	-19.1	-15.8	-12.7	-9.6	-6.2	-1.8	7.4
Controls												
	35.1-45.0	-22.6	-11.1	-7.2	-4.6	-2.4	-0.6	1.2	3.1	5.1	7.9	13.8
	45.1-55.0	-30.2	-16.1	-11.5	-8.5	-6.2	-4.0	-2.0	0.0	2.3	5.3	11.6
	55.1-65.0	-38.9	-21.4	-16.0	-12.6	-9.9	-7.5	-5.3	-3.0	-0.5	2.7	9.6

Abbreviation: GAMLSS, General Additive Model for Location Scale and Shape; m, meters; s, seconds. The values corresponded to the 1^{st}, 10^{th}, 20^{th}, 30^{th}, 40^{th}, 50^{th}, 60^{th}, 70^{th}, 80^{th}, 90^{th}, 99^{th}. Percentiles values were estimated simultaneously for shown decades and the exact percentile for the mid point of the age interval is shown; for example, for the age range 35.1-45.0, percentiles for the age of 40.0 years are shown. Percentiles for extreme range of age (≤35 and >65.0) were omitted due to the small sample in these age groups.

Table 15. Percentiles of lower-limb and upper-limb muscular strength calculated with GAMLSS in fibromyalgia and control women.

	Age	P_1	P_{10}	P_{20}	P_{30}	P_{40}	P_{50}	P_{60}	P_{70}	P_{80}	P_{90}	P_{99}
30-s chair stand test (rep)												
Fibromyalgia	35.1-45.0	3.8	7.2	8.6	9.6	10.5	11.3	12.1	13.0	14.0	15.5	18.8
	45.1-55.0	3.0	6.3	7.8	8.8	9.7	10.5	11.3	12.2	13.2	14.6	18.0
	55.1-65.0	2.1	5.5	6.9	8.0	8.8	9.6	10.5	11.3	12.4	13.8	17.2
Controls												
	35.1-45.0	9.7	12.7	14.0	14.9	15.7	16.5	17.2	18.0	18.9	20.2	23.2
	45.1-55.0	8.3	11.4	12.6	13.6	14.4	15.1	15.8	16.6	17.5	18.8	21.9
	55.1-65.0	6.9	10.0	11.3	12.2	13.0	13.7	14.5	15.2	16.2	17.4	20.5
Arm curl test (rep)												
Fibromyalgia	35.1-45.0	4.1	9.2	11.4	13.0	14.3	15.5	16.8	18.1	19.7	21.8	27.0
	45.1-55.0	3.0	8.2	10.3	11.9	13.2	14.5	15.7	17.0	18.6	20.8	25.9
	55.1-65.0	2.0	7.1	9.3	10.9	12.2	13.4	14.7	16.0	17.6	19.7	24.9
Controls												
	35.1-45.0	14.5	18.8	20.6	21.9	23.0	24.0	25.1	26.2	27.5	29.3	33.6
	45.1-55.0	12.9	17.2	19.0	20.3	21.4	22.4	23.5	24.6	25.9	27.7	32.0
	55.1-65.0	11.4	15.7	17.5	18.8	19.9	20.9	22.0	23.1	24.4	26.2	30.5
Handgrip test (kg)												
Fibromyalgia	35.1-45.0	6.6	13.2	16.0	18.0	19.7	21.3	23.0	24.7	26.7	29.5	36.1
	45.1-55.0	4.8	11.4	14.1	16.2	17.9	19.5	21.1	22.8	24.8	27.6	34.2
	55.1-65.0	2.9	9.5	12.3	14.3	16.0	17.6	19.2	20.9	22.9	25.7	32.3
Controls												
	35.1-45.0	17.2	22.0	24.0	25.4	26.6	27.8	28.9	30.2	31.6	33.6	38.3
	45.1-55.0	15.6	20.3	22.3	23.8	25.0	26.2	27.3	28.5	30.0	32.0	36.7
	55.1-65.0	14.0	18.7	20.7	22.1	23.4	24.5	25.7	26.9	28.3	30.3	35.1

Abbreviation: GAMLSS, General Additive Model for Location Scale and Shape; m, meters; s, seconds. The values corresponded to the 1^{st}, 10^{th}, 20^{th}, 30^{th}, 40^{th}, 50^{th}, 60^{th}, 70^{th}, 80^{th}, 90^{th}, 99^{th}. Percentiles values were estimated for decades and the exact percentile for the mid point of the age interval is shown; for example, for the age range 35.1-45.0, percentiles for the age of 40.0 years are shown. Percentiles for extreme range of age (≤35 and >65.0) were omitted due to the small sample in these age groups.

Figures 7-9 show the smoothed percentile curves (P_1, P_3, P_{10}, P_{25}, P_{50}, P_{75}, P_{90}, P_{97}, P_{99}) for different physical fitness test in women with fibromyalgia and controls by age.

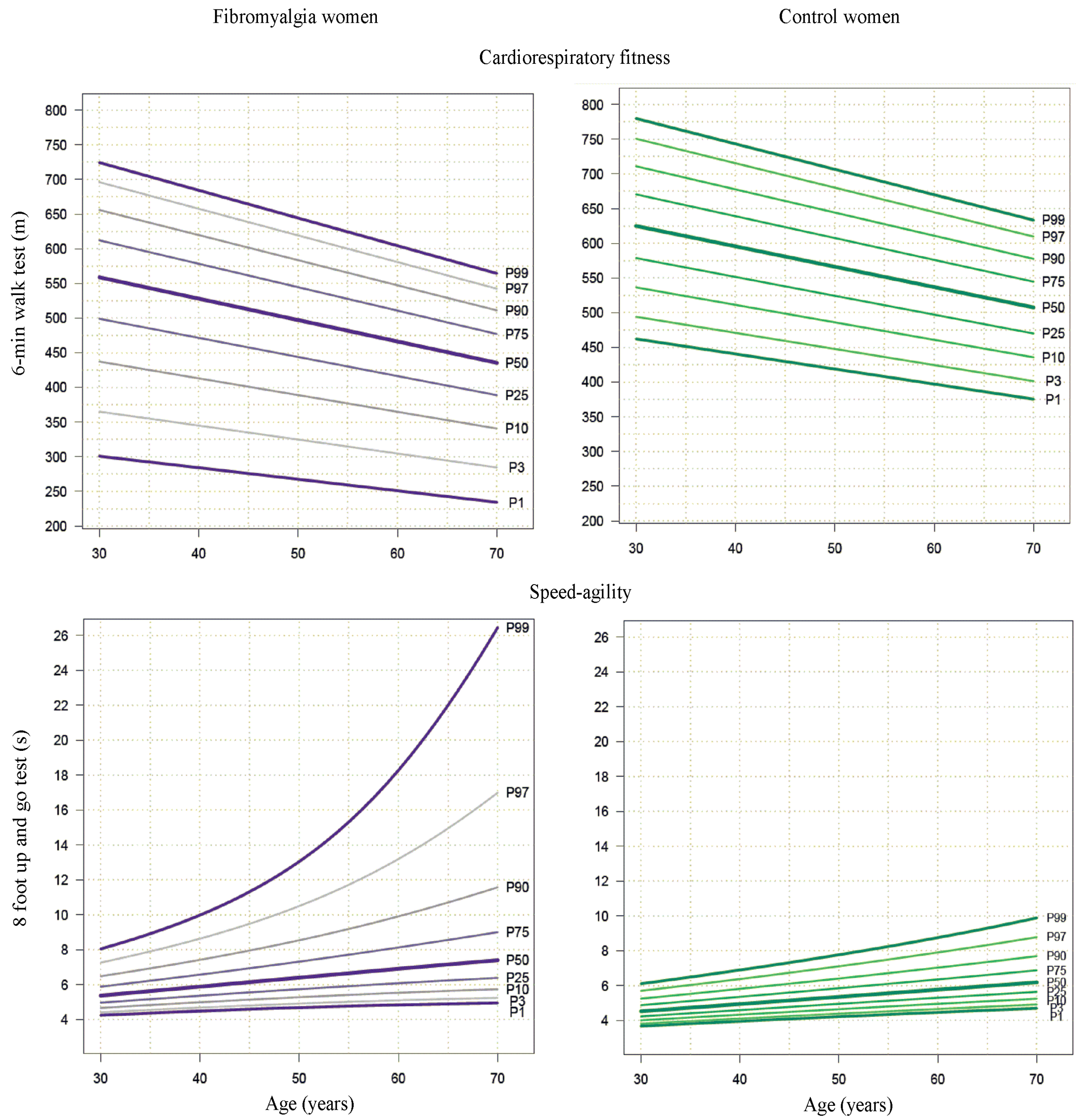

Figure 7. Percentiles curves (GAMLSS method from the bottom to the top: P_1, P_3, P_{10}, P_{25}, P_{50}, P_{75}, P_{90}, P_{97}, P_{99}) of the two physical fitness test assessing cardiorespiratory fitness and speed-agility. For the 8-foot up-and-go test lower scores indicate better performance, so that to be in the P_1 means to have the best performance and the other way around.

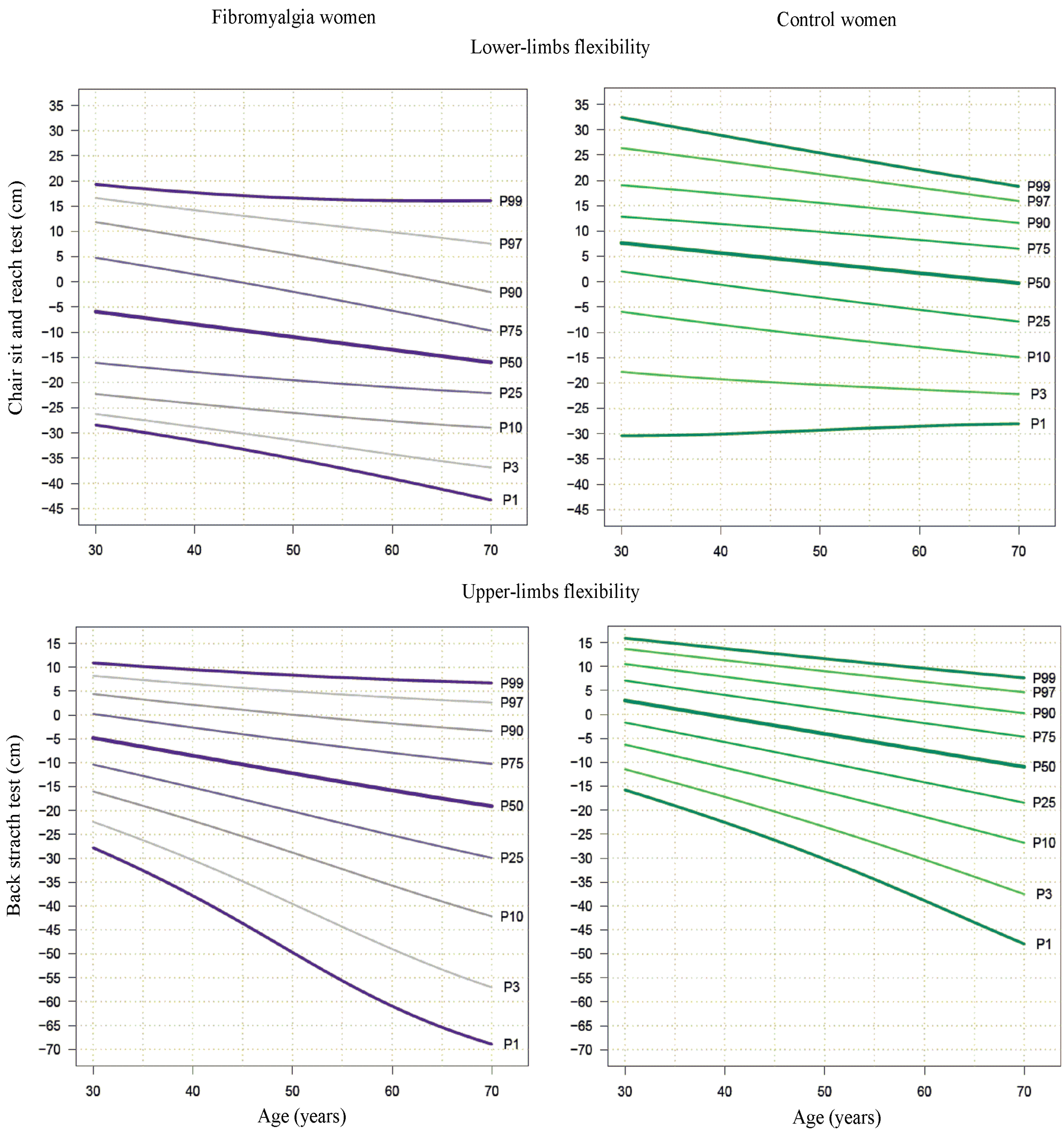

Figure 8. Percentiles curves (GAMLSS method, from the bottom to the top: P_1, P_3, P_{10}, P_{25}, P_{50}, P_{75}, P_{90}, P_{97}, P_{99}) of the two physical fitness test assessing lower-limb flexibility and upper-limb flexibility.

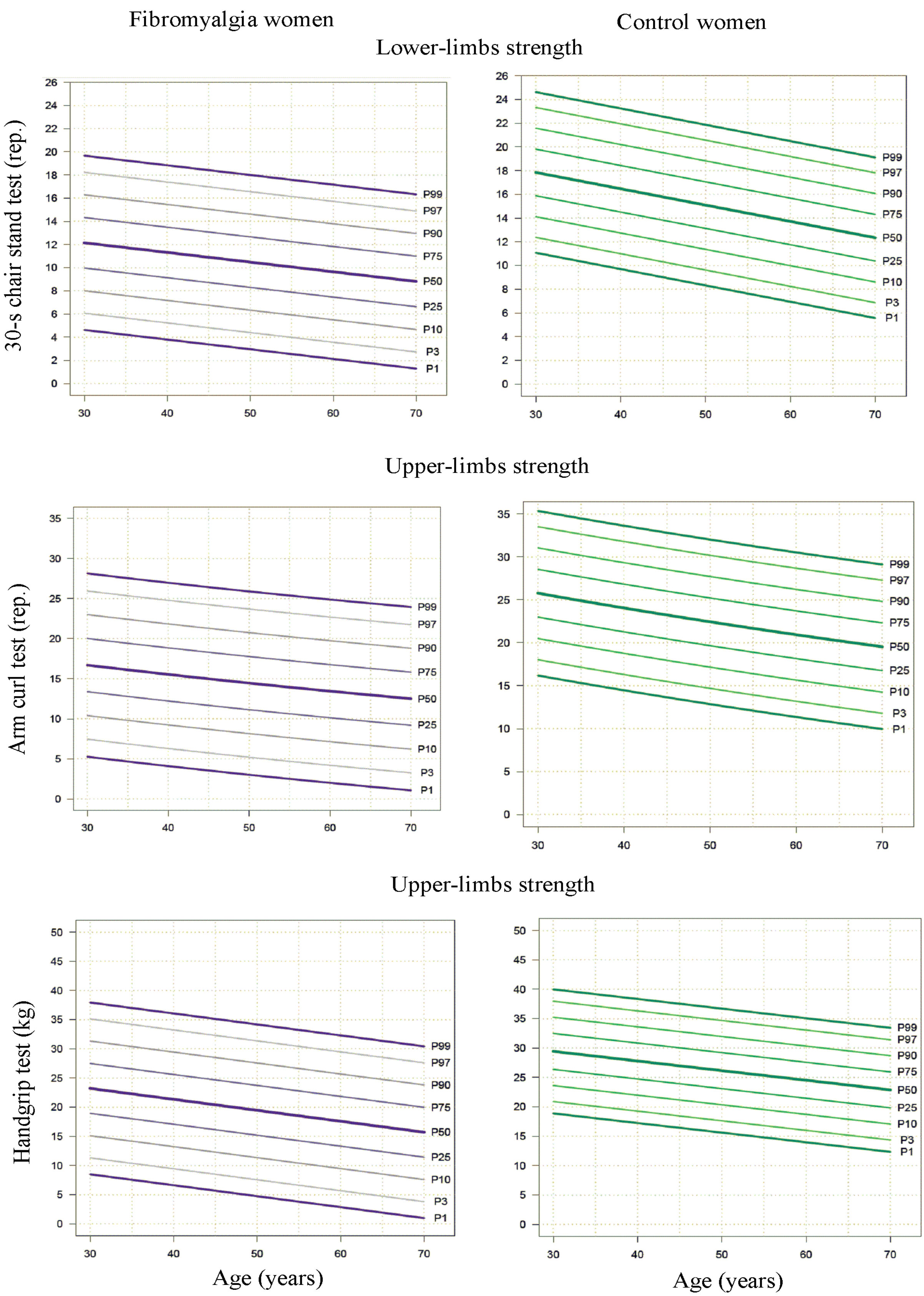

Figure 9. Percentiles curves (GAMLSS method, from the bottom to the top: P_1, P_3, P_{10}, P_{25}, P_{50}, P_{75}, P_{90}, P_{97}, P_{99}) of the three physical fitness test assessing lower-limb strength and upper-limb strength.

Table 16 shows linear regression models for men with fibromyalgia and controls of Study III**.**

Table 16. Linear regression models for men with fibromyalgia and controls.

Variable	**N FM**	**Model: fibromyalgia**		**N control**	**Model: controls**	
		intercept	slope		intercept	slope
6-minute walk test (m)	21	578.76	-1.01	54	777.27	-2.9
8-foot up-and-go test (s)*	21	0.54	0.13	55	3.4	0.03
Chair sit-and-reach test (cm)	21	0.83	-0.29	55	6.14	-0.11
Back scratch test (cm)	21	5.62	-0.47	55	7.59	-0.36
30-s chair stand test (rep)	21	13.92	-0.08	55	18.12	-0.05
Arm curl test (rep)	21	24.32	-0.18	55	31.44	-0.16
Handgrip test (kg)	21	41.47	-0.15	55	48.28	-0.11

FM, fibromyalgia.
Age was considered as covariate.

Figures 10-12 show fitted mean curves for men with fibromyalgia and controls.

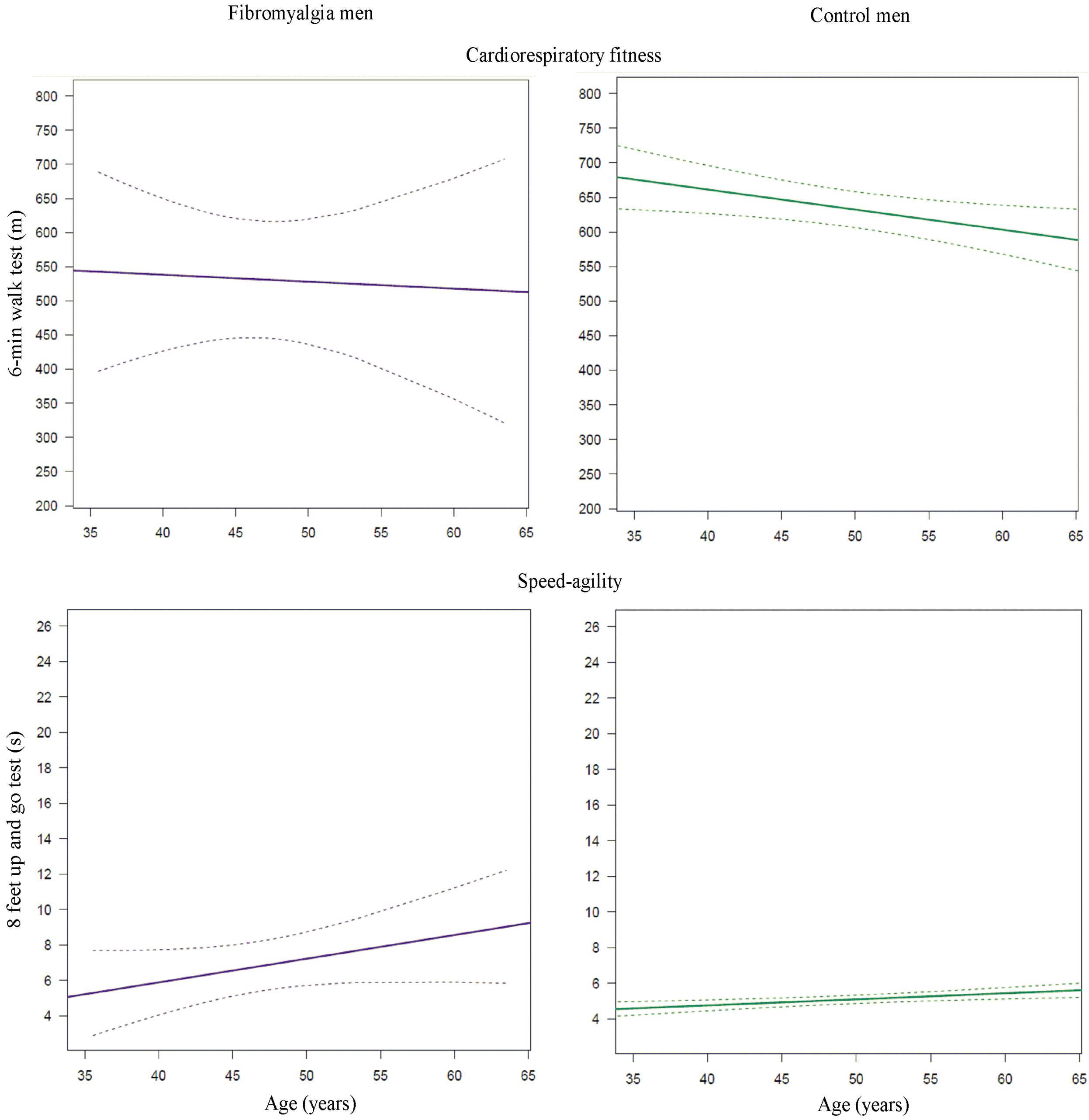

Figure 10. Fitted mean curves using a linear regression of the two physical fitness test assessing cardiorespiratory fitness and speed-agility for men. Additionally 95% confidence bands constructed using Scheffé's method are shown. For the 8-foot up-and-go test lower scores indicate better performance.

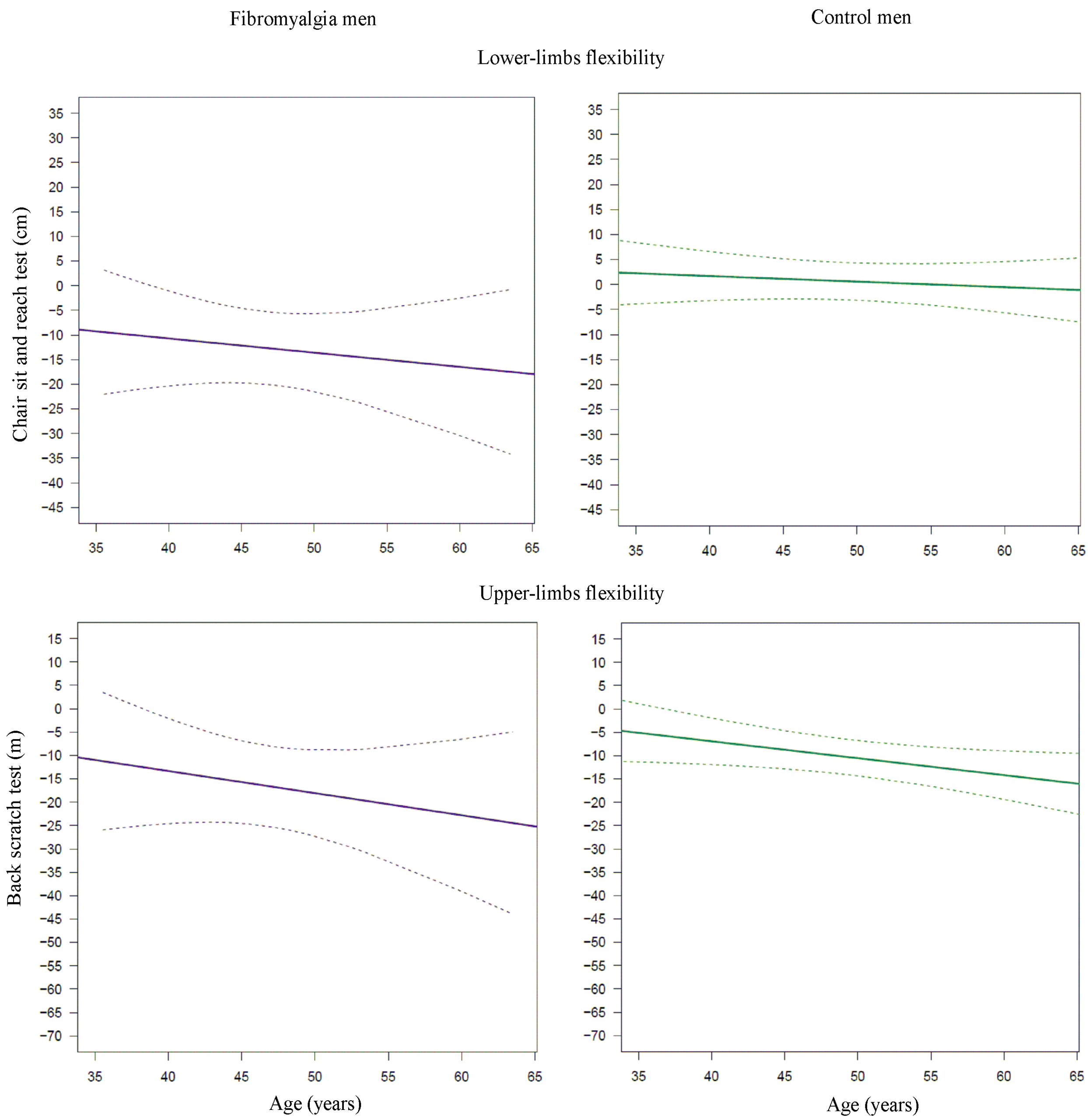

Figure 11. Fitted mean curves using a linear regression of the two physical fitness test assessing flexibility (lower and upper limbs flexibility) for men. Additionally 95% confidence bands constructed using Scheffé's method are shown.

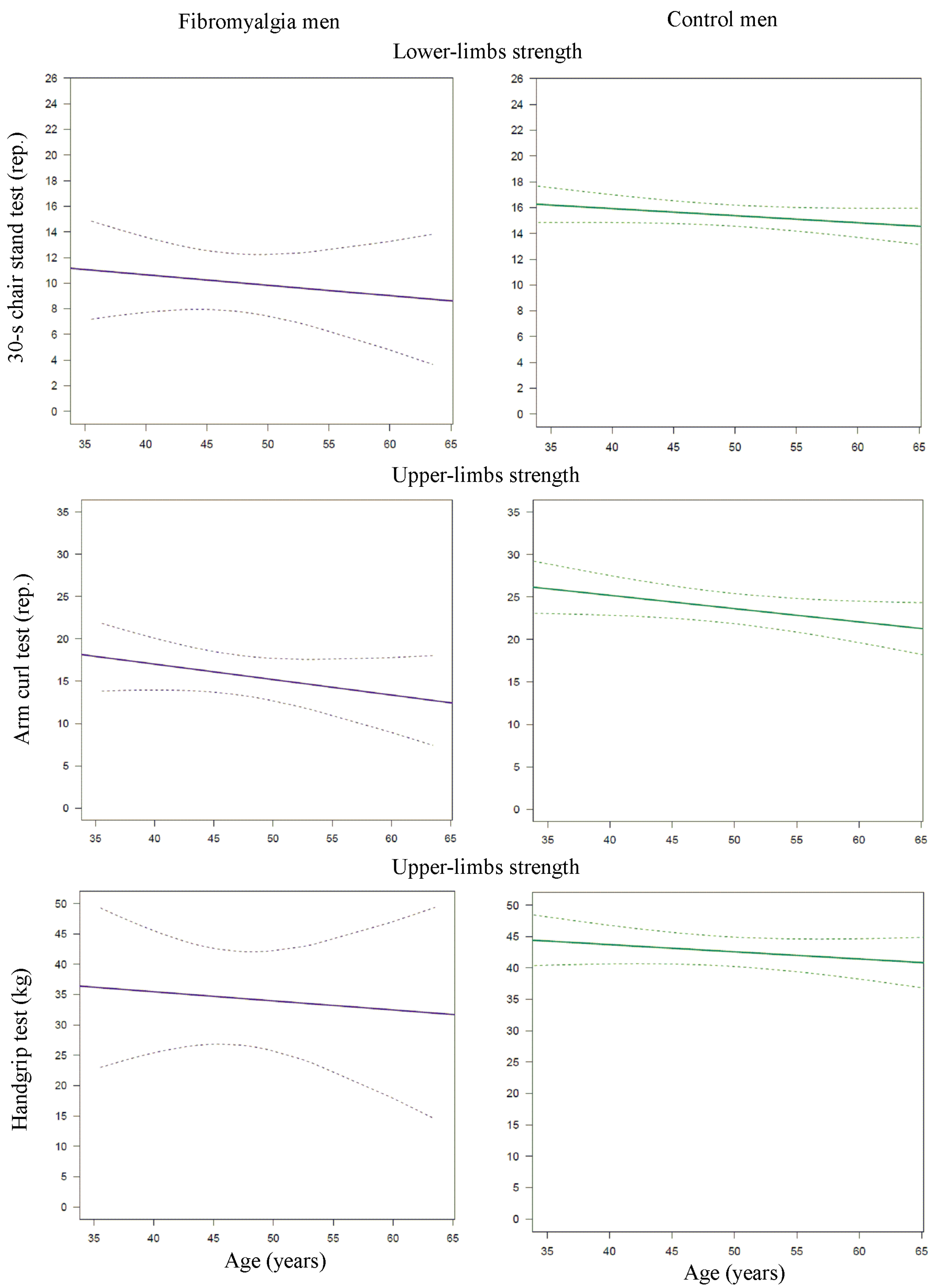

Figure 12. Fitted mean curves using a linear regression of the three physical fitness test assessing strength (lower and upper limb strength) for men. Additionally 95% confidence bands constructed using Scheffé's method are shown.

STUDY IV. Association of physical fitness with health-related quality of life in women with fibromyalgia

The final sample of the Study IV comprised 466 women with fibromyalgia. The descriptive characteristics of the study participants are presented in **table 17**.

Table 17. Descriptive characteristics of the study participants of Study IV.

	N	Mean	SD
Age (years)	466	52.1	8.0
Weight (kg)	465	71.2	13.8
Height (m)	465	157.9	6.0
Body mass index (kg/m2)	465	28.6	7.6
Total body fat (%)	456	40.1	5.4
Years since clinical diagnosis	453	5.79	1.7
SF-36			
Physical functioning (0-100)	466	38.8	18.9
Physical role (0-100)	466	33.4	21.8
Bodily pain (0-100)	466	20.9	14.7
General health (0-100)	466	28.5	15.2
Vitality (0-100)	466	22.5	17.7
Social functioning (0-100)	466	43.5	25.0
Emotional role (0-100)	466	56.0	28.5
Mental health (0-100)	466	45.5	20.3
Physical component scale (0-100)	466	29.6	6.9
Mental component scale (0-100)	466	35.7	11.9
Chair sit-and-reach test (cm)	466	-11.3	12.1
Back scratch test (cm)	466	-14.3	12.6
Handgrip test (kg)	466	19.0	6.6
30-s chair stand test (rep)	459	10.3	3.3
Arm curl test (rep)	456	14.3	1.9
8-foot up-and-go test (s)*	460	69.3	5.0
6-min walk test (m)	455	485.5	78.9
	N	**n**	**%**
Marital status	466		
Married		354	76.0
Single		36	7.7
Separated/divorced/widowed		76	16.3
Occupational status			
Housewife		147	31.5
Working		116	24.9
Unemployed		121	26.0
Retired		82	17.6
Educational level			
No studies		51	11.0
Primary school		225	48.3
Secondary school		56	12.0
Professional training		70	15.0
University degree		64	13.7
Medication usage ♯			
Analgesics (yes)		418	89.7
Antidepressants (yes)		268	57.5
Stimulants (yes)		34	7.3

SD, standard deviation; BMI, body mass index; SF36, 36-item Short-Form Health Survey.
* Lower score indicates better performance. ♯ Each participant can be included in several medicament groups depending on medication consumption.

The association of each physical fitness test and the global fitness profile with the eight dimensions of the SF-36, the PCS and the MCS are presented in **table 18**. Overall, higher performance on physical fitness tests was associated with higher levels of HRQoL in all SF-36 dimensions and subscales (all $p<0.05$ or $p<0.001$) except for associations of handgrip with social functioning, emotional role, mental health and MCS, and of the chair sit-and-reach test with the general health dimension.

Table 18. Linear regression models examining the association of each physical fitness test with the eight dimensions and the global physical and mental component scores of the 36-item Short-Form Health Survey (SF-36).

	β	B	95% CI		p
Physical function					
Chair sit-and-reach test (cm)	0.247	0.386	0.244	0.527	**<0.001**
Back scratch test (cm)	0.211	0.322	0.177	0.466	**<0.001**
Handgrip test (kg)	0.201	0.578	0.318	0.837	**<0.001**
30-s chair stand test (rep)	0.454	3.203	2.782	3.625	**<0.001**
Arm curl test (rep)	0.437	1.964	1.692	2.236	**<0.001**
8-foot up-and-go test (s)*	-0.305	-4.823	-5.795	-3.852	**<0.001**
6-minute walk test (m)	0.387	0.117	0.097	0.138	**<0.001**
Global fitness profile (z-score)	0.329	8.362	5.997	10.728	**<0.001**
Physical role					
Chair sit-and-reach test (cm)	0.128	0.228	0.066	0.391	**0.006**
Back scratch test (cm)	0.165	0.288	0.125	0.451	**0.001**
Handgrip test (kg)	0.117	0.385	0.090	0.680	**0.011**
30-s chair stand test (rep)	0.386	3.059	2.588	3.530	**<0.001**
Arm curl test (rep)	0.408	2.056	1.758	2.353	**<0.001**
8-foot up-and-go test (s)*	-0.267	-4.733	-5.797	-3.669	**<0.001**
6-minute walk test (m)	0.305	0.104	0.081	0.127	**<0.001**
Global fitness profile (z-score)	0.272	7.986	5.265	10.706	**<0.001**
Bodily pain					
Chair sit-and-reach test (cm)	0.161	0.195	0.087	0.302	**<0.001**
Back scratch test (cm)	0.159	0.187	0.079	0.296	**0.001**
Handgrip test (kg)	0.100	0.223	0.027	0.420	**0.026**
30-s chair stand test (rep)	0.368	2.671	2.255	3.086	**<0.001**
Arm curl test (rep)	0.370	1.714	1.448	1.980	**<0.001**
8-foot up-and-go test (s)*	-0.199	-3.235	-4.191	-2.278	**<0.001**
6-minute walk test (m)	0.276	0.086	0.066	0.106	**<0.001**
Global fitness profile (z-score)	0.187	3.694	1.860	5.528	**<0.001**

	β	B	95% CI		p
General health					
Chair sit-and-reach test (cm)	0.084	0.105	-0.011	0.222	0.077
Back scratch test (cm)	0.138	0.170	0.053	0.287	**0.004**
Handgrip test (kg)	0.108	0.250	0.040	0.461	**0.020**
30-s chair stand test (rep)	0.353	2.159	1.780	2.539	**<0.001**
Arm curl test (rep)	0.342	1.339	1.095	1.584	**<0.001**
8-foot up-and-go test (s)*	-0.216	-2.967	-3.822	-2.112	**<0.001**
6-minute walk test (m)	0.265	0.070	0.052	0.088	**<0.001**
Global fitness profile (z-score)	0.184	3.839	1.845	5.834	**<0.001**
Vitality					
Chair sit-and-reach test (cm)	0.096	0.140	0.004	0.276	**0.044**
Back scratch test (cm)	0.139	0.198	0.061	0.334	**0.005**
Handgrip test (kg)	0.116	0.311	0.065	0.557	**0.013**
30-s chair stand test (rep)	0.340	2.303	1.882	2.724	**<0.001**
Arm curl test (rep)	0.351	1.525	1.255	1.794	**<0.001**
8-foot up-and-go test (s)*	-0.192	-2.922	-3.871	-1.973	**<0.001**
6-minute walk test (m)	0.262	0.077	0.056	0.097	**<0.001**
Global fitness profile (z-score)	0.202	4.917	2.575	7.259	**<0.001**
Social functioning					
Chair sit-and-reach test (cm)	0.134	0.276	0.095	0.457	**0.003**
Back scratch test (cm)	0.111	0.224	0.041	0.407	**0.017**
Handgrip test (kg)	0.055	0.209	-0.122	0.539	0.216
30-s chair stand test (rep)	0.265	2.015	1.540	2.491	**<0.001**
Arm curl test (rep)	0.260	1.267	0.960	1.573	**<0.001**
8-foot up-and-go test (s)*	-0.150	-2.554	-3.612	-1.497	**<0.001**
6-minute walk test (m)	0.237	0.078	0.056	0.100	**<0.001**
Global fitness profile (z-score)	0.207	7.021	3.960	10.082	**<0.001**
Emotional role					
Chair sit-and-reach test (cm)	0.093	0.218	0.008	0.427	**0.041**
Back scratch test (cm)	0.155	0.353	0.144	0.563	**0.001**
Handgrip test (kg)	0.085	0.366	-0.013	0.745	0.058
30-s chair stand test (rep)	0.241	1.781	1.286	2.276	**<0.001**
Arm curl test (rep)	0.215	1.016	0.697	1.335	**<0.001**
8-foot up-and-go test (s)*	-0.193	-3.188	-4.264	-2.111	**<0.001**
6-minute walk test (m)	0.210	0.067	0.044	0.090	**<0.001**
Global fitness profile (z-score)	0.216	8.334	4.833	11.835	**<0.001**
Mental health					
Chair sit-and-reach test (cm)	0.163	0.273	0.122	0.423	**<0.001**
Back scratch test (cm)	0.186	0.303	0.152	0.454	**<0.001**
Handgrip test (kg)	0.089	0.273	-0.001	0.548	0.051
30-s chair stand test (rep)	0.232	1.386	0.981	1.791	**<0.001**
Arm curl test (rep)	0.220	0.844	0.584	1.105	**<0.001**
8-foot up-and-go test (s)*	-0.188	-2.517	-3.395	-1.639	**<0.001**
6-minute walk test (m)	0.209	0.054	0.035	0.073	**<0.001**
Global fitness profile (z-score)	0.220	6.073	3.516	8.629	**<0.001**

	β	B	95% CI		p
Physical component scale					
Chair sit-and-reach test (cm)	0.153	0.087	0.034	0.140	**0.001**
Back scratch test (cm)	0.136	0.075	0.022	0.129	**0.006**
Handgrip test (kg)	0.147	0.153	0.057	0.249	**0.002**
30-s chair stand test (rep)	0.435	1.303	1.125	1.480	**<0.001**
Arm curl test (rep)	0.444	0.844	0.731	0.957	**<0.001**
8-foot up-and-go test (s)*	-0.258	-1.734	-2.148	-1.321	**<0.001**
6-minute walk test (m)	0.337	0.043	0.035	0.052	**<0.001**
Global fitness profile (z-score)	0.227	2.090	1.200	2.980	**<0.001**
Mental component scale					
Chair sit-and-reach test (cm)	0.112	0.110	0.024	0.197	**0.013**
Back scratch test (cm)	0.156	0.150	0.063	0.237	**0.001**
Handgrip test (kg)	0.069	0.124	-0.033	0.282	0.122
30-s chair stand test (rep)	0.199	0.663	0.441	0.885	**<0.001**
Arm curl test (rep)	0.185	0.395	0.252	0.537	**<0.001**
8-foot up-and-go test (s)*	-0.151	-1.126	-1.608	-0.645	**<0.001**
6-minute walk test (m)	0.181	0.026	0.016	0.036	**<0.001**
Global fitness profile (z-score)	0.208	3.374	1.910	4.838	**<0.001**

β standardized regression coefficient; B, unstandardized regression coefficient expressing the expected unit change in the dependent variable for each unit change in the independent variable (when the rest of variables in the model remain unchanged; CI, confidence interval. All the analyses were adjusted for occupational status, total body fat percentage, analgesics, antidepressants and stimulants.
* The lower the score, the better the performance.

A graphical representation of the association of flexibility, muscle strength, speed-agility, cardiorespiratory fitness and global fitness (composite scores) with the PCS and MCS is shown in **figure 13**. In general, there was a linear (dose-response) relationship, where higher levels of physical fitness were associated with better levels of HRQoL. The difference on HRQoL between physical fitness quintiles (Q5 vs. Q1) can be observed in **table 19**. Overall, there were differences between quintiles of physical fitness tests (all $p<0.05$), except for flexibility in the PCS and for strength in the MCS. Effect sizes (Cohen´s d) were moderate or large (range from 0.53 to 0.90) and the percentage of change was greater than 5 points in all measures except for PCS with flexibility (3.6), speed-agility (4.8) and global fitness profile (4.6).

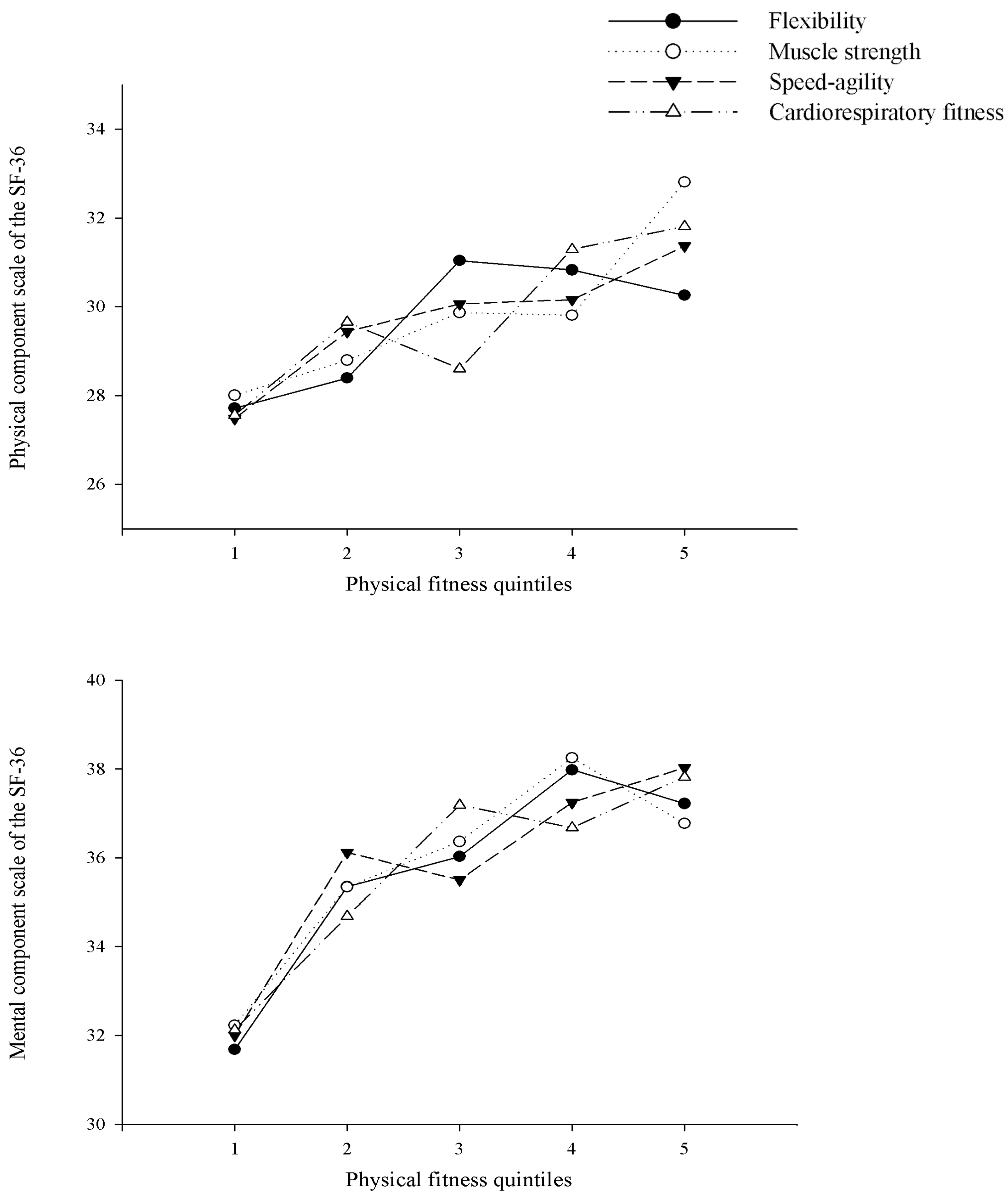

Figure 13. Graphic representation of the association between quintiles of flexibility, muscle strength, speed-agility, cardiorespiratory fitness and global fitness with the physical and mental component of the 36-item Short-Form Health Survey (SF-36). Quintile 1 represents the group with the lowest fitness level. Flexibility was computed as the average of the z-scores from the chair sit-and-reach and back scratch tests. Muscle strength was computed as the average of the z-scores form the handgrip, chair stand and arm curl tests. Speed-agility was computed as the z-score from the 8-foot up-and-go test multiplied by -1 (since higher time implies lower performance). Cardiorespiratory fitness was computed as de z-score from the 6-minute walk test.

Table 19. Average 36-item Short-Form Health Survey subscale scores and effect sizes for the physical fitness components at quintile 1 and quintile 5.

	Q1 Mean ± SD	Q5 Mean ± SD	Q5-Q1	P	Cohen's *d*
Physical component scale					
Flexibility	27.2 ± 6.5	30.7 ± 6.8	3.6	0.157	0.53
Muscle strength	27.7 ± 6.0	33.2 ± 6.9	5.5	**<0.001**	0.85
Speed-agility	27.1 ± 6.5	31.9 ± 6.9	4.8	**0.002**	0.72
Cardiorespiratory fitness	27.0 ± 6.0	32.4 ± 6.7	5.4	**0.001**	0.85
Global fitness	28.1 ± 6.3	32.6 ± 6.7	4.6	**0.002**	0.70
Mental component scale					
Flexibility	30.2 ± 10.8	39.2 ± 11.8	9.0	**0.013**	0.80
Muscle strength	31.1 ± 12.0	38.4 ± 11.7	7.3	0.071	0.62
Speed-agility	30.3 ± 12.2	39.3 ± 12.6	9.0	**0.004**	0.73
Cardiorespiratory fitness	30.5 ± 10.9	38.9 ± 11.5	8.4	**0.009**	0.75
Global fitness	29.9 ± 11.1	40.2 ± 11.7	10.3	**<0.001**	0.90

Q1, quintile of fitness 1 (lowest fitness level); Q5, quintile of fitness 5 (better fitness level).

The independent association of the different physical fitness components with the SF-36 PCS and MCS are presented in **table 20**. Muscle strength was independently associated with the SF-36 PCS ($p<0.001$), and flexibility and cardiorespiratory fitness were independently associated with the SF-36 MCS (both $p<0.05$).

Table 20. Stepwise regression models assessing the independent association of the different components of physical fitness with the physical and mental component of the 36-item Short-Form Health Survey in women with fibromyalgia.

Physical component scale	β	B	95% CI		P	Adj. R^2	R^2 change	P (model)
Step 1						0.032		**0.002**
Occupational status	0.118	1.801	0.355 ,	3.247	**0.015**			
Total body fat %	-0.122	-0.107	-0.190 ,	-0.024	**0.011**			
Analgesics	0.025	0.559	-1.537 ,	2.655	0.600			
Antidepressants	-0.094	-1.276	-2.573 ,	0.021	0.054			
Stimulants	-0.008	-0.208	-2.693 ,	2.276	0.869			
Step 2						0.091	0.079	**<0.001**
Occupational status	0.094	1.441	0.022 ,	2.859	**0.047**			
Total body fat %	-0.111	-0.098	-0.178 ,	-0.017	**0.018**			
Analgesics	0.024	0.528	-1.518 ,	2.573	0.612			
Antidepressants	-0.049	-0.666	-1.956 ,	0.623	0.310			
Stimulants	-0.021	-0.538	-2.966 ,	1.890	0.664			
Strength	0.226	1.852	1.089 ,	2.616	**<0.001**			

Mental component scale	β	B	95% CI		P	Adj. R^2	R^2 change	P (model)
Step 1						0.162		**<0.001**
Occupational status	0.057	1.535	-0.841 ,	3.912	0.205			
Total body fat %	-0.009	-0.015	-0.151 ,	0.121	0.834			
Analgesics	-0.092	-3.633	-7.078 ,	-0.188	**0.039**			
Antidepressants	-0.365	-8.735	-10.866 ,	-6.603	**<0.001**			
Stimulants	-0.068	-3.149	-7.233 ,	0.934	0.130			
Step 2						0.192	0.031	**<0.001**
Occupational status	0.031	0.835	-1.523 ,	3.194	0.487			
Total body fat %	0.017	0.027	-0.108 ,	0.162	0.696			
Analgesics	-0.089	-3.515	-6.899 ,	-0.131	**0.042**			
Antidepressants	-0.315	-7.534	-9.705 ,	-5.362	**<0.001**			
Stimulants	-0.071	-3.268	-7.279 ,	0.743	0.110			
Flexibility	0.188	2.768	1.437 ,	4.099	**<0.001**			
Step 3						0.202	0.012	**<0.001**
Occupational status	0.019	0.507	-1.851 ,	2.864	0.673			
Total body fat %	0.035	0.054	-0.082 ,	0.189	0.438			
Analgesics	-0.083	-3.268	-6.637 ,	0.101	0.057			
Antidepressants	-0.300	-7.184	-9.359 ,	-5.009	**<0.001**			
Stimulants	-0.074	-3.420	-7.408 ,	0.568	0.093			
Flexibility	0.138	2.022	0.577 ,	3.468	**0.006**			
Cardiorespiratory	0.126	1.522	0.333 ,	2.711	**0.012**			

β, standardized regression coefficient; B, unstandardized regression coefficient; CI, confidence interval; Adj. R^2, adjusted coefficient of determination, expressing the percent variability of the dependent variable explained by each model; R^2 change, additional percent variability explained by the model due to the inclusion of the new term. The variables included into Step 1 were forced to be entered into the models in order to account for their potential confounding effect. In the next bloc, all fitness components were entered at the same time and stepwise regression (method forward) was entering into the model the variable more strongly associated with the outcome step by step.

DISCUSSION

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DISCUSSION

STUDY I. Reliability and feasibility of physical fitness tests in women with fibromyalgia

The purpose of the Study I was to determine the reliability and feasibility of a physical fitness tests in women with fibromyalgia. The ICC values for all the physical fitness were high and represented a good reliability. The SEMs provide a low index of error. We used the SEM to estimate the MDC, providing clinically useful information in terms of defining the minimal amount of change needed to be considered "real" and that is not likely to be attributable to a chance variation in measurement[108]. All the physical fitness tests were well tolerated by the patients. These results confirm that this battery of tests is successful in measuring performance across a wide range of ability levels. The ICC values observed in our women with fibromyalgia are similar than those reported in the original study of the Senior Fitness test battery with older women[67].

We observed significant differences between test and retest performance in the arm curl, 30-s chair stand and 8-foot up-and-go tests, yet the mean inter-trial differences for these measurements were low. Furthermore, the effect size of the mean differences, as measured by the Cohen's *d* were small (<0.25). This suggests that, from a practical point of view, these tests can be used to evaluate physical fitness in women with fibromyalgia. The better scores performed in the retest assessment may hint learning effects (positive systematic bias), but others reasons, as the intensity of symptoms, could also have influenced the results. The intensity of the symptoms is not always constant across the day or between days and the changes in one symptom can affect other symptoms[117–119]. The fatigue, the quality of resting the night before, or even the weather, could also affect the patients, and hence physical performance[118–121]. Previous studies have observed an association between the performance in physical fitness tests and the level of pain[50,99,122,123], but in the present study, the results remained unchanged after the adjustment for change of pain.

Results from the heteroscedasticity analysis and Bland-Altman plots indicate that the poorer in the performance in the back scratch, 8-foot up-and-go and chair sit-and-reach tests, the worse the degree of the agreement. Mannerkorpi et al.[124] analysed in 15 women

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with fibromyalgia the reliability of a battery composed by the following tests: shoulder range of motion (flexion and abduction), hand-to-neck, hand-to-scapula and isometric endurance of the shoulder abductor muscles for the upper extremity, and 30-s chair stand test and 6-minute walk for lower extremity. They did not find differences between the test and retest performance (interval of 2-3 days) and concluded, that all the tests, except the hand to-neck test, possessed acceptable reliability. Two studies focused on the reliability of the 6-minute walk test. The ICC obtained in the study by Pankoff et al.[125] (0.91) was similar to ours (0.92). King et al.[100] repeated the 6-minute walk test five times over 10 days in 12 patients. They reported a correlation of 0.733 for five 6-minute walk tests over 10 days, and 0.885 for the final 4 walks.

Three recent studies have analysed the reliability of strength tests. Adsuar et al. carried out 2 studies to analyse the reliability of isokinetic peak torque and work and isometric peak torque measurements for knee flexion and extension[126] and the reliability of isokinetic strength measurements during concentric and eccentric actions of the shoulder muscles[127]. In the first study[126], focused in the lower extremity, all peak torque measures had an ICC >0.90 with the exception of eccentric flexion (0.83), and all work measures had an ICC >0.85. In the second study[127], focused in the upper extremity, they found that peak torque showed high reliability for the abduction (ICC=0.88) and adduction (ICC=0.89) phases in the concentric/eccentric test. However, in the concentric/concentric test, peak torque showed low reliability in the abduction phase (ICC=0.29) and good reliability in the adduction phase (ICC=0.92). Finally, Munguia et al.[128] analyzed the reliability of a low loads endurance strength tests for upper and lower extremities. The tests showed a good reliability (ICC=0.973-0.979) and the SEMs were between 1.44 and 1.66 repetitions.

The physical fitness assessment in daily clinical practice is limited by the availability of scientific instruments or time. In this sense, the proposed tests have a great potential in a clinical setting for several reasons: First, the equipment needed to perform these tests is cheap; the handgrip dynamometer is the only equipment that needs an economical inversion. Second, the time needed to perform these 7 tests together is less than 30-40 minutes. Third, the procedures for these tests are simple and do not require any special training.

The present study has several limitations that need to be mentioned. The sample was of convenience and was only composed by women.

STUDY II. The International FItness Scale (IFIS): construct validity and reliability in women with fibromyalgia

This study demonstrated that the IFIS has moderate validity and test-retest reliability for ranking women with fibromyalgia according to their objectively measured physical fitness level. The IFIS was able to identify women with fibromyalgia who had very low fitness and distinguish them from those with average fitness levels. Although objective measures of physical fitness are generally recommended, these findings suggest that that IFIS could be useful when performance-based testing is not feasible. The IFIS may also be useful as an screening test in epidemiological studies to detect women with fibromyalgia who have poor fitness, since low fitness is a consistent indicator of more severe symptomatology in this population[51,53,70,71,80]. Therefore, both self-reported questionnaires and performance-based tests are essential components of a comprehensive clinical assessment[129].

Consistent with previous work[130–132], participants with fibromyalgia in the current study had lower educational level than healthy women, and many were retired, were on sick leave or unemployed. The reduced employment status of those with fibromyalgia could be due to the symptomatology and the physical disability associated with the condition, emphasizing the importance of physical fitness assessment in fibromyalgia.

Validity of the IFIS

Women with fibromyalgia reported worse physical fitness levels than age- and sex-matched controls. Approximately 65-85% of women with fibromyalgia reported very poor or poor physical fitness while only 8-50% of control women reported very poor or poor physical fitness. The results from performance-based fitness testing confirmed that women with fibromyalgia had lower physical fitness levels than age- and sex-matched controls, which is also supported by previous studies[45,46,133,134]. The IFIS was able to detect these differences in fitness, supporting the validity of the IFIS to discriminate between levels of fitness in women with fibromyalgia and healthy controls.

Our results indicate that the IFIS can identify women with fibromyalgia who have very poor fitness, and these women are significantly different from those with an average fitness level. Paradoxically, no differences were found for many of the tests studied between patients reporting a very poor fitness and those reporting good/very good fitness. We believe that this lack of significance is explained by the low statistical power due to the low number of participants reporting good/very good fitness. The opposite situation was found in the healthy control women, in that there were few reporting very poor fitness. Consequently, the results involving participants reporting good/very good fitness in the fibromyalgia group and very poor in the control group must be interpreted with caution. In this regards, it is also possible that the clinical utility of the IFIS is limited in women with fibromyalgia with high fitness levels. However, the IFIS could have still an important role in clinical settings to identify patients with very low fitness. In the general population, individuals with a very low fitness (i.e. 1st quintile) have more than double risk of cardiovascular disease and death from any cause than individuals with higher fitness levels. The health risks are much smaller among those groups with higher fitness level (i.e. 2nd to 5th quintiles)[34,35,135]. This evidence strongly support that the key group to be screened and targeted is the one belonging to the 1st quintile or equivalent, i.e. individuals with a very low fitness level. From a clinical point of view, it is also important to identify those individuals with fibromyalgia with very low physical fitness, since they are at higher risk of general future diseases and perhaps also at a higher risk of worsen specific fibromyalgia symptoms.

The findings of this study are consistent with previous work examining the validity of the IFIS in children[77], adolescents[78] and young adults[79], supporting a linear association between self-reported and objectively measured physical fitness in both fibromyalgia and control women. Our results also concur with previous studies using other questionnaires or scales to estimate fitness, in which a moderate to good agreement with measured fitness was observed in middle-age[136] and older adults[137,138].

Reliability of the IFIS

The test re-test reliability of the IFIS was 0.45, indicating moderate reliability[139] of the IFIS in women with fibromyalgia. The most reliable fitness component was flexibility (*k*=0.63) whereas muscular strength was the least reliable (*k*=0.40). The large variability of the fibromyalgia-related symptoms, with intermittent periods of exacerbation and remission[140] may explain these differences.[141] For example, symptoms such as fatigue, the quality of rest on the night before testing, or even the weather, could vary from one day to another, which could influence self-reported fitness responses[118–121]. Even if the physical performance of women with fibromyalgia remains steady from day-to-day, daily variations in symptoms severity might influence their perceptions about physical capability. The average test-retest weighted Kappa for IFIS when used in healthy young adults was 0.59[79], which is slightly higher than observed in the present study, but leads to a similar conclusion, i.e. IFIS is a moderately reliable tool in these two populations. It must also be taken into account that the biological variability (in addition of the instrument's variability) might have an effect on the reliability of the IFIS. Previous research[142] reported significant test-retest differences in the arm curl, 30-s chair stand, and 8-foot up-and-go tests in women with fibromyalgia, however, the mean inter-trial difference for these measurements were low and the effect size of the mean differences were small (Cohen's d <0.25). It appears therefore that, from a practical point of view, these tests can be used to evaluate physical fitness in women with fibromyalgia. Our findings support this previous study[44] in that muscular strength was the least reliable of all fitness components in women with fibromyalgia.

Study Limitations and strengths

The Study II had some limitations, for example there was no control group for the reliability study. The IFIS was designed to be used in large populations, however, the number of participants in some categories in our study, was small and the results regarding categories with small sample size should be interpreted with caution. For this reason, two categories of the IFIS were merged (good and very good), which could have influenced the results. Although the physical fitness tests used have been shown to be feasible and reliable in women with fibromyalgia[142], but the validity of some of the fitness tests used has not been studied, therefore, their use as a comparative standard should be taken with caution. Finally, the design of the current study did not allow examination of the possible variability of physical capabilities at different time points. On the other hand, this is one of the largest studies examining the construct validity of a self-reported fitness tool against performance-based physical fitness in women with fibromyalgia. Moreover, the fact that sampling was designed to be representative of the fibromyalgia population in southern Spain should also be acknowledged[7].

STUDY III. Reference values of physical fitness in Andalusian fibromyalgia patients

The major contribution of the Study III is to provide reference data in a relatively large and geographically representative sample of women with fibromyalgia from the south of Spain, as well as in age-matched healthy controls, allowing accurate comparisons. Patients with fibromyalgia had consistently (across age and gender groups) worse performance in all physical fitness components than controls. Study III also informs that the mean differences in physical fitness between women with fibromyalgia and controls are lower as age increases. Finally and as expected, our results suggest that older patients with fibromyalgia and controls have a lower physical fitness level than their younger peers. Likewise men perform better in upper body muscular strength, while worse in upper body flexibility, yet this finding should be interpreted with caution due to the small number of male participants.

Recently, Rikli and Jones[143] proposed criterion fitness standards (for people between 60 to 94 years of age) that are associated with the physical fitness levels needed to perform the types of everyday activities required to remain physical independence until late in life (with late life defined as 90+ years). When comparing our results with the physical fitness standards[143,144], our findings are even more alarming given that the physical fitness of the most of people with fibromyalgia in our study did not meet the physical fitness standards for their age and it is similar to people without fibromyalgia 30 years older. These results are consistent with those of a previous study,[145] indicating a risk for disability in women with fibromyalgia.

On average, women with fibromyalgia showed a significant poorer performance on physical fitness compared with aged-matched healthy peer women, in agreement with the previous literature demonstrating that cardiorespiratory fitness[133,146,147], speed-agility[146,148], flexibility[146,149], and strength [46,50,146] of women with fibromyalgia are deteriorated. As expected, there was a decreasing trend of physical fitness in both, people with fibromyalgia and controls with age. However, a very interesting findings was that between-groups differences were smaller as age increased, i.e. the fitness level of older women with and without fibromyalgia was less different than in younger women, which is in agreement with a previous study[145]. Our interpretation of this finding is that physical fitness in patients with fibromyalgia is deeply deteriorated already at young ages, in other words, these patients have might be aging earlier.

A previous study, which measured cardiorespiratory fitness using the 6-minute walk test, also indicated that cardiorespiratory fitness was associated with tenderness, symptomatology, quality of life, and coping strategies in women with fibromyalgia[122]. We showed that women with fibromyalgia with high aerobic fitness+high flexibility had the best pain-related catastrophizing and chronic pain self-efficacy profiles[51]. On the other hand, speed-agility has been found to be related to several important mobility tasks of daily living as well as to the number of falls in fibromyalgia patients. We, therefore[45,150,151], suggest that women with fibromyalgia should be screened for dynamic balance and mobility in clinical settings. Physical fitness has shown to discriminate between women with fibromyalgia and their healthy counterparts, as well as between patients with moderate and severe fibromyalgia[70]. Therefore, future exercise intervention studies are warranted to determine the benefits of enhancing specific components of physical fitness.

Simple stretching exercises in combination with other exercises improved functional activities, symptoms and self-efficacy in patients with fibromyalgia[152]. In the same way, stretching exercises program showed to be efficient to reduce pain and painful sensibility at tender points, thus enhancing patients´ quality of life[153]. Nevertheless, the evidence is very limited for flexibility in patients with fibromyalgia. Moreover, maintaining lower extremity muscular strength is very important to prevent and delay the onset of physical frailty and dependency in later years[46]. Furthermore, lower body strength is essential for several mobility tasks of daily living (e.g., walking, stair climbing, maintaining balance, getting out of a chair or bathtub). Women with severe fibromyalgia have lower handgrip strength and worse health-related quality of life than women with moderate fibromyalgia[71], therefore, handgrip testing could be used as a complementary tool in the assessment and monitoring of fibromyalgia[69,71]. In addition, it has been found that following exercise interventions, patients who showed higher changes in muscular strength also got the higher benefits in postural balance and in several dimensions of the health-related quality, such as physical role and psychological/emotional problems[154]. In a recent study, it has been observed that women with fibromyalgia with high muscular strength+high flexibility had significantly lower levels of pain[51].

Clinical and public health implications of Study III

Recent literature indicates that physical fitness is an important health marker in fibromyalgia[51–53,80]. Since there is no cure for fibromyalgia yet, it is critical for both economic and personal reasons that health care providers identify individuals at risk for losing physical independence assessing regularly the physical fitness status and providing appropriate exercise recommendations. Thus, it is important to know which are the physical fitness components more deteriorated in each patient to design intervention programs personalized and focused on improving these deficiencies that could improve their physical function and symptomatology. The need of meaningful and accurate physical fitness assessment is highlighted in fibromyalgia. Proper interpretation of current physical fitness levels requires comparisons between the score obtained in a particular person with normative values from the general population or from a determined health condition such as fibromyalgia. For instance, a 55-year old woman with fibromyalgia who receives a score of 14 on a particular test item, such as the arm curl test for assessing upper body strength, could look at the percentile tables and see how she is compared with others in her age group and know whether she had scored better or worse than any given percentage of her peers (i.e. percentile 50 approximately). The normative physical fitness standards (percentile tables) of the people with fibromyalgia from Andalusia developed in this study make possible for individuals and clinicians to compare their performance with peers of their same age and sex and help to manage the illness.

Limitations and strengths of Study III

This study includes women and men with fibromyalgia from the south of Spain; therefore, inferences to all Spanish people with fibromyalgia should be made cautiously. In addition, the men sample was too small to offer percentiles for each age range, and results must be interpreted with caution. Nevertheless, the prevalence of fibromyalgia in men is very small (0.2%)[18].

On the other hand, this study represents one of the largest sample size in women with fibromyalgia with fitness assessment, includes an age-matched control group and sampling was done so that it is geographically representative from Andalusia which covers the whole south of Spain. Finally, the present study is cross-sectional, longitudinal studies should contrast or confirm the results presented here about how fitness change across age. To the best of our knowledge, this is the first study providing reference values of a wide set of physical fitness components in people with fibromyalgia.

STUDY IV. Association of physical fitness with health-related quality of life in women with fibromyalgia

The results of the Study IV indicated that higher physical fitness levels were positively and linearly associated with better HRQoL in women with fibromyalgia. The differences between extreme physical fitness levels (Q1 vs. Q5) might be considered clinically relevant[106,116]. From all physical fitness components, muscle strength showed an independent positive association with the SF-36 PCS, while flexibility and cardiorespiratory fitness were independently associated with the SF-36 MCS.

Our results with a geographically representative sample of women with fibromyalgia from southern Spain indicate that higher physical fitness is consistently associated with better HRQoL. These results are in line with previous research suggesting that low physical fitness in fibromyalgia is related with an enormous impact on the management of daily simple tasks, as bathing, doing the bed, or simply walking[8,48,53] and consequently on HRQoL[8,155]. Moreover, exercise interventions studies in fibromyalgia have shown that improvements in physical fitness are related with an increase in HRQoL[58,59,156,157]. However, to the best of our knowledge, only one study has measured the association between physical fitness status and HRQoL in fibromyalgia[90]. This study pointed out that low muscle strength was related to reduced HRQoL, which is in concordance with the results of the present study. Other study[122], which measured the association between cardiorespiratory fitness (measured with the 6-minute walk test) and HRQoL, also indicated a positive association between these variables in women with fibromyalgia.

Multidisciplinary interventions may improve functional capacity and HRQoL in people with fibromyalgia[88] but usually, studies are focused in only one of the physical components and not in global fitness interventions. We have found a positive association between all physical fitness tests used (that measured all physical fitness components) and the SF-36 dimensions. Therefore, our findings provide support for current recommendations for the management of fibromyalgia that advocate the development of interventions to improve physical fitness holistically[158], rather than those that focus separately on individual components of physical fitness. Future researches could be focus on detect people with fibromyalgia in quintiles 1 and 2 of physical fitness and to perform exercise interventions adapted and focused on improve physical fitness holistically and carefully examine the clinical impact on main symptoms and HRQoL.

Muscle strength was the fitness component independently associated with the SF-36 PCS, while flexibility and cardiorespiratory fitness were independently associated with the SF-36 MCS. These results support previous research[90], where low muscle strength was associated with reduced HRQoL. Other study, which measured cardiorespiratory fitness using the 6-minute walk test, also found that cardiorespiratory fitness was positively associated with HRQoL in women with fibromyalgia[122]. In addition, previous studies[50,159] have suggested that flexibility might be a relevant component of physical fitness in this population. Although exercise programs rarely focus on specific flexibility training, the present study provide evidence suggesting that flexibility is independently associated with HRQoL, and consequently, it might be taken into account in future exercise interventions studies as well as muscle strength and cardiorespiratory fitness. However, the above-mentioned studies analysed the association of muscle strength or cardiorespiratory fitness with the mean score of the SF-36, while in the present study the associations were done with the PCS and MCS, in order to examine the association with the mental and physical components of HRQoL independently. Furthermore, our results are in line with the study by Gavi et al.[156] that showed that strengthening exercises were more effective and faster for pain control, whereas flexibility exercises were better for anxiety control[160], since pain and anxiety could be related with the physical and mental component of the SF-36, respectively. The Ottawa Panel Guidelines[58,59] concluded that strengthening exercises showed clinical benefits for muscle strength and HRQoL (between other symptoms), as well as aerobic fitness programs showed clinical benefits in HRQoL and pain relief, and found that emerging evidence support the use of strengthening and aerobic exercises as part of the overall management of fibromyalgia.

To know which physical fitness components are independently associated with the physical and mental component to the HRQOL could facilitate the selection of the most suitable exercise interventions according to the clinical profile of each patient. Due to the characteristics of fibromyalgia and its unknown aetiology, it is important to highlight that the aim of the treatments should be focused on reducing symptoms and improve HRQoL[10], which might be achieved through the improvement of physical fitness[58,59,89,114,115]. Therefore, if future longitudinal studies contrast our results, the importance of maintaining a good physical fitness to keep a good HRQoL in women with fibromyalgia will be highlighted.

Limitations and strengths of Study IV

The cross-sectional design precludes establishment of causality. Additionally, only women were included in the study because fibromyalgia predominantly affects women. The main strength of the present study is the relatively large sample size, which is geographically representative of the Andalusian (southern Spain) population of women with fibromyalgia. Furthermore, it has been used tests that measure the different components of physical fitness and this enabled us to study which components were independently associated with HRQOL.

Future Research Directions

The results of Study I suggest that the Senior Fitness Test battery and handgrip test are feasible and reliable to measure physical fitness in women with fibromyalgia. This set of performance-based test provides tools to measure each component of physical fitness as well as the possibility of computing a global fitness profile. Additionally, Study II shows the IFIS as a valid and moderately reliable tool to measure self-reported fitness in this population. Since Studies I and II have been conducted among women, future research analysing the feasibility, validity and reliability of the Senior Fitness Test battery and IFIS on men with fibromyalgia is warranted.

The reference values of physical fitness provided in the present Doctoral Thesis (Study III) can be useful to better interpret physical fitness assessments and helping health care providers to identify individuals with a very low fitness level, whom based on existing evidence would be at a higher risk for general diseases and higher specific fibromyalgia symptomatology. In addition, the results of this Doctoral Thesis suggest that physical fitness of people with fibromyalgia is alarmingly deteriorated compared with aged-matched healthy controls, consequently, exercise interventions should be included and taken into account as part of the treatment in the health care setting. Future studies should provide reference values of fitness for others geographical areas. Meanwhile this happens, the reference data provided in this study might be used for more accurate interpretations in fitness assessment in fibromyalgia population.

The findings of Study IV suggest that, in general, better physical fitness is related with better HRQoL and specific components of physical fitness could potentially be associated with a better HRQoL in women with fibromyalgia. Furthermore, we have found minimal clinical important changes on HRQoL between groups with the quintiles with worst and the best physical fitness levels. These results warrant further prospective research on the potential of physical fitness to predict HRQoL in this population. On the other hand, the findings of Study IV are not necessarily applicable to men, and future investigations to determine the potential relation of physical fitness and HRQoL in men could elucidate if the same results are found that with women.

Therefore, fitness testing and reference values of physical fitness could help to detect patients with very low physical fitness and give information about which components of physical fitness are more deteriorated. Thereby, with this information, professional could design exercise interventions more personalised and efficient to improve the HRQoL of people with fibromyalgia.

CONCLUSIONES/CONCLUSIONS

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CONCLUSIONES

I. La batería de condición física "Senior Fitness Test", y la prueba de fuerza de dinamometría manual presentan una buena fiabilidad para medir la condición física de mujeres con fibromialgia. Estas pruebas han mostrado una alta viabilidad, siendo rápidas y fáciles de administrar.

II. IFIS puede ser una herramienta útil para identificar mujeres con fibromialgia con muy baja condición física y distinguirlas de aquellas que tienen mayores niveles de condición física. Además, IFIS ha demostrado moderada fiabilidad en mujeres con fibromialgia.

III. Los niveles de condición física de personas con fibromialgia de Andalucía son muy bajos en comparación con personas sanas de la misma edad.

IV. Mayores niveles de condición física se asocian de forma consistente a una mayor calidad de vida en mujeres con fibromialgia. La fuerza muscular se asocia de forma independiente con el componente físico de calidad de vida, mientras que la flexibilidad y la condición física cardiorrespiratoria lo hacen con el componente mental de calidad de vida.

CONCLUSIONS

I. The Senior Fitness Test battery, and the handgrip test present good reliability to measure physical fitness in women with fibromyalgia. They have shown a high feasibility and they are quick and easy to administer.

II. IFIS can be a useful tool to identify women with fibromyalgia who had very low fitness and distinguish them from those with higher fitness levels. Furthermore, the IFIS has demonstrated moderate test-retest reliability in women with fibromyalgia.

III. Physical fitness levels of people with fibromyalgia from Andalusia are very low in comparison with age-matched healthy controls.

IV. Higher levels of physical fitness are consistently associated with better HRQoL in women with fibromyalgia. Muscular strength is independently associated with the physical component of HRQoL, whereas flexibility and cardiorespiratory fitness are independently associated with the mental component of HRQoL.

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fibromyalgia. *Clin. Biomech. (Bristol, Avon)* **27,** 578–83 (2012).

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160. Córdoba-Torrecilla, S. *et al.* Physical fitness is associated with anxiety levels in women with fibromyalgia: the al-Ándalus project. *Qual. Life Res.* (2015). Accepted.

Short CV

INMACULADA C. ÁLVAREZ GALLARDO

Date of birth: 19/05/1985

E-mail: alvarezg@ugr.es

Department of Physical Education and Sport

Faculty of Sport Sciences

University of Granada (Spain)

Academic training

- GRADUATE DEGREE IN SPORT SCIENCES. Faculty of Sport Sciences, University of Granada.
  Date: 2003-2008

- MÁSTER DEGREE IN HUMAN NUTRITION (404/56.1; 63 ECTS credits, 600 hours). Faculty of Pharmacy. University of Granada.
  Date: 2008-2009

- PhD STUDENT IN OFFICIAL DOCTORAL PROGRAM IN BIOMEDICINE (D11.56.1). Department of Physical Education and Sport, Faculty of Sport Sciences. University of Granada.
  Date: 2011-2015

- RESEARCH STAY (6 months). Centre of Health and Rehabilitation Technologies (CHaRT). University of Ulster, Jordanstown Campus. Belfast (United Kingdom).
  Date: 7/01/2013 to 11/07/2013

- RESEARCH STAY (3 months). Faculty of Health Sciences, School of Rehabilitation Sciences. University of Ottawa. Ottawa (Canada).
  Date: 1/06/2014 to 1/09/2014

- RESEARCH STAY (3 months). Department of Physical Education, Faculty of Education Science. University of Cadiz. Cádiz (Spain).
  Date: 15/04/2015 to 31/07/2015

- FORMAL UNIVERSITY TEACHING. Department of Physical Education and Sport, Faculty of Sport Sciences, University of Granada.
  Academic year 2013-2014: 6 credits
  Academic year 2014-2015: 6 credits

- INVITED LECTURE at the "I Congreso de Escuela de Pacientes". Andalusian School of Public Health, Junta de Andalucía. Date: 20th January 2012 (2 hours).

- INVITED LECTURE at the Degree of Physiotherapy. University of Granada. Subject: Methodology Training in Physiotherapy. Academic years 2013-2015 and 2014-2015 (2 hours each year).

- INVITED LECTURE at the Master of Physical activity and quality of life of adults and elderly people. University of Seville. Date: 17th January 2014 (2 hours).

- INVITED LECTURE at the Master in Sports Performance and Health. University of Miguel Hernández (Elche, Spain). Subject: Aging and Health. Date: 27th June 2015 (5 hours).

- INVITED INTERNATIONAL TALK at the 5st International Congress of the Regional Council of Physical Education (5ºConCREF7). Date: 28th-29th of May 2015. Brasilia, Brazil.

Scientific Publications directly derived from the present Doctoral Thesis:

1. [Study I] Carbonell-Baeza A, **Álvarez-Gallardo IC**, Segura-Jiménez V, Castro-Piñero J, Ruiz J, Delgado-Fernández M, Aparicio VA. Reliability and Feasibility of Physical Fitness Tests in Female Fibromyalgia Patients. Int J Sports Med. 2015;36(2):157–62. IF: 2.065 (Q2 Sports Sciences).

2. [Study II] **Álvarez-Gallardo IC**, Soriano-Maldonado A, Segura-Jiménez V, Carbonell-Baeza A, Estévez-López F, McVeigh JG, Delgado-Fernández M, Ortega FB. The International FItness Scale (IFIS): construct validity and reliability in women with fibromyalgia. The al-Ándalus project. Arch Phys Med Rehabil. Accepted 25/08/2015. IF: 2.565 (Q1 Sports Sciences and Q1 in Rehabilitation).

3. [Study III] **Álvarez-Gallardo IC**, Carbonell-Baeza A, Segura-Jiménez V, Soriano-Maldonado A, Intermann T, Aparicio VA, Estévez-López F, Camiletti-Moirón D, Herrador-Colmenero M, Ruiz JR, Delgado-Fernández M, Ortega FB. Reference values of physical fitness in Andalusian fibromyalgia patients: the al-Ándalus project. Submitted.

4. [Study IV] **Álvarez-Gallardo IC**, Soriano-Maldonado A, Segura-Jiménez V, Estévez-López F, Camiletti-Moirón D, Aparicio VA, Herrador-Colmenero M, Castro-Piñero J, Ortega FB, Delgado-Fernández M, Carbonell-Baeza A. Association of physical fitness with health-related quality of life in women with fibromyalgia: the al-Ándalus project. Submitted.

Other scientific publications

1. Carbonell-Baeza A, Aparicio VA, Ortega FB, Cuevas AM, **Álvarez IC**, Ruiz JR, Delgado-Fernández M. Does a 3-month multidisciplinary intervention improve pain, body composition and physical fitness in women with fibromyalgia? British Journal of Sport Medicine; 2011;45(15):1189–95.
2. Carbonell-Baeza A, Ruiz JR, Aparicio VA, Ortega FB, Munguía-Izquierdo D, **Álvarez-Gallardo IC** et al. Land- and Water-Based Exercise Intervention in Women with Fibromyalgia: The Al-Andalus Physical Activity Randomised Control Trial. BMC Musculoskeletal Disorders; 2012;13(1):18.
3. Munguía-Izquierdo D, Segura-Jiménez V, Camiletti-Moirón D, Pulido-Martos M, **Alvarez-Gallardo IC**, Romero A et al. Multidimensional Fatigue Inventory: Spanish adaptation and psychometric properties for fibromyalgia patients. The Al-Andalus study. Clinical and Experimental Rheumatology; 2012: 30 (6 Suppl 74) 94-102.
4. Munguia-Izquierdo D, Segura-Jimenez V, Camiletti-Moiron D, **Alvarez-Gallardo IC**, Estevez-Lopez F, Romero A, et al. Spanish adaptation and psychometric properties of the Sedentary Behaviour Questionnaire for fibromyalgia patients: the al-Andalus study. Clinical and Experimental Rheumatology. 2013; 31(6): S22-S33.
5. Ruiz JR, Segura-Jiménez V, Ortega FB, **Alvarez-Gallardo IC**, Camiletti-Moirón D, Aparicio VA et al. Objectively measured sedentary time and physical activity in women with fibromyalgia: a cross-sectional study; BMJ Open 2013: 3(6):1–10.
6. Segura-Jiménez V, **Alvarez-Gallardo IC**, Romero-Zurita A, Camiletti-Moirón D, Munguía-Izquierdo D, Carbonell-Baeza A, Ruiz JR. Comparison of physical activity using questionnaires (LTPAI and PAHWI) and accelerometry in fibromyalgia patients: the al-Ándalus project. Arch Phys Med Rehabil 2014; 95(10):1903-1911.
7. Segura-Jiménez V, Munguía-Izquierdo D, Camiletti-Moirón D, **Alvarez-Gallardo IC**, Ortega FB, Ruiz JR, et Delgado-Fernández M. Comparison of the International Physical Activity Questionnaire (IPAQ) with a multi-sensor armband accelerometer in women with fibromyalgia: the al-Ándalus project. Clin Exp Rheumatol 2013. 31(6 Suppl 79):S94–101.

8. Segura Jiménez V, Camiletti-Moirón D, Munguía-Izquierdo D, **Álvarez-Gallardo IA**, Ruiz JR, Ortega FB, Delgado-Fernández M. Agreement between self-reported sleep patterns and actigraphy in fibromyalgia and healthy women. Clin Exp Rheumatol. 2015;33(suppl.88):S58–67.

9. Segura-Jiménez V, Aparicio VA, **Álvarez-Gallardo IC**, Carbonell-Baeza A, Tornero-Quiñones I, Delgado-Fernández M. Does body composition differ between fibromyalgia patients and controls? The al-Ándalus project. Clin Exp Rheumatol. 2015; 33(suppl.88):S25-32.

10. Segura-Jiménez V, Aparicio VA, **Alvarez-Gallardo IC**, Soriano-Maldonado A, Estévez-López F, Delgado-Fernández M, et al. Validation of the modified 2010 American College of Rheumatology diagnostic criteria for fibromyalgia in a Spanish population. Rheumatology 2014; 53(10):1803–11.

11. Segura-Jiménez V, **Álvarez-Gallardo IC**, Carbonell-Baeza A, Aparicio VA, Ortega FB, Casimiro AJ, et al. Fibromyalgia Has a Larger Impact on Physical Health Than on Psychological Health, Yet Both are Markedly Affected: The Al-Ándalus Project. Semin Arthritis Rheum 2015; 44(5):563-70

12. Herrador-Colmenero M, Ruiz JR, Ortega FB, Segura-Jiménez V, **Álvarez-Gallardo IC**, Camiletti-Moirón D, et al. Reliability of the ALPHA environmental questionnaire and its association with physical activity in female fibromyalgia patients: the al-Ándalus project. J Sports Sci 2014;33(8):850–62.

13. Aparicio VA, Segura-Jiménez V, **Alvarez-Gallardo IC**, Estévez-López F, Camiletti-Moirón D, Latorre-Román PA, et al. Are there differences in quality of life, symptomatology and functional capacity among different obesity classes in women with fibromyalgia? The al-Ándalus project. Rheumatol Int 2014; 34(6):811-21.

14. Aparicio VA, Segura-Jiménez V, **Alvarez-Gallardo IC**, Soriano-Maldonado A, Castro-Piñero J, Delgado-Fernández M, et al. Fitness Testing in the Fibromyalgia Diagnosis: the al-Ándalus Project. Medicine and science in sports and exercise. 2015; 47(3):451-459.

15. Carbonell-Baeza A, Soriano-Maldonado A, Gallo FJ, López del Amo MP, Ruiz-Cabello P, Andrade A, Borges-Cosic M, Peces-Rama R, Spacírova S, **Álvarez-Gallardo IC** et al. Cost-effectiveness of an exercise intervention program in perimenopausal women: the Fitness League Against MENopause COst (FLAMENCO) randomized controlled trial. BMC Public Health 2015;15(1):555.

16. Estévez-López F, Gray CM, Segura-Jiménez V, Soriano-Maldonado A, **Álvarez-Gallardo IC**, Arrayás-Grajera MJ, et al. Independent and combined association of overall physical fitness and subjective well-being with fibromyalgia severity: the al-Ándalus project. Qual Life Res 2015; 24(8): 1865-73.

17. Camiletti-Moirón D, Segura-Jiménez V, **Álvarez-Gallardo** IC, Aparicio VA, Carbonell-Baeza A, Ruiz JR, Delgado-Fernández M. Inter-accelerometer comparison to measure physical activity and sedentary time in female fibromyalgia patients : the al-Ándalus project. Clin Exp Rheumatol. 2015;33(88):s46–52.

18. Latorre-Román PA, Segura-Jiménez V, Aparicio VA, Santos e Campos MA, García-Pinillos F, Herrador-Colmenero M, **Álvarez-Gallardo IC**, Delgado-Fernández M. Ageing influence in the evolution of strength and muscle mass in women with fibromyalgia: the al-Ándalus project. Rheumatol Int 2015;35(7):1243–50.

19. Soriano-Maldonado A, Amris K, Ortega FB, Segura-Jiménez V, Estévez-López F, **Álvarez-Gallardo IC**, et al. Association of different levels of depressive symptoms with symptomatology, overall disease severity, and quality of life in women with fibromyalgia. Qual Life Res 2015; 24(8): 1865-73.

20. Soriano-Maldonado A, Ruiz JR, **Álvarez-Gallardo IC**, Segura-Jiménez V, Santalla A, Munguía-Izquierdo D. Validity and reliability of rating perceived exertion in women with fibromyalgia: exertion-pain discrimination. J Sports Sci 2015; 33(14):1515-22.

21. Soriano-Maldonado A, Ruiz JR, Aparicio VA, Estévez-López F, Segura-Jiménez V, **Álvarez-Gallardo IC**, et al. Association of Physical Fitness with Pain in Women with Fibromyalgia: The al-Ándalus project. Arthritis Care Res. 2015. Accepted.

Books and Book Chapters

- Ana Carbonell-Baeza, Virginia A. Aparicio García-Molina, **Inmaculada C. Álvarez-Gallardo**, Manuel Delgado Fernández (2014). Programa de Ejercicio Físico en fibromyalgia. Consejería de Igualdad, Salud y Políticas Sociales. http://www.juntadeandalucia.es/salud/export/sites/csalud/galerias/documentos/c_3_c_1_vida_sana/alimentacion_equilibrada_actividad_fisica/material_ciudadano/Fibromialgia_ejercicios.pdf

- Víctor Segura-Jiménez, **Inmaculada C. Álvarez-Gallardo**, Alberto Soriano-Maldonado, Fernando Estévez-López, Daniel Camiletti-Moirón, Manuel Herrador-Colmenero, Milkana Borges Cosic, Ana Carbonell-Baeza, Manuel Delgado-Fernández, Virginia A. Aparicio (2015). Cap. 9 “Criterios de diagnóstico, composición corporal, condición física, actividad física y ejercicio físico en fibromyalgia: el proyecto al-Ándalus” (pp. 187-209). FM, SFC y SSQM un auténtico reto para la ciencia. Federación Andaluza FM, SFC y SSQM “Alba Andalucía”. Círculo Rojo Editorial. ISBN: 978-84-9095-508-6

Research Grants and Contracts

- Research contract. Project: Intervention for the improvement of the health-related quality of life. Fundación Empresa- University of Granada. Date: 1/7/2008 to 30/10/2008

- Research contract. Project: Physical activity in women with fibromyalgia: effects on pain, health and quality of life. University of Granada. Date: 1/5/2011 to 31/8/2011

- Research Fellowship FPI [Formación de Personal Investigador (FPI)] from the Spanish Ministry of Science and Innovation [grant number: BES-2011-047133). Date: 1/09/2011 to 31/08/2015

- Mobility grant for PhD students from the Spanish Ministry of Economy and Competitiveness 2014/2015. Research stay in the Department of Physical Education, Faculty of Education Science. University of Cadiz. Cádiz (Spain). Date: 15/04/2015 to 31/07/2015

- Research contract. Project: Longitudinal study and genetics modulation in fibromyalgia. The effects of exercise and hidroterapy in pain, health status and quality of life. University of Granada. Date: 1/10/2015 to 31/12/2015

- Research and Teaching post-doctoral contract: "Contrato Puente". Vicerrectorado de Investigación. University of Granada. Accepted to be conducted. Starting from January 2016. Duration: 6 months.

Research Projects:

1. Evaluación y promoción de calidad de vida relacionada con la salud para enfermos de fibromialgia. Instituto Andaluz del Deporte. Term: 04/01/2008 to 04/01/2009.

2. Intervención para la mejora de la calidad de vida relacionada con la salud. Fibromyalgia Association of Granada [Asociación Granadina de Fibromialgia] AGRAFIM. Term: 18/01/2008 to 18/01/2015

3. Efectos de programas de actividad física en la calidad de vida de personas con Fibromialgia (EPAFI). Fundación MAPFRE. Research grant 2009. Term**:** 2009

4. Evaluación de los hábitos de salud y calidad de vida de mujeres peri y menopáusicas tras un programa de intervención educativa multidisciplinar. Consejería de Salud de la Junta de Andalucía. Term: 26/12/2008 to 25/12/2011

5. Physical activity in women with fibromyalgia: effects on pain, health and quality of life. [Actividad física en mujeres con fibromialgia: efectos sobre el grado de dolor, salud y calidad de vida]. DEP2010-15639 (subprograma DEPO). Plan Nacional I+D+i 2008-2011, Ministry of Science and Innovation. Term: 01/07/2010 to 30/09/2014

6. Niveles de actividad física, condición física, salud y calidad de vida en población andaluza con fibromialgia: efectos del ejercicio físico y determinantes genéticos. Consejería de Turismo, Comercio y Deporte, de la Junta de Andalucía. Term: 24/08/2010 to 23/08/2013

7. PROGRESS towards healthy ageing in Europe. The European Union Programme for Employment and Social Solidarity. VS/2011/0489. Term: 01/12/2011 to 30/11/2013

8. Cost-effectiveness of execise program in premenopausal women [Coeste-efectividad de un programa de ejercicio físico en mujeres perimenopáusicas]. PI-0667/2013. Consejería de Igualdad, Salud y Políticas Sociales. Term: 01/01/2014 to 31/12/2015.

9. Longitudinal study and genetics modulation in fibromyalgia. The effects of exercise and hidroterapy in pain, health status and quality of life. DEP2013-40908-R. Ministerio de Economía y Competitividad. Programa Estatal de Investigación, Desarrollo e Innovación Orientada a los Retos de la Sociedad, modalidad 1, "Retos Investigación", Proyectos de I+D+i. Term: 01/01/2014 to 31/12/2016

10. Influencia de los niveles de actividad física, condición física y hábitos nutricionales de la gestante sobre diversos marcadores de salud maternal y fetal (GESTAFIT). Proyecto aprobado por el programa Andalucía Talent Hub de la Agencia Andaluza del Conocimiento de la Junta de Andalucía, cofinanciado por el Séptimo Programa Marco de la Comunidad Europea, Acciones Marie Skłodowska-Curie (COFUND – Acuerdo nº291780) y por la Consejería de Economía, Innovación, Ciencia y Empleo de la Junta de Andalucía.
Term: 01/03/2015 to 28/02/2017

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A. Todos con personalidades muy diferentes pero que hemos sabido encajar para que la máquina funcione empujados por una pasión común. La convivencia en esos viajes, los momentos vividos y esas miles de anécdotas siempre quedarán en nuestro recuerdo y forman parte del aprendizaje de la vida. ¡Fibromialgicos team!

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"Juntos es posible"

Annexes

1. International FItness Scale
2. 36-item Short Form health survey

Universidad de Granada

CUESTIONARIO DE AUTOEVALUACIÓN DE LA CONDICIÓN FÍSICA - *IFIS-International Fitness Scale*

CLAVE

0	0	0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

Por favor, marque la opción que se corresponda con su respuesta y siga las instrucciones determinadas en cada caso.

MARQUE CORRECTAMENTE

Bien Mal Mal Mal Mal

FECHA

Es muy importante que conteste a estas preguntas usted solo, sin tener en cuenta las respuestas de sus compañeros/as. Sus respuestas sólo son útiles para el progreso de la Ciencia. Por favor, conteste todas las preguntas y no las deje en blanco. Y aún más importante, sea sincero. Gracias por su cooperación con la Ciencia.

Por favor, piense sobre su nivel de condición física (comparado con personas de su edad) y elija la opción más adecuada.

	1 Muy mala	2 Mala	3 Aceptable	4 Buena	5 Muy buena
1. Su condición física general es:					
2. Su condición física cardio-respiratoria (capacidad para hacer ejercicio, por ejemplo, correr durante mucho tiempo) es:					
3. Su fuerza muscular es:					
4. Su velocidad / agilidad es:					
5. Su flexibilidad es:					

Compruebe si ha contestado a todas las frases con una sola respuesta.

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SALUD SF-36

FECHA

NOMBRE.................................

CLAVE

Nº pág

Por favor, marque la opción que se corresponda con su respuesta y siga las instrucciones determinadas en cada caso.

MARQUE CORRECTAMENTE

Bien Mal Mal Mal Mal

Por favor conteste las siguientes preguntas. Algunas preguntas pueden parecerse a otras pero cada una es diferente.

Tómese el tiempo necesario para leer cada pregunta, y marque la casilla que mejor describa su respuesta.

	1 Excelente	2 Muy buena	3 Buena	4 Regular	5 Mala
1. En general, usted diría que su salud es:					

	1	2	3	4	5
2. ¿Cómo diría usted que es su salud actual, comparada con la de hace un año?					

1= Mucho mejor ahora que hace un año
2= Algo mejor ahora que hace un año
3= Más o menos igual que hace un año
4= Algo peor ahora que hace un año
5= Mucho peor ahora que hace un año

Para cada una de las cuestiones siguientes, seleccionar la respuesta más adecuada. Teniendo en cuenta que:

1. Sí, me limita mucho.
2. Sí, me limita un poco.
3. No, no me limita nada.

3. Las siguientes preguntas se refieren a actividades o cosas que usted podría hacer un día normal. Su salud actual, ¿le limita para hacer esas actividades o cosas? Si es así, ¿cuánto?

	1	2	3
a) Esfuerzos intensos, tales como correr, levantar objetos pesados, o participar en deportes agotadores.			
b) Esfuerzos moderados, como mover una mesa, pasar la aspiradora, jugar a los bolos o caminar más de 1 hora.			
c) Coger o llevar la bolsa de la compra.			
d) Subir varios pisos por la escalera.			
e) Subir un solo piso por la escalera.			
f) Agacharse o arrodillarse.			
g) Caminar un kilómetro o más.			
h) Caminar varios centenares de metros.			
i) Caminar unos 100 metros.			
j) Bañarse o vestirse por sí mismo.			

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SALUD SF-36

Por favor, marque la opción que se corresponda con su respuesta y siga las instrucciones determinadas en cada caso.

MARQUE CORRECTAMENTE

Bien | Mal | Mal | Mal | Mal

CLAVE

Nº pág

NOMBRE..................................

4. Durante las 4 últimas semanas, ¿con qué frecuencia ha tenido alguno de los siguientes problemas en su trabajo o en sus actividades cotidianas, a causa de su salud física?

1= Siempre
2= Casi siempre
3= Algunas veces
4= Sólo alguna vez
5= Nunca

	1	2	3	4	5
a) ¿Tuvo que reducir el tiempo dedicado al trabajo o a sus actividades cotidianas?					
b) ¿Hizo menos de lo que hubiera querido hacer?					
c) ¿Tuvo que dejar de hacer algunas tareas en su trabajo o en sus actividades cotidianas?					
d) ¿Tuvo dificultad para hacer su trabajo o sus actividades cotidianas (por ejemplo, le costó más de lo normal)?					

5. Durante las 4 últimas semanas, ¿con qué frecuencia ha tenido alguno de los siguientes problemas en su trabajo o en sus actividades cotidianas, a causa de algún problema emocional (como estar triste, deprimido o nervioso)?

1= Siempre
2= Casi siempre
3= Algunas veces
4= Sólo alguna vez
5= Nunca

	1	2	3	4	5
a) ¿Tuvo que reducir el tiempo dedicado al trabajo o a sus actividades cotidianas por algún problema emocional?					
b) ¿Hizo menos de lo que hubiera querido hacer por algún problema emocional?					
c) ¿Hizo su trabajo o sus actividades cotidianas menos cuidadosamente que de costumbre, por algún problema emocional?					

	Nada	Un poco	Regular	Bastante	Mucho
6. Durante las 4 últimas semanas, ¿hasta qué punto se salud fisica o los problemas emocionales han dificultado sus actividades sociales habituales con la familia, amigos, los vecinos u otras personas?					

	No, ninguno	Sí, muy poco	Sí, un poco	Sí, moderado	Sí, mucho	Sí, muchísimo
7. ¿Tuvo dolor en alguna parte del cuerpo **durante las 4 últimas semanas**?						

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SALUD SF-36

Por favor, marque la opción que se corresponda con su respuesta y siga las instrucciones determinadas en cada caso.

MARQUE CORRECTAMENTE

Bien Mal Mal Mal Mal

CLAVE

Nº pág

NOMBRE..

	Nada	Un poco	Regular	Bastante	Mucho
8. Durante las 4 últimas semanas, ¿hasta qué punto el dolor le ha dificultado su trabajo habitual (incluido el trabajo fuera de casa y las tareas domésticas)?					

9. Las preguntas que siguen se refieren a cómo se ha sentido y cómo le han ido las cosas **durante las 4 últimas semanas**. En cada pregunta responda lo que se parezca más a cómo se ha sentido usted. Durante las últimas 4 semanas ¿con que frecuencia.....

1= Siempre
2= Casi siempre
3= Algunas veces
4= Sólo alguna vez
5= Nunca

	1	2	3	4	5
a) ¿Se sintió lleno de vitalidad?					
b) ¿Estuvo muy nervioso?					
c) ¿Se sintió tan bajo de moral que nada podía animarle?					
d) ¿Se sintió calmado o tranquilo?					
e) ¿Tuvo mucha energía?					
f) ¿Se sintió desanimado y deprimido?					
g) ¿Se sintió agotado?					
h) ¿Se sintió feliz?					
i) ¿Se sintió cansado?					

	1	2	3	4	5
10. Durante las 4 últimas semanas, ¿con qué frecuencia la salud física o los problemas emocionales le han dificultado sus actividades sociales (como visitar a los amigos o familiares)?					

1= Siempre
2= Casi siempre
3= Algunas veces
4= Sólo alguna vez
5= Nunca

11. Por favor, diga si le parece **CIERTA o FALSA** cada una de las siguientes frases:

1= Totalmente cierta
2= Bastante cierta
3= No lo sé
4= Bastante falsa
5= Totalmente falsa

	1	2	3	4	5
a) Creo que me pongo enfermo más fácilmente que otras personas.					
b) Estoy tan sano como cualquiera.					
c) Creo que mi salud va a empeorar.					
d) Mi salud es excelente.					