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Physical fitness reference standards in fibromyalgia: The al-Ándalus project

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We aimed (1) to report age-specific physical fitness levels in people with fibromyalgia of a representative sample from Andalusia; and (2) to compare the fitness levels of people with fibromyalgia with non-fibromyalgia controls. This cross-sectional study included 468 (21 men) patients with fibromyalgia and 360 (55 men) controls. The fibromyalgia sample was geographically representative from southern Spain. Physical fitness was assessed with the Senior Fitness Test battery plus the handgrip test. We applied the Generalized Additive Model for Location, Scale and Shape to calculate percentile curves for women and fitted mean curves using a linear regression for men. Our results show that people with fibromyalgia reached worse performance in all fitness tests than controls ($P < 0.001$) in all age ranges ($P < 0.001$). This study provides a comprehensive description of age-specific physical fitness levels among patients with fibromyalgia and controls in a large sample of patients with fibromyalgia from southern of Spain. Physical fitness levels of people with fibromyalgia from Andalusia are very low in comparison with age-matched healthy controls. This information could be useful to correctly interpret physical fitness assessments and helping health care providers to identify individuals at risk for losing physical independence.

Fibromyalgia is a chronic musculo-skeletal condition (Klaver-Król et al., 2012) characterized by chronic pain in multiple tender sites throughout the body (Wolfe et al., 1990; Sarzi-Puttini et al., 2012) usually accompanied by a wide spectrum of symptoms (Wolfe et al., 1990; Munguía-Izquierdo & Legaz-Arrese, 2007; Silverman et al., 2010) and low levels of physical fitness, similar to that of healthy older adults (Panton et al., 2006; Jones et al., 2014). Fibromyalgia affects predominantly women and is currently a burden for health care systems in Europe, with the highest prevalence of unemployment (~6%), claims for disability benefit (up to 30%), and number of days of absence from work (Leadley et al., 2012).

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Physical fitness has been consistently identified as a powerful predictor of morbidity and mortality (Blair et al., 1989; Barry et al., 2014) in the general population, regardless of physical activity (Lee et al., 2011), age, smoking, adiposity, and other disease risk factors (Lee et al., 2010). In fibromyalgia, different components of physical fitness (i.e., cardiorespiratory fitness, speed-agility, flexibility, and muscular strength) have shown to be consistently associated with lower levels of pain (de Bruijn et al., 2011; Soriano-Maldonado et al., 2015b), lower fibromyalgia severity (Soriano-Maldonado et al., 2015a) and better health-related quality of life (Carbonell-Baeza et al., 2013; Sener et al., 2013). In addition, Aparicio et al. (2011, 2013b, 2015) revealed that physical fitness might serve as a complementary tool in the diagnosis and monitoring of fibromyalgia. Therefore, physical fitness might be considered a relevant marker of health in people with fibromyalgia. In this

context, it is of clinical interest to provide normative values of different components of physical fitness using easy-to-use, inexpensive, feasible and reliable assessment tools for their quantification. In the last years, reference data have been provided in healthy adults (Wang et al., 2010), adolescents (Ortega et al., 2011) and children, (De Miguel-Etayo et al., 2014) 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 (Carbonell-Baeza et al., 2011b).

The Senior Fitness Test battery (Rikli & Jones, 1999a,b) is a set of field-based tests widely used in patients with fibromyalgia (Carbonell-Baeza et al., 2011a; Cherry et al., 2012; Aparicio et al., 2013b; Jones et al., 2014), that is feasible and reliable to assess physical fitness in this population (Carbonell-Baeza et al., 2015). The al-Ándalus cross-sectional study provides the opportunity to establish age-specific reference values of different components of physical fitness in a large and geographically representative sample of people with fibromyalgia from the south of Spain. Therefore, the aims of this study were: (1) to report age-specific physical fitness levels in people with fibromyalgia of a geographically representative sample from the south of Spain; and (2) to compare them with age-matched controls.

Methods

Subjects and experimental design

This study is part of the al-Ándalus project (cross-sectional study) that focused on recruiting a geographically representative sample of people with fibromyalgia (between 2011 and 2013) from Andalusia, southern Spain. The sample size needed was calculated (n = 300), and a sex and province proportional recruitment was planned (Segura-Jiménez et al., 2015). In addition, we recruited control participants via fibromyalgia participants' acquaintances, e-mail and Internet advertisements. We also included data from another research project conducted by our team in perimenopausal women (used as controls for this study), since this women were from the same geographical area, were in the same age range, and performed exactly the same tests carried out in the al-Ándalus project and by the same evaluators. All interested participants (n = 1087), 579 women with fibromyalgia (28 men) and 422 control women (58 men) gave their written informed consent after receiving detailed information about the aims and study procedures.

The inclusion criteria for participants with fibromyalgia were: (1) to be previously diagnosed with fibromyalgia and meeting the American College of Rheumatology criteria: widespread pain for more than 3 months, and pain with ≤4 kg/cm of pressure reported for 11 or more of 18 tender points for fibromyalgia classification; (Wolfe et al., 1990) (2) not to have acute or terminal illness, nor severe cognitive impairment (the Mini Mental State Examination score <10); (Folstein et al., 1975) (3) be able to ambulate and communicate; and (4) to have valid data for at least one of the physical fitness tests. In order to be included in the study, control participants had to meet the same criteria except those that were disease-specific (i.e., fibromyalgia diagnosis and to meet the 1990 ACR criteria).

Ninety-two women and seven men with fibromyalgia did not meet the 1990 ACR criteria, whereas 44 control women and one control men met it. One woman with fibromyalgia had severe dementia. Additionally, 18 women with fibromyalgia, 18 control women, and two control men did not have data for at least one of the physical fitness tests. The final sample comprised 468 people with fibromyalgia (21 men) and 360 controls (55 men). The study protocol was reviewed and approved by the Ethics Committee of the Hospital Virgen de las Nieves (Granada, Spain).

Anthropometric measurements

We used a portable eight-polar tactile-electrode impedanciometer (InBody R20, Biospace, Seoul, Korea) to measure weight (kg). Height (cm) was measured using a stadiometer (Seca 22, Hamburg, Germany). BMI was calculated as weight (kg) divided by height squared (meters).

Physical fitness assessment

We assessed the following physical fitness components: cardiorespiratory, speed-agility, flexibility and muscular strength by means of the standardized Senior Fitness Test battery (Rikli & Jones, 1999a,b). In addition, the handgrip strength test (Ruiz-Ruiz et al., 2002) was included to assess muscular strength due to its capacity to discriminate between presence/absence of fibromyalgia (Aparicio et al., 2011, 2015). This set of performance-based tests has proved to be reliable and feasible in patients with fibromyalgia (Carbonell-Baeza et al., 2015). 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-min walk tests. A brief description of each test is provided below:

Cardiorespiratory fitness

Cardiorespiratory fitness was assessed with the "6-minute walk test". This test measures the maximum distance (in meters) that participants are able to walk in six minutes along a 45.7 m rectangular course.

Speed-agility

The "8-foot up-and-go test" involves standing up from a chair, walking 8 feet (2.44 m) to a cone, and returning to the chair in the shortest period of time. The best time of the two trials was recorded.

Flexibility

Lower body flexibility was assessed with 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. The test was performed twice for each leg, and the average of the best score for each leg was selected. For measure *upper body flexibility* was used the "Back scratch test," which

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. The participants performed the test twice (alternating between arms), and the average of the best score for each hand was used in the analysis.

Strength

The "30-s chair stand test" was used to measure *lower body muscular strength*. This test involves counting the number of times in 30 s that an individual can rise to a full stand from a seated position. *Upper body muscular strength* was assessed with the "Arm curl test". This test involves determining the number of times a hand weight (2.3 kg for women and 3.6 kg for men) can be curled in 30 s. The test was performed once with each arm and the obtained number of repetitions was recorded. The "handgrip test" was performed with a digital dynamometer (TKK 5101 Grip-D; Takey, Tokyo, Japan) as described by Ruiz-Ruiz et al. (2002). Participants performed the test twice for each hand (alternating between hands). The best score measured for each hand was used.

In order to standardize and minimize the potential inter-rater variability, the same trained researchers team carried out all the assessments. A pilot study was done before the mean project to design and detail a manual of operations.

Statistical analysis

Anthropometric and physical fitness characteristics of the study sample are presented as means and standard deviations (SD). 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*) (Cohen, 1988) to be able compare the magnitude of the differences between fibromyalgia patients and controls across different fitness tests. The statistical analysis was performed with IBM SPSS (IBM SPSS Statistics for Windows, Version 20.0; IBM Corp, Armonk, New York, USA).

We applied the Generalized Additive Model for Location, Scale and Shape (GAMLSS) (Stasinopoulos & Rigby, 2007) to calculate percentile curves for women. GAMLSS allows the age depending modeling 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) of the statistical software R (version 3.1.2). The exact procedure is described elsewhere (Intemann et al., 2015). 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 (van Buuren & Frederiks, 2001) and Q-Q plots to select a final model. For example, for the 6-min walk test a model based on the Box-Cox Cole and Green distribution was used where μ were modeled with a linear function, log (σ) and ν both were modeled 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 weighing 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.

Results

The resulting models derived with GAMLSS for women and lineal regression for men are listed in tables S1 and S2, respectively (supplementary material). Table 1 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 strength tests, $P < 0.05$ and $P < 0.001$,

Table 1. Characteristics of the study participants by group (fibromyalgia/control) and sex

	Women		Men		Sex effect	Group effect
	Fibromyalgia (n = 468)	Control (n = 360)	Fibromyalgia (n = 21)	Control (n = 55)	P	P
Age (year)	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
Body mass index (kg/m^2)	28.59 (5.4)	27.5 (4.8)	28.1 (4.8)	28.2 (3.9)	0.9	0.53
6-minute walk test (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 test (s)*	6.9 (1.9)	5.6 (1.0)	6.8 (2.6)	5.1 (1.7)	0.17	<0.001
Chair sit-and-reach test (cm)	−11.3 (12.1)	2.2 (11.1)	−12.7 (12.6)	0.6 (10.9)	0.34	<0.001
Back scratch test (cm)	−14.4 (12.6)	−5.0 (9.0)	−16.6 (15.0)	−10.4 (11.8)	0.01	<0.001
30-s chair stand test (rep)	10.3 (3.3)	14.6 (3.3)	10.1 (3.8)	15.4 (2.5)	0.5	<0.001
Arm curl test (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

Data are shown as mean (SD). Sex and group (fibromyalgia/control) differences were analyzed 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.

respectively) in which men performed better, and for upper body flexibility, in which women performed better ($P < 0.01$).

Means and standard deviations of all physical fitness tests were calculated in women with fibromyalgia and controls in different age groups (Table 2). Overall, there was a trend toward 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.

Tables 3–5 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}). Figures 1–3 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. Figures S1-S3 show fitted mean curves for men with fibromyalgia and controls.

Discussion

The major contribution of this study 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. This study 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

Table 2. Sample size, mean, and standard deviation (SD) of all physical fitness tests in fibromyalgia and control women

	Age	Fibromyalgia			Controls			Effect size†
		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	–	–	
Arm curl test (rep)	≤35	6	–	–	14	–	–	
	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	–	–	
Handgrip test (kg)	≤35	6	–	–	14	–	–	
	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 tests in all age ranges between fibromyalgia and controls were $P < 0.001$.

Table 3. Percentiles of cardiorespiratory fitness and speed-agility calculated with GAMLSS in fibromyalgia and control women

Age	P1	P10	P20	P30	P40	P50	P60	P70	P80	P90	P99
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

GAMLSS, General Additive Model for Location Scale and Shape (ref); 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 4. Percentiles of lower limb and upper limb flexibility calculated with GAMLSS in fibromyalgia and control women

Age	P1	P10	P20	P30	P40	P50	P60	P70	P80	P90	P99
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

GAMLSS, General Additive Model for Location Scale and Shape (ref); 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 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 (2013) proposed criterion fitness standards (for people between 60 and 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. When comparing our results with the physical fitness standards (Rikli & Jones, 1999a, b, 2013), 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 (Jones et al., 2014), indicating an early risk for disability in women with fibromyalgia.

Table 5. Percentiles of lower limb and upper limb muscular strength calculated with GAMLSS in fibromyalgia and control women

Age	P1	P10	P20	P30	P40	P50	P60	P70	P80	P90	P99
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

GAMLSS, General Additive Model for Location Scale and Shape (ref); m, meters; s, seconds. The values corresponded to The 1st, 10th, 20th, 30th, 40th, 50th, 60th, 70th, 80th, 90th, 99th. Percentiles values were estimated for decades and the exact percentile for the midpoint 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.

On average, women with fibromyalgia showed a significant poorer performance on physical fitness compared with age-matched healthy peer women, in agreement with the previous literature demonstrating that cardiorespiratory fitness (Valim et al., 2002; Aparicio et al., 2013a), speed-agility (Góes et al., 2012; Aparicio et al., 2013a), flexibility (Okifuji et al., 2010; Aparicio et al., 2013a), and strength (Panton et al., 2006; Carbonell-Baeza et al., 2011b; Aparicio et al., 2013a) 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, that is, 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 (Jones et al., 2014). 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-min walk test, also indicated that cardiorespiratory fitness was associated with tenderness, symptomatology, quality of life, and coping strategies in women with fibromyalgia (Carbonell-Baeza et al., 2013). We showed that women with fibromyalgia with high aerobic fitness+high flexibility had the best pain-related catastrophizing and chronic pain self-efficacy profiles (Soriano-Maldonado et al., 2015b). 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 (Jones et al., 2009; Rutledge et al., 2013). We, therefore, 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 (Aparicio et al., 2013b). 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 (Pescatello et al., 2013). 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 (Matsutani et al., 2007). Nevertheless, the evidence is very limited for flexibility in patients with fibromyalgia. Moreover,

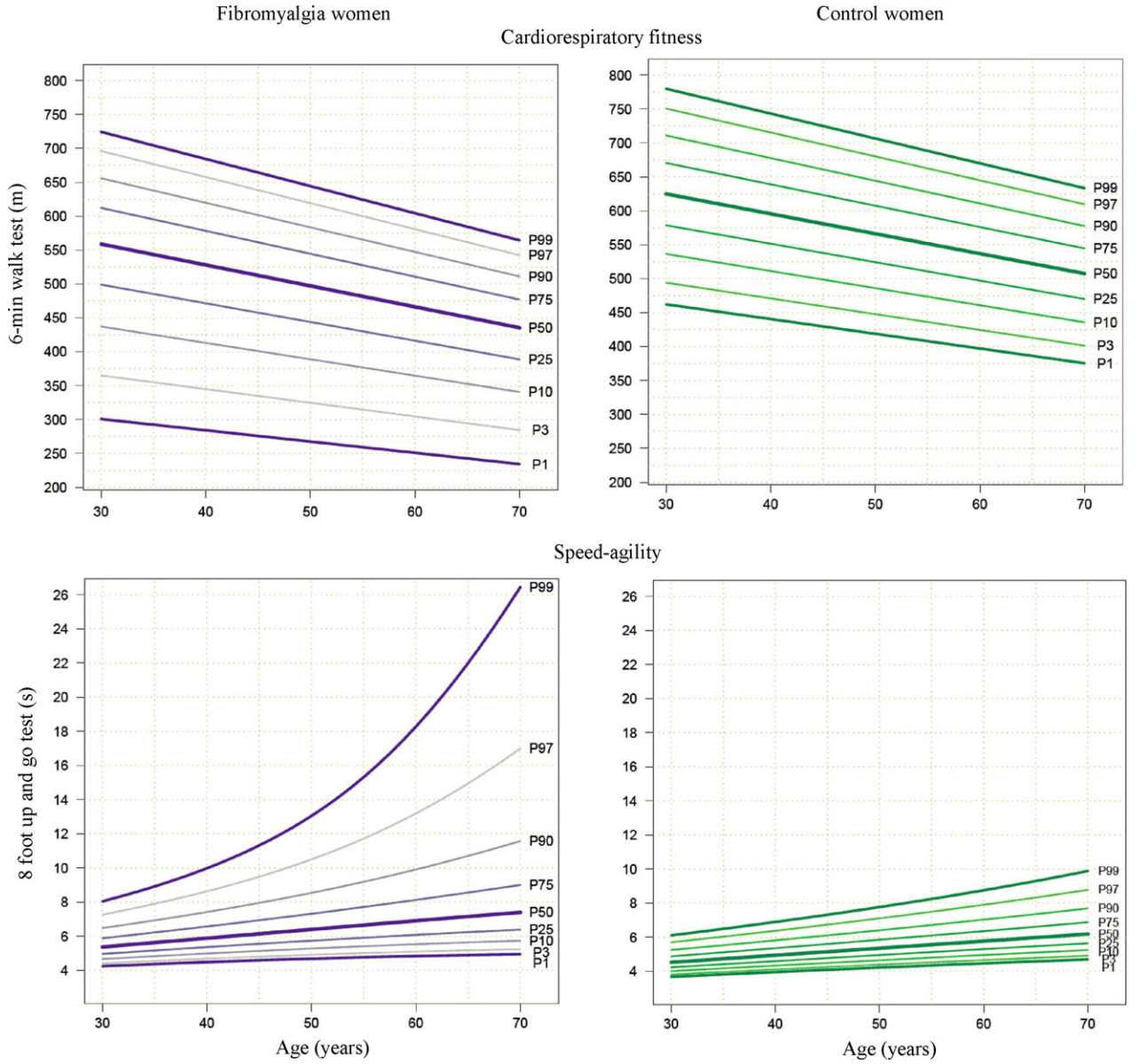

Fig. 1. Percentiles curves (GAMLSS method, from the bottom to the top: P1, P3, P10, P25, P50, P75, P90, P97, P99) of the two physical fitness test assessing cardiorespiratory fitness and speed-agility. For the 8-foot up-and-go test lower scores indicate better performance, so that to be in the P1 means to have the best performance and the other way around.

maintaining lower extremity muscle strength is very important to prevent and delay the onset of physical frailty and dependency in later years (Panton et al., 2006). 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 (Aparicio et al., 2011), therefore, handgrip testing could be used as a complementary tool in the assessment and monitoring of fibromyalgia (Aparicio et al., 2011). In addition, it has been found that following exercise interventions, patients who showed higher changes in muscle 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 (Tomas-Carus et al., 2009). In a recent study, it has been observed that women with fibromyalgia with high muscle strength+high flexibility had significantly lower levels of pain (Soriano-Maldonado et al., 2015b).

Limitations and strengths

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

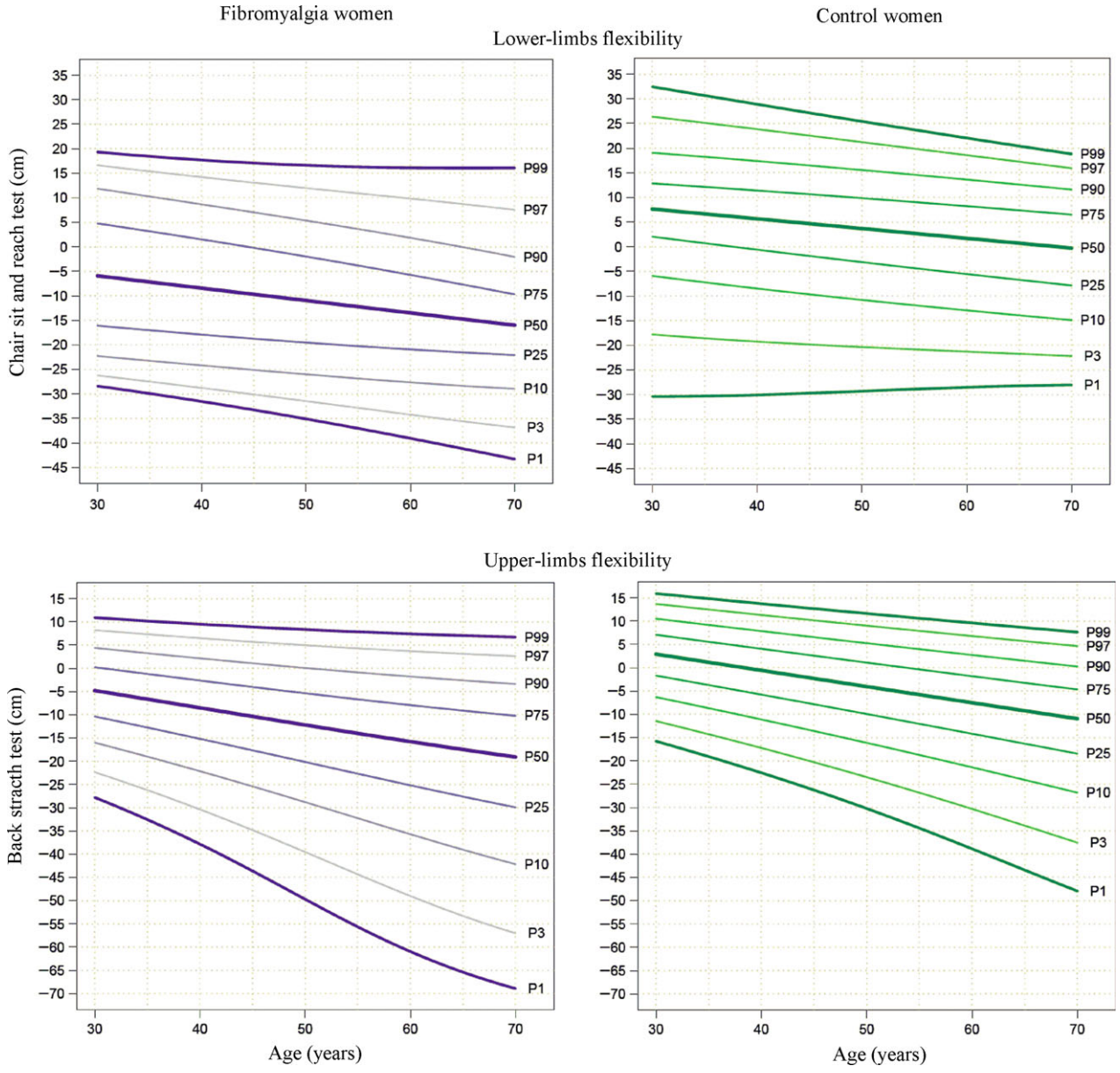

Fig. 2. Percentiles curves (GAMLSS method, from the bottom to the top: P1, P3, P10, P25, P50, P75, P90, P97, P99) of the two physical fitness test assessing lower limb flexibility and upper limb flexibility.

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%) (Mas et al., 2008). 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, this 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. Future studies should provide reference values of fitness for other parts of Spain, Europe, and the world. While this happens, the reference data provided in this study might be used for more accurate interpretations in fitness assessment in fibromyalgia population.

Conclusions

This study provides a comprehensive description of age-specific physical fitness levels in a relatively large sample of patients with fibromyalgia from the south of Spain, as well as in age-matched controls. Our data suggest that physical fitness levels of people with fibromyalgia from Andalusia are very low in comparison with age-matched healthy controls, and

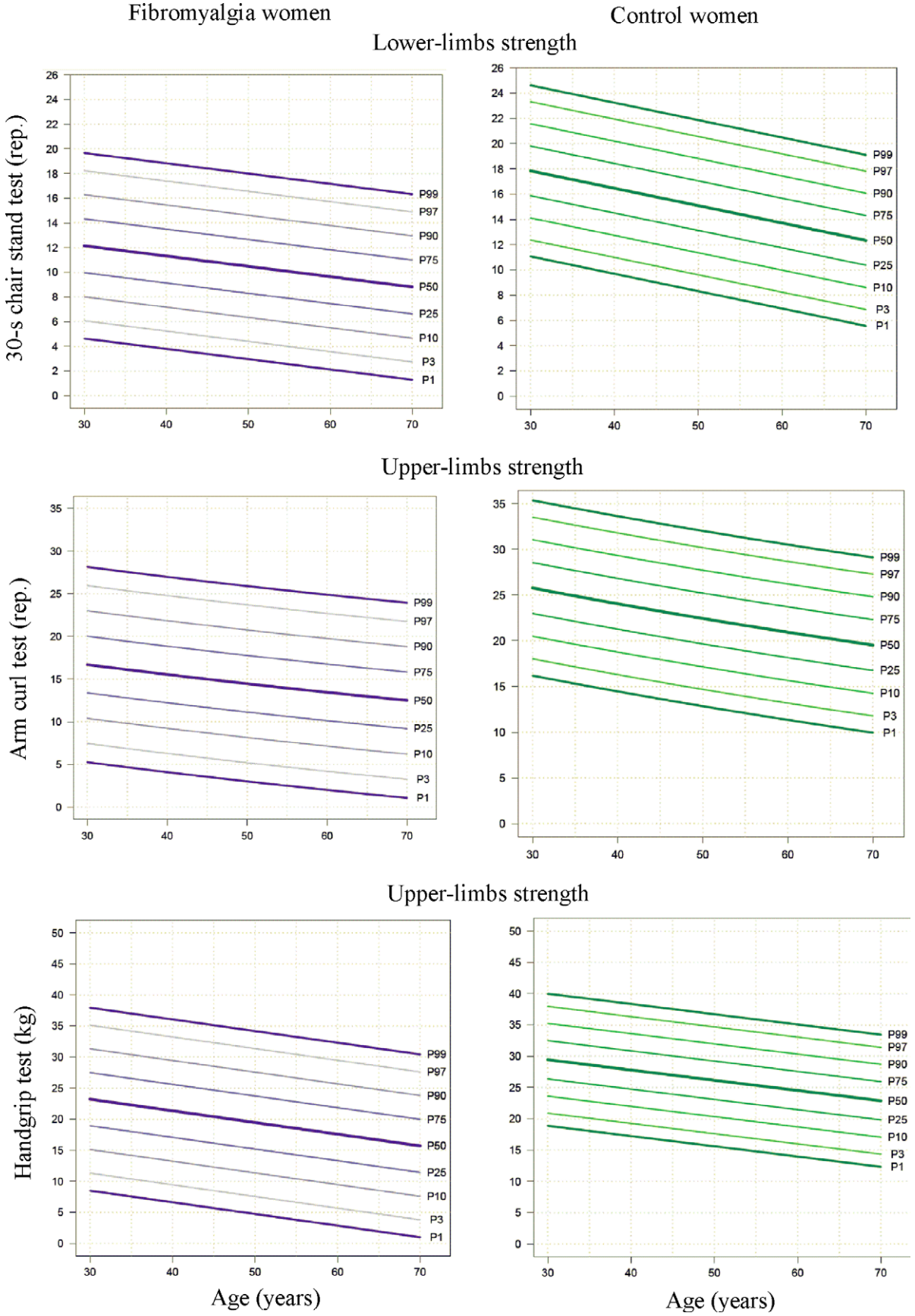

Fig. 3. Percentiles curves (GAMLSS method, from the bottom to the top: P1, P3, P10, P25, P50, P75, P90, P97, P99) of the three physical fitness test assessing lower limb strength and upper limb strength.

similar to those in older adults reported in the literature. The reference values of physical fitness hereby provided 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.

Perspective

Recent literature indicates that physical fitness is an important health marker in fibromyalgia (Aparicio et al., 2015; Estévez-López et al., 2015; Soriano-Maldonado et al., 2015a,b). 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. 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. The normative physical fitness standards (percentile tables) of the people with fibromyalgia from Andalusia developed in this study make it possible.

Key words: Cardiorespiratory fitness, speed-agility, flexibility, strength, chronic pain, physical performance, physical function.

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Competing interests

None of the authors had any conflict of interests.

Supporting Information

Additional Supporting Information may be found online in the supporting information tab for this article:

Fig. S1. Fitted mean curves using a linear regression of the two physical fitness test assessing cardiorespiratory fitness and speed-agility for men.

Fig. S2. Fitted mean curves using a linear regression of the two physical fitness test assessing flexibility (lower and upper limbs flexibility) for men.

Fig. S3. Fitted mean curves using a linear regression of the two physical fitness test assessing strength (lower and upper limb strength) for men.

Table S1. Selected GAMLSS models to calculate the fitness percentile curves for women with fibromyalgia and controls.

Table S2. Linear regression models for men with fibromyalgia (FM) and controls.

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