Thieme

The Potential of Established Fitness Cut-off Points for Monitoring Women with Fibromyalgia: The al-Ándalus Project

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ABSTRACT

The aim of the present study was to determinate whether fitness cut-off points discriminate the severity of major fibromyalgia symptoms and health-related quality of life. Additionally, we investigated which American Colleague of Rheumatology (ACR) fibromyalgia criteria (1990 vs. modified 2010) better discriminate fibromyalgia symptomatology. A total of 488 women with fibromyalgia and 200 non-fibromyalgia (control) women participated. All participants underwent both the 1990 and the modified 2010 ACR preliminary criteria (hereinafter 1990c and m-2010c, respectively). We used fitness cut-off points (Senior Fitness Tests Battery plus handgrip strength test) to discriminate between presence and absence of fibromyalgia. Additionally, we employed several instruments to assess fibromyalgia symptoms. Fitness cut-off points discriminated between high and low levels of the main symptoms the disease in all age groups (P from < 0.001 to 0.01). Overall, the arm-curl and the 30-s chair stand tests presented the highest effect sizes in all symptoms, reinforcing the inclusion of fitness testing as a complementary tool for fibromyalgia diagnosis and monitoring. Moreover, the effect size of the differences in symptoms between women with fibromyalgia and controls were overall larger using the m-2010c compared with the 1990c, except for the tender points count, reflecting better the polysymptomatic distress condition of fibromyalgia.

Introduction

Fibromyalgia is characterized by widespread pain of unknown aetiology and additional physical and psychological symptoms such as fatigue, stiffness, cognitive problems, depression, anxiety, and other complaints [40, 46, 50]. This disease remains not fully understood [20, 40], thus there is not a gold standard method for its diagnosis, which makes the fibromyalgia diagnosis difficult and controversial. Therefore, fibromyalgia diagnosis is still a dynamic process involving different clinical, psychosocial, and functional assessments [8, 17, 33, 40, 51]. In 1990, the first American College of Rheumatology (ACR) criteria for the diagnosis of fibromyalgia (hereinafter referred as 1990c) were developed [50]. However, the 1990c did not consider the presence of other multiple symptoms (apart from chronic pain) associated with fibromyalgia [33, 48]. To avoid these problems, the ACR released new preliminary diagnostic criteria in 2010 [48] which were completed a year later (i. e., the modified 2010 ACR preliminary diagnostic criteria, hereinafter m-2010c) [47]. However, the 1990c and the m-2010c are used interchangeably.

Fibromyalgia patients tend to be less physically active than age-matched controls [36] and display a deconditioned fitness status compared to their age-matched healthy counterparts [24, 31]. In fact, physical fitness has been inversely related to fibromyalgia severity [3, 4, 42], pain [39, 44], fatigue [5], anxiety [15, 39], depression [39, 41], risk of falls [14] and stiffness [5]; and positively associated with health-related quality of life [13, 39].

Given the close relationship between physical fitness and fibromyalgia symptoms, it is possible that fitness might serve a means for monitoring this chronic condition. Our group has recently stud-

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ied the usefulness of fitness testing as a complementary tool for the diagnosis of fibromyalgia, proposing fitness cut-off points to discriminate between the presence and absence of fibromyalgia in women across different age groups [5]. Therefore, in the present study we sought to determine whether the previously proposed fitness cut-off points discriminate the severity of major fibromyalgia symptoms and health-related quality of life. Additionally, we investigated which ACR fibromyalgia criteria (1990c vs. m-2010c) better discriminate the fibromyalgia symptomatology.

Methods

Participants

We calculated the sample size needed (n = 300) to obtain a representative sample of fibromyalgia patients from southern Spain (Andalusia). A sex- and province-proportional recruitment of participants was planned and carried out [35]. We recruited fibromyalgia patients via associations, internet advertisement, flyers and e-mail. We asked those fibromyalgia patients interested in participating to recruit a pairwise non-fibromyalgia individual (control) with similar age and socio-demographic characteristics to perform appropriate comparisons between groups. All interested participants (n = 960; 617 fibromyalgia patients and 343 controls) gave their written informed consent after receiving detailed information about the aims and study procedures and before taking part in the study. Fibromyalgia patients were required to be previously diagnosed by a rheumatologist and to meet either the 1990c or the m-2010c [37, 50]. The inclusion criteria for control participants were not to meet the 1990c or the m-2010c. Those participants (patients or controls) that reported to have either acute or terminal illness or showed severe cognitive impairment (Mini Mental State Examination (MMSE) score < 10) were excluded [18]. Men were also excluded because of the small sample size (n = 86, 26 men with fibromyalgia). 38 patients were not previously diagnosed by a rheumatologist. 92 fibromyalgia patients did not meet the 1990c or the m-2010c criteria, whereas 6 controls met them. Additionally one women with fibromyalgia had severe cognitive impairment. To achieve age-matched groups, women < 35 and > 65 years old were not included in the present study (56 participants excluded). Moreover, only participants with complete data for all the variables were included. Thus, the final study sample comprised 488 women with fibromyalgia vs. 200 controls. The study was reviewed and approved by the Ethics Committee of the "Hospital Virgen de las Nieves" (Granada, Spain). All procedures were conducted in accordance with the ethical standards of the IJSM [21].

Outcome measures

Cognitive function

The MMSE [25] assesses cognitive capacity and impairment and was used for exclusion criteria purpose only.

Depression

The Beck Depression Inventory-II (BDI-II) was used to assess depression severity [6]. The BDI-II contains 21 items and its score ranges from 0 to 63, where higher score indicates greater depression.

Anthropometric measures

Weight (kg), height (cm) and body fat (%) were measured using a portable 8-polar tactile-electrode impedanciometer (InBody R20, Biospace, Seoul, Korea) and a stadiometer (Seca 22, Hamburg, Germany), respectively.

Pain medication

We registered the consumption of painkillers (analgesics) as a binary variable (yes/no).

The 1990 ACR fibromyalgia diagnostic criteria

We assessed 18 tender points [50] using a standard pressure algometer (FPK 20; Wagner Instruments, Greenwich, CT, USA). 2 alternative measurements at each tender point were performed and the mean score was recorded. A tender point was scored as positive when the patient reported pain at a pressure of $\leq 4\,kg/cm^2$ and the total count of positive tender points was recorded for each participant.

The Modified 2010 ACR fibromyalgia preliminary diagnostic criteria

These preliminary criteria are based on a self-reported questionnaire [37, 47]. We obtained 2 scores from 2 different scales: i) the Widespread Pain Index (WPI), where participants graded whether they had experienced pain or tenderness over the previous week on 19 body areas; ii) the Symptom Severity (SS) scale, where participants indicated the severity of fatigue, trouble thinking or remembering, and waking up tired (unrefreshed) over the previous week, and whether they had pain or cramps in the lower abdomen, depression, or headache during the previous 6 months. Patients were diagnosed if they presented WPI ≥ 7 and SS ≥ 5, or WPI 3–6 and SS scale score ≥ 9. The Spanish version of the m-2010c has shown high sensitivity and specificity as a diagnostic tool for fibromyalgia [37].

Fibromyalgia severity

The Revised Fibromyalgia Impact Questionnaire (FIQR) is a self-administered questionnaire, comprising 21 individual questions with a 0–10 numeric rating scale. The FIQR includes 3 different domains: function, overall impact and symptoms score (ranging 0–30, 0–20 and 0–50, respectively) [7]. The FIQR total score range from 0 to 100, with a higher score indicating greater effect of the condition on the person's life. The Symptom Impact Questionnaire [19] is a slightly modified version of the FIQR used with controls. Number of questions, domains and scoring is the same as the FIQR.

Health-related quality of life

The 36-item Short-Form Health Survey is a generic instrument for assessing health-related quality of life [1]. It contains 36 items grouped into 8 dimensions: physical functioning, physical role, bodily pain, general health, vitality, social functioning, emotional role, and mental health; which are standardized in 2 main global domains of health: physical and mental health-related quality life. The scores range from 0 to 100 in every dimension, where higher scores indicate better health.

Fatigue

The Multidimensional Fatigue Inventory Spanish version (MFI-S) was used to measure fatigue severity. 5 subscales compose this questionnaire: general fatigue, physical fatigue, mental fatigue, reduced activity, and reduced motivation [29, 34]. Each subscale includes 4 items with 5-point Likert scales. Scores on each subscale range from 4 to 20, where higher scores indicate greater fatigue.

Anxiety

The State-Trait Anxiety Inventory (STAI) was used to assess the level of current anxiety (i. e., state anxiety) [45]. The STAI is a 20-item self-administered questionnaire, and its score ranges from 20 to 80, where higher scores indicate greater state anxiety.

Physical fitness cut-off points

We used the handgrip strength and Senior Fitness Tests Battery to measure physical fitness components [11, 32].

The proposed cut-off points of physical fitness tests to discriminate between presence and absence of fibromyalgia in women aged 35–65 years were [5]: (i) 35–44 age group: the arm-curl (< 20 repetitions), 30-s chair stand (< 13 repetitions), handgrip strength (< 22.1 kg), 8-ft up-and-go (≥ 5.1 s), 6-min walk (< 551 m), chair sit-and-reach (< − 5.7 cm), and back scratch (< − 8.7 cm) tests; (ii) 45–54 age group: the arm-curl (< 16 repetitions), 30-s chair stand (< 12 repetitions), handgrip strength (< 21.6 kg), 8-ft up-and-go (≥ 5.3 s), 6-min walk (< 504 m), chair sit-and-reach (< − 6.7 cm), and back scratch (< − 8.9 cm) tests; (iii) 55–65 age group: the arm-curl (< 16 repetitions), 30-s chair stand (< 11 repetitions), handgrip strength (< 19.1 kg), 8-ft up-and-go (≥ 5.9 s), 6-min walk (< 500 m), chair sit-and-reach (< − 9.7 cm), and back scratch (< − 11.7 cm) tests.

Statistical analysis

Descriptive data are shown as mean and standard deviation (SD) or frequencies and percentages for continuous and categorical variables, respectively. The t-test was used to analyse the differences between women with fibromyalgia and controls in continuous variables. Chi-square was used to test differences between groups in socio-demographic categorical variables. Each participant was categorized as a woman with fibromyalgia or a control woman according to established cut points for the diagnosis of fibromyalgia within each fitness test [5]. The area under the curve (range 0.74–0.89) of the fitness tests are published elsewhere [5]. To analyse the differences in tender points count, the impact of fibromyalgia, health-related quality of life (physical and mental components), fatigue, depression, anxiety, 1990c and m-2010c between those participants categorized as having or not fibromyalgia according to the physical fitness cut-off points previously stated, we carried out analysis of covariance (ANCOVA), where significant socio-demographic data (marital status, educational level and current occupational status), body fat (%) and pain medication were used as covariates in all the analyses, due to the differences between women with fibromyalgia and controls. The effect size statistic was calculated in all the analyses using Cohen's d (standardized mean difference) [30]. The effect size was interpreted as small (~0.25), medium (~0.5) or large (~0.8 or greater) [30].

The statistical analyses were performed using the Statistical Package for the Social Sciences (IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp), and the level of significance was set at $P < 0.05$.

Results

The characteristics of the study participants by age groups are shown in ▶ **Table 1**.

▶ **Table 2** shows tenderness of women with fibromyalgia and women without fibromyalgia according to fitness cut-off points by age groups. Tender points count were lower in women categorized as having fibromyalgia compared to women categorized as without fibromyalgia according to the fitness cut-off points (all, $P < 0.001$). The largest effect sizes were observed in the arm-curl and 30-s chair stand tests in the 35–44 and 45–54 age groups (Cohen's d ~ 1.3 and 0.9, respectively) and in the handgrip strength and chair sit and reach tests in the 55–65 age group (Cohen's d ~ 0.8 in both tests).

Impact of fibromyalgia for women with fibromyalgia and women without fibromyalgia according to fitness cut-off points by age groups is shown in ▶ **Table 3**. Women categorized as having fibromyalgia according to the fitness cut-off points presented worse scores in the FIQR total score compared to women categorized as without fibromyalgia for all the fitness tests assessed (all, $P < 0.001$). The effect sizes were generally large, except for the back scratch test in all 3 groups (medium effect size). The arm-curl and the 30-s chair stand tests showed the largest effect sizes (Cohen's d ≥ 1.0) for all the age groups. However, the 30-s chair stand and handgrip strength tests showed the largest effect sizes (Cohen's d ~ 1.0) in the 55–65 age group.

The physical component of health-related quality of life in women with fibromyalgia and without fibromyalgia according to fitness cut-off points by age groups are shown in ▶ **Table 4**. All fitness tests showed worse physical health-related quality of life values in women categorized as having fibromyalgia compared to women categorized as without fibromyalgia in all age groups (all, $P < 0.001$, except for the back scratch test in the 35–44 age group, $P = 0.01$). The largest effect values were observed in the arm-curl and the 30-s chair stand tests, in all 3 age groups (Cohen's d ≥ 1.0).

▶ **Table 5** presents the psychological component of health-related quality of life for women with fibromyalgia and women without fibromyalgia according to fitness cut-off points by age groups. All fitness tests showed worse mental health-related quality of life values in women categorized as having fibromyalgia compared to women without fibromyalgia in all age groups (P between 0.025 and $P < 0.001$). The effect sizes were small and medium in all fitness tests in the 3 groups, except for the 30-s chair stand and the arm-curl tests in the 35–44 age group (Cohen's d = 0.82 and 0.80, respectively).

Fatigue values for women with fibromyalgia and women without fibromyalgia according to fitness cut-off points by age groups are depicted in ▶ **Table 6**. Women categorized as having fibromyalgia presented worse scores in fatigue compared to women categorized without fibromyalgia for all fitness tests and age groups (all, $P \leq 0.001$). Larger effect sizes were presented in the arm-curl

▶ **Table 1** Characteristics of the study sample by age groups.

	Age groups								
	35–44 years			45–54 years			55–65 years		
	Fibromyalgia (n = 102)	Control (n = 44)	P	Fibromyalgia (n = 230)	Control (n = 101)	P	Fibromyalgia (n = 160)	Control (n = 51)	P
Weight (Kg)	66.3 (12.6)	64.5 (11.1)	0.411	73.0 (14.9)	68.7 (11.1)	**0.011**	71.9 (13.0)	69.1 (13.1)	0.187
Height (cm)	159.8 (6.1)	162.6 (7.2)	**0.019**	158.6 (5.7)	159.5 (5.7)	0.226	156.2 (5.9)	158.9 (5.8)	**0.004**
Fat (%)	36.2 (7.6)	32.7 (7.7)	**0.012**	40.3 (7.4)	37.4 (6.1)	**<0.001**	42.1 (7.2)	39.1 (7.2)	**0.010**
MMSE (0–30)	28.4 (1.7)	28.9 (1.5)	0.105	28.3 (2.0)	28.5 (1.9)	0.483	27.1 (2.4)	28.2 (1.9)	**0.004**
Marital status, n (%)									
Married	75 (73.5)	33 (75.0)	0.853	177 (77.0)	76 (75.2)	0.701	124 (77.5) *	31 (60.8) *	**0.019**
Not married	27 (26.5)	11 (25.0)		53 (23.0)	25 (24.8)		36 (22.5) *	20 (39.2) *	
Educational level, n (%)									
Non-university	84 (82.4) *	28 (63.6) *	**0.014**	193 (83.9)	76 (75.2)	0.063	149 (93.1) *	41 (80.4) *	**0.008**
University	18 (17.6) *	16 (36.4) *		37 (16.1)	25 (24.8)		11 (6.9) *	10 (19.6) *	
Occupational status, n (%)									
Working	37 (36.3) *	22 (50.0) *	**0.002**	80 (34.8) *	50 (49.5) *	**0.002**	19 (11.9) *	12 (23.5) *	**0.030**
Housewife	30 (29.4)	13 (29.5)		66 (28.7)	33 (32.7)		61 (38.1)	23 (45.1)	
Not working	35 (34.3) *	9 (20.5) *		84 (36.5) *	18 (17.8) *		80 (50.0) *	16 (31.4) *	
Pain medication (yes), n (%)	189 (89.0)	25 (54.3)	**<0.001**	207 (90.8)	58 (56.3)	**<0.001**	136 (85.0)	25 (49.0)	**<0.001**
Fitness tests									
Arm-curl (rep.)	16.1 (5.5)	24.4 (4.0)	**<0.001**	14.8 (5.0)	22.1 (4.6)	**<0.001**	14.1 (4.7)	19.8 (4.2)	**<0.001**
30-s chair stand (rep.)	11.9 (3.3)	17.0 (3.2)	**<0.001**	10.5 (3.2)	14.7 (2.7)	**<0.001**	10.3 (3.0)	14.0 (2.9)	**<0.001**
Handgrip strength (kg)	21.7 (6.4)	27.8 (4.1)	**<0.001**	19.6 (6.5)	27.3 (4.8)	**<0.001**	18.9 (5.9)	24.5 (4.6)	**<0.001**
8-feet up-and-go (s)	6.0 (1.0)	5.0 (0.6)	**<0.001**	6.8 (1.8)	5.4 (0.7)	**<0.001**	7.1 (1.8)	5.8 (1.1)	**<0.001**
6-min walk (m)	529.9 (76.5)	608.4 (64.9)	**<0.001**	490.0 (76.9)	574.6 (57.7)	**<0.001**	473.6 (74.0)	541.3 (64.5)	**<0.001**
Chair sit-and-reach (cm)	−8.6 (13.3)	7.8 (9.5)	**<0.001**	−10.5 (11.7)	2.0 (11.2)	**<0.001**	−10.7 (12.1)	1.4 (9.9)	**<0.001**
Back scratch (cm)	−9.9 (11.1)	−1.4 (8.4)	**<0.001**	−12.8 (11.6)	−5.3 (8.7)	**<0.001**	−15.6 (12.2)	−8.0 (10.2)	**<0.001**

Values represent mean ± (standard deviation), unless otherwise indicated. MMSE, Mini-Mental State Examination. * Subgroups which are statistically different

▶ **Table 2** Tender points count of the study sample according to fitness tests cut-off points by age groups.

	Age groups																	
	35–44 years (n = 146)						45–54 years (n = 331)						55–65 years (n = 211)					
	Yes		No		P	Effect size	Yes		No		P	Effect size	Yes		No		P	Effect size
	Mean	(SE)	Mean	(SE)			Mean	(SE)	Mean	(SE)			Mean	(SE)	Mean	(SE)		
Fitness tests																		
Arm-curl (rep.)	14.8	0.6	7.5	0.7	**<0.001**	−1.35	14.1	0.5	9.0	0.4	**<0.001**	−0.86	13.5	0.6	9.7	0.7	**<0.001**	−0.65
30-s chair stand (rep.)	15.7	0.8	8.3	0.6	**<0.001**	−1.27	14.2	0.5	8.8	0.4	**<0.001**	−0.9	14.2	0.7	9.7	0.6	**<0.001**	−0.72
Handgrip strength (kg)	15.3	0.8	9.3	0.6	**<0.001**	−1.00	14.0	0.5	9.2	0.4	**<0.001**	−0.79	14.4	0.6	9.6	0.6	**<0.001**	−0.76
8-feet up-and-go (s)	13.5	0.6	7.2	1.0	**<0.001**	−1.04	12.7	0.4	7.5	0.7	**<0.001**	−0.82	12.7	0.5	9.4	0.9	**<0.001**	−0.49
6-min walk (m)	14.5	0.7	9.3	0.7	**<0.001**	−0.84	13.5	0.6	9.8	0.5	**<0.001**	−0.58	13.4	0.6	10.0	0.6	**<0.001**	−0.51
Chair sit & reach (cm)	14.5	0.8	9.5	0.7	**<0.001**	−0.81	13.4	0.5	9.3	0.5	**<0.001**	−0.66	14.3	0.6	9.5	0.6	**<0.001**	−0.77
Back scratch (cm)	13.9	0.8	10.2	0.7	**<0.001**	−0.59	12.4	0.5	10.2	0.5	**<0.001**	−0.34	13.0	0.6	10.3	0.7	**<0.001**	−0.41
Fibromyalgia Criteria																		
1990 Criteria	16.7	0.3	3.5	0.3	**<0.001**	−5.35	16.7	0.2	3.7	0.2	**<0.001**	−4.92	16.6	0.2	3.5	0.3	**<0.001**	−5.64
2010 Criteria	15.2	0.5	6.1	0.7	**<0.001**	−1.77	14.3	0.4	6.3	0.5	**<0.001**	−1.43	14.2	0.5	6.2	0.7	**<0.001**	−1.38

SE, standard error. Differences between fibromyalgia and control groups were performed using analyses of the covariance (ANCOVA) with marital status, educational level, current occupational status, body fat (%) and pain medication as covariates. Effect size statistics are expressed as Cohen's d. Yes = women categorized as having fibromyalgia; No = women categorized without fibromyalgia

▶ **Table 3** Impact of fibromyalgia (FIQR) of the study sample according to fitness tests cut-off points by age groups.

	Age groups																	
	35–44 years (n = 146)						45–54 years (n = 331)						55–65 years (n = 211)					
	Yes		No		P	Effect size	Yes		No		P	Effect size	Yes		No		P	Effect size
	Mean	(SE)	Mean	(SE)			Mean	(SE)	Mean	(SE)			Mean	(SE)	Mean	(SE)		
Fitness tests																		
Arm-curl (rep.)	59.9	2.3	32.5	2.8	**<0.001**	−1.27	62.2	1.6	39.3	1.5	**<0.001**	−1.16	62.9	2.0	43.7	2.2	**<0.001**	−0.98
30-s chair stand (rep.)	64.9	2.9	38.0	2.3	**<0.001**	−1.22	62.3	1.6	38.5	1.5	**<0.001**	−1.2	66.3	2.1	43.8	1.9	**<0.001**	−1.08
Handgrip strength (kg)	63.2	3.0	38.5	2.5	**<0.001**	−1.08	60.2	1.8	41.4	1.5	**<0.001**	−0.9	65.3	2.2	44.9	1.9	**<0.001**	−0.98
8-feet up-and-go (s)	54.7	2.4	32.7	3.9	**<0.001**	−0.9	54.7	1.3	33.3	2.4	**<0.001**	−1.01	59.5	1.8	40.0	2.9	**<0.001**	−0.89
6-min walk (m)	62.0	2.8	36.7	2.6	**<0.001**	−1.1	60.8	1.8	41.7	1.5	**<0.001**	−0.9	60.9	2.2	46.5	2.2	**<0.001**	−0.69
Chair sit & reach (cm)	61.5	2.8	37.5	2.6	**<0.001**	−1.03	58.6	1.7	40.9	1.6	**<0.001**	−0.83	64.3	2.2	45.7	2.0	**<0.001**	−0.88
Back scratch (cm)	57.2	3.2	42.4	2.6	**<0.001**	−0.61	56.9	1.8	42.5	1.7	**<0.001**	−0.64	60.7	2.2	46.2	2.3	**<0.001**	−0.63
Fibromyalgia Criteria																		
1990 Criteria	61.6	2.1	26.8	2.8	**<0.001**	−1.69	61.4	1.4	32.9	1.6	**<0.001**	−1.49	63.1	1.7	38.5	2.3	**<0.001**	−1.22
2010 Criteria	64.9	1.7	21.3	2.2	**<0.001**	−2.65	62.8	1.2	27.6	1.5	**<0.001**	−2.11	64.9	1.4	28.5	1.9	**<0.001**	−2.22

SE. standard error. Differences between fibromyalgia and control groups were performed using analyses of the covariance (ANCOVA) with marital status, educational level, current occupational status, body fat (%) and pain medication as covariates. Effect size statistics are expressed as Cohen's d. Yes = women categorized as having fibromyalgia; No = women categorized without fibromyalgia

▶ **Table 4** Physical component of health-related quality of life of the study sample according to fitness tests cut-off points by age groups.

	Age groups																	
	35–44 years (n = 146)						45–54 years (n = 331)						55–65 years (n = 211)					
	Yes		No		P	Effect size	Yes		No		P	Effect size	Yes		No		P	Effect size
	Mean	(SE)	Mean	(SE)			Mean	(SE)	Mean	(SE)			Mean	(SE)	Mean	(SE)		
Fitness tests																		
Arm-curl (rep.)	31.9	1.0	44.1	1.2	**<0.001**	1.29	29.9	0.7	39.8	0.6	**<0.001**	1.18	30.7	0.8	37.8	0.9	**<0.001**	0.80
30-s chair stand (rep.)	30.7	1.4	41.0	1.1	**<0.001**	1.01	29.8	0.7	40.3	0.6	**<0.001**	1.24	30.4	0.9	36.9	0.8	**<0.001**	0.74
Handgrip strength (kg)	30.6	1.3	41.3	1.1	**<0.001**	0.9	31.6	0.8	38.4	0.7	**<0.001**	0.73	30.4	0.9	36.9	0.8	**<0.001**	0.74
8-feet up-and-go (s)	34.2	1.0	44.1	1.7	**<0.001**	0.92	33.3	0.6	42.0	1.0	**<0.001**	0.95	32.4	0.8	37.9	1.2	**<0.001**	0.60
6-min walk (m)	32.0	1.3	41.3	1.2	**<0.001**	0.87	31.2	0.8	38.4	0.7	**<0.001**	0.77	31.9	0.9	36.2	0.9	**<0.001**	0.46
Chair sit & reach (cm)	31.3	1.3	41.8	1.2	**<0.001**	1.02	31.8	0.7	38.9	0.7	**<0.001**	0.76	30.6	0.9	36.7	0.8	**<0.001**	0.69
Back scratch (cm)	34.1	1.4	39.0	1.2	**0.01**	0.44	33.0	0.8	37.8	0.7	**<0.001**	0.49	31.5	0.9	36.9	0.9	**<0.001**	0.58
Fibromyalgia Criteria																		
1990 Criteria	31.1	0.9	46.6	1.2	**<0.001**	1.69	30.7	0.6	42.0	0.7	**<0.001**	1.33	30.6	0.7	39.6	1.0	**<0.001**	1.06
2010 Criteria	30.5	0.9	47.7	1.1	**<0.001**	2.06	30.8	0.6	43.1	0.7	**<0.001**	1.5	30.4	0.7	41.9	1.0	**<0.001**	1.42

SE. standard error. Differences between fibromyalgia and control groups were performed using analyses of the covariance (ANCOVA) with marital status, educational level, current occupational status, body fat (%) and pain medication as covariates. Effect size statistics are expressed as Cohen's d. Yes = women categorized as having fibromyalgia; No = women categorized without fibromyalgia

▶ **Table 5** Mental component of health-related quality of life of the study sample according to fitness tests cut-off points by age groups.

	Age groups																	
	35–44 years (n = 146)						45–54 years (n = 331)						55–65 years (n = 211)					
	Yes		No		P	Effect size	Yes		No		P	Effect size	Yes		No		P	Effect size
	Mean	(SE)	Mean	(SE)			Mean	(SE)	Mean	(SE)			Mean	(SE)	Mean	(SE)		
Fitness tests																		
Arm-curl (rep.)	34.8	1.3	43.4	1.3	**<0.001**	0.80	37.2	1.0	42.1	0.9	**<0.001**	0.41	37.5	1.1	42.8	1.2	**0.002**	0.51
30-s chair stand (rep.)	33.4	1.7	43.0	1.4	**<0.001**	0.82	37.5	1.0	42.0	0.9	**0.001**	0.37	35.5	1.2	43.6	1.1	**<0.001**	0.71
Handgrip strength (kg)	36.7	1.8	41.0	1.5	**0.009**	0.31	36.4	1.0	42.6	0.9	**<0.001**	0.51	35.9	1.2	43.1	1.1	**<0.001**	0.61
8-feet up-and-go (s)	37.6	1.3	43.6	2.2	**0.01**	0.44	38.6	0.8	43.8	1.4	**0.002**	0.43	37.8	1.0	45.4	1.6	**<0.001**	0.63
6-min walk (m)	34.4	1.6	43.5	1.5	**<0.001**	0.71	36.9	1.1	42.0	0.9	**0.002**	0.41	36.9	1.2	43.1	1.2	**<0.001**	0.51
Chair sit & reach (cm)	35.7	1.7	42.2	1.5	**0.006**	0.48	37.9	1.0	41.8	1.0	**0.006**	0.27	35.5	1.2	43.4	1.1	**<0.001**	0.69
Back scratch (cm)	34.9	1.7	42.3	1.4	**0.001**	0.58	36.9	1.0	42.8	1.0	**<0.001**	0.48	38.0	1.2	42.2	1.3	**0.01**	0.34
Fibromyalgia Criteria																		
1990 Criteria	35.3	1.4	45.8	1.8	**<0.001**	0.87	37.6	0.9	43.2	1.1	**<0.001**	0.48	37.4	1.0	44.1	1.4	**<0.001**	0.57
2010 Criteria	33.707	1.282	48.4	1.7	**<0.001**	1.24	35.6	0.8	47.0	1.1	**<0.001**	0.98	35.7	0.9	49.2	1.4	**<0.001**	1.23

SE, standard error. Differences between fibromyalgia and control groups were performed using analyses of the covariance (ANCOVA) with marital status, educational level, current occupational status, body fat (%) and pain medication as covariates. Effect size statistics are expressed as Cohen's d. Yes = women categorized as having fibromyalgia; No = women categorized without fibromyalgia

▶ Table 6 Fatigue of the study sample according to fitness tests cut-off points by age groups.

	Age groups																	
	35–44 years (n = 146)						45–54 years (n = 331)						55–65 years (n = 211)					
	Yes		No		P	Effect size	Yes		No		P	Effect size	Yes		No		P	Effect size
	Mean	(SE)	Mean	(SE)			Mean	(SE)	Mean	(SE)			Mean	(SE)	Mean	(SE)		
Fitness tests																		
Arm-curl (rep.)	17.8	0.4	12.8	0.5	**<0.001**	−1.3	17.8	0.3	14.0	0.3	**<0.001**	−0.99	16.8	0.4	14.2	0.4	**<0.001**	−0.66
30-s chair stand (rep.)	18.4	0.5	13.6	0.4	**<0.001**	−1.27	17.8	0.3	13.9	0.3	**<0.001**	−1.04	17.2	0.4	14.3	0.4	**<0.001**	−0.69
Handgrip strength (kg)	18.4	0.5	13.8	0.4	**<0.001**	−1.22	17.3	0.3	14.5	0.3	**<0.001**	−0.76	17.1	0.4	14.4	0.4	**<0.001**	−0.67
8-feet up-and-go (s)	16.9	0.4	12.5	0.7	**<0.001**	−1.13	16.7	0.2	13.7	0.4	**<0.001**	−0.92	16.4	0.3	13.6	0.6	**<0.001**	−0.66
6-min walk (m)	17.2	0.5	14.4	0.5	**<0.001**	−0.64	17.1	0.4	14.7	0.3	**<0.001**	−0.57	16.7	0.4	14.4	0.4	**<0.001**	−0.55
Chair sit & reach (cm)	18.0	0.5	13.7	0.5	**<0.001**	−1.03	17.3	0.3	14.2	0.3	**<0.001**	−0.77	17.2	0.4	14.4	0.4	**<0.001**	−0.69
Back scratch (cm)	16.8	0.6	14.9	0.5	**0.001**	−0.41	16.7	0.3	14.7	0.3	**<0.001**	−0.49	16.9	0.4	14.2	0.4	**<0.001**	−0.63
Fibromyalgia Criteria																		
1990 Criteria	17.8	0.4	12.2	0.5	**<0.001**	−1.45	17.6	0.3	13.1	0.3	**<0.001**	−1.18	17.1	0.3	13.0	0.4	**<0.001**	−1.05
2010 Criteria	18.5	0.3	11.1	0.4	**<0.001**	−2.35	17.9	0.2	12.0	0.3	**<0.001**	−1.74	17.3	0.3	11.9	0.5	**<0.001**	−1.45

SE, standard error. Differences between fibromyalgia and control groups were performed using analyses of the covariance (ANCOVA) with marital status, educational level, current occupational status, body fat (%) and pain medication as covariates. Effect size statistics are expressed as Cohen's d. Yes = women categorized as having fibromyalgia; No = women categorized without fibromyalgia

and 30-s chair stand tests in the 35–44 and 45–54 age groups (Cohen's d ~ 1.3 and 1.0, respectively). The effect sizes were medium for all fitness tests in the 55–65 age group.

▶ **Table 7** shows depression levels in women with fibromyalgia and women without fibromyalgia according to fitness cut-off points by age groups. All fitness tests showed higher depression in women categorized as having fibromyalgia compared to women without fibromyalgia in all age groups (all, $P \leq 0.001$). The arm-curl and 30-s chair stand tests presented the largest effect sizes in the 35–44 age group. Likewise, the 30-s chair stand test presented the largest effect size in the 45–54 age group. The effect sizes were medium for all fitness tests in the 55–65 age group.

Anxiety levels for women with fibromyalgia and women without fibromyalgia according to fitness cut-off points by age groups are represented in ▶ **Table 8**. Women categorized as having fibromyalgia presented higher anxiety compared to those categorized without fibromyalgia in all age groups (P between 0.01 and $P < 0.001$). The effect sizes were medium for all fitness tests and the 3 age groups.

Differences in all the main symptoms for women with fibromyalgia compared to women without fibromyalgia, according to the 1990c and the m-2010c are depicted in ▶ **Table 2–8**. Women categorized as having fibromyalgia presented more impaired symptoms compared to women categorized as without fibromyalgia in all age groups (all, $P < 0.001$). The effect sizes were larger using the m-2010c in the 3 age groups, except for the tender points where the effect size were quite larger with the 1990c.

Discussion

The main finding of the present study showed that women categorized as having fibromyalgia according to fitness cut-off points presented worse status than women without fibromyalgia in all the symptoms assessed and for all age groups. Furthermore, the m-2010c better discriminated the overall picture of fibromyalgia symptomatology than the 1990c.

Our findings confirm that physical fitness levels are reduced in fibromyalgia patients compared to age-matched healthy controls [2, 3, 5, 24, 31]. Moreover, physical fitness levels in fibromyalgia patients are similar to healthy older adults [24, 31]. Carbonell-Baeza et al. [12] showed that physical fitness level in fibromyalgia patients is approximately in the 50th percentile of healthy women aged 85–89 years, which suggests that fibromyalgia may increase the risk of premature age associated disability. Indeed, women with fibromyalgia have a high risk of disability [23, 31] and difficulties with doing tasks that require physical independence [24]. It seems that the thought of a possible aggravation of their symptoms conducts fibromyalgia patients to refrain from physical activity [9, 28], leading consequently to decreased physical fitness [16].

Several studies, focused on the association of single components of physical fitness and pain separately, have shown that levels of cardiorespiratory fitness [13, 43] and muscle strength [12, 22] are inversely associated with pain. Recently, Soriano-Maldonado et al. [42] studied the influence of independent and combined components of physical fitness on different components of pain (i. e., algometry, numerical rating scale, visual analogue scale and bodily pain subscale, pain-related catastrophizing and chronic pain self-efficacy), showing that higher physical fitness is consistently associ-

▶ **Table 7** Depression of the study sample according to fitness tests cut-off points by age groups.

	Age groups																	
	35–44 years (n = 146)						45–54 years (n = 331)						55–65 years (n = 211)					
	Yes		No		P	Effect size	Yes		No		P	Effect size	Yes		No		P	Effect size
	Mean	(SE)	Mean	(SE)			Mean	(SE)	Mean	(SE)			Mean	(SE)	Mean	(SE)		
Fitness tests																		
Arm-curl (rep.)	26.4	1.4	15.3	1.6	**<0.001**	−0.88	25.5	1.0	18.3	0.9	**<0.001**	−0.59	24.6	1.1	18.4	1.1	**<0.001**	−0.61
30-s chair stand (rep.)	28.4	1.7	17.5	1.4	**<0.001**	−0.86	26.6	1.0	17.1	0.9	**<0.001**	−0.81	26.1	1.2	18.1	1.0	**<0.001**	−0.75
Handgrip strength (kg)	26.4	1.8	18.6	1.4	**0.001**	−0.58	25.8	1.0	18.2	0.9	**<0.001**	−0.65	25.9	1.1	18.4	1.0	**<0.001**	−0.67
8-feet up-and-go (s)	23.9	1.3	16.2	2.2	**0.001**	−0.56	23.1	0.8	16.6	1.4	**<0.001**	−0.52	24.0	0.9	16.2	1.5	**<0.001**	−0.68
6-min walk (m)	27.0	1.6	16.2	1.4	**<0.001**	−0.85	24.7	1.1	19.3	0.9	**0.001**	−0.44	25.3	1.1	17.9	1.1	**<0.001**	−0.65
Chair sit & reach (cm)	26.7	1.6	17.5	1.5	**<0.001**	−0.69	24.9	1.0	18.2	0.9	**<0.001**	−0.54	25.3	1.2	18.8	1.0	**<0.001**	−0.58
Back scratch (cm)	26.4	1.7	18.5	1.4	**0.001**	−0.6	24.8	1.0	18.3	1.0	**<0.001**	−0.52	25.0	1.1	18.0	1.2	**<0.001**	−0.60
Fibromiyalgia Criteria																		
1990 Criteria	26.8	1.3	13.4	1.7	**<0.001**	−1.05	25.4	0.9	16.0	1.0	**<0.001**	−0.82	24.1	1.0	17.7	1.3	**<0.001**	−0.62
2010 Criteria	28.2	1.2	11.1	1.6	**<0.001**	−1.46	27.2	0.8	12.1	1.0	**<0.001**	−1.38	25.8	0.8	12.7	1.3	**<0.001**	−1.27

SE, standard error. Differences between fibromyalgia and control groups were performed using analyses of the covariance (ANCOVA) with marital status, educational level, current occupational status, body fat (%) and pain medication as covariates. Effect size statistics are expressed as Cohen's d. Yes = women categorized as having fibromyalgia; No = women categorized without fibromyalgia

▶ **Table 8** State anxiety symptomatology of the study sample according to fitness tests cut-off points by age groups.

	Age groups																	
	35–44 years (n = 146)						45–54 years (n = 331)						55–65 years (n = 211)					
	Yes		No		P	Effect size	Yes		No		P	Effect size	Yes		No		P	Effect size
	Mean	(SE)	Mean	(SE)			Mean	(SE)	Mean	(SE)			Mean	(SE)	Mean	(SE)		
Fitness tests																		
Arm-curl (rep.)	33.4	1.5	25.2	1.7	**<0.001**	−0.61	34.7	1.1	28.0	1.0	**<0.001**	−0.52	33.3	1.2	26.0	1.3	**<0.001**	−0.56
30-s chair stand (rep.)	35.3	1.8	26.6	1.4	**<0.001**	−0.65	35.5	1.0	27.1	1.0	**<0.001**	−0.65	34.6	1.3	26.0	1.2	**<0.001**	−0.67
Handgrip strength (kg)	33.7	1.8	27.5	1.5	**0.01**	−0.45	34.7	1.1	28.2	1.0	**<0.001**	−0.5	34.9	1.3	25.9	1.1	**<0.001**	−0.73
8-feet up-and-go (s)	32.2	1.4	24.2	2.2	**0.003**	−0.57	32.7	0.8	25.6	1.5	**<0.001**	−0.54	32.5	1.0	23.4	1.7	**<0.001**	−0.71
6-min walk (m)	34.6	1.7	26.0	1.6	**<0.001**	−0.62	34.2	1.2	28.8	0.9	**0.001**	−0.4	33.6	1.2	25.9	1.3	**<0.001**	−0.59
Chair sit & reach (cm)	33.4	1.7	27.1	1.6	**0.01**	−0.44	35.0	1.0	27.2	1.0	**<0.001**	−0.6	33.9	1.3	26.6	1.2	**<0.001**	−0.58
Back scratch (cm)	34.2	1.8	27.1	1.5	**0.003**	−0.52	35.5	1.0	26.7	1.0	**<0.001**	−0.67	33.4	1.2	25.8	1.3	**<0.001**	−0.58
Fibromiyalgia Criteria																		
1990 Criteria	35.0	1.4	21.7	1.8	**<0.001**	−1.02	34.1	1.0	26.7	1.1	**<0.001**	−0.56	32.4	1.1	25.5	1.5	**<0.001**	−0.54
2010 Criteria	36.3	1.3	19.6	1.7	**<0.001**	−1.37	36.4	0.8	22.0	1.1	**<0.001**	−1.2	34.2	1.0	20.3	1.5	**<0.001**	−1.16

SE, standard error. Differences between fibromyalgia and control groups were performed using analyses of the covariance (ANCOVA) with marital status, educational level, current occupational status, body fat (%) and pain medication as covariates. Effect size statistics are expressed as Cohen's. Yes = women categorized as having fibromyalgia; No = women categorized without fibromyalgia

ated with lower levels of pain, lower pain-related catastrophizing, and higher chronic pain self-efficacy in women with fibromyalgia. Likewise, other key fibromyalgia symptoms such as fatigue [5], anxiety [15, 39], depression [39] and stiffness [5] have shown an inverse association with physical fitness levels, whereas a positive association with health-related quality of life (i. e., physical and metal components) [13, 39] has been found. This fact explains that lower physical fitness is associated with higher fibromyalgia severity [3, 4, 42].

Given the complex nature of the fibromyalgia, its diagnosis is challenging, especially in primary care settings [17, 27], where different clinical, psychosocial, and functional assessments are involved [8, 17, 33, 46, 48]. In fact, the diagnosis of fibromyalgia appears to be a dynamic process that requires new tools to facilitate the physician's final decision [49]. Consequently, our group suggested cut-off points for fitness testing that were powerful to discriminate between presence and absence of fibromyalgia [5].

Overall, the arm-curl and the 30-s chair stand tests presented the highest effect sizes for all the symptoms studied, since this effect is large in the 35–44 and 45–54 age groups, except for the mental component of health-related quality of life and anxiety; whereas the effect sizes in both fitness tests were large-medium in the 55–65 age group. It is noteworthy that the handgrip strength test presented similar effect size values, even better in some symptoms, than the arm-curl and the 30-s chair stand tests in the 55–65 age group. These findings, joined to those found by Aparicio et al. [5], who observed that muscle strength tests were those that better discriminated between the presence or absence of fibromyalgia in women, suggest the usefulness of the arm curl and 30-s chair stand tests as a complement to the current fibromyalgia diagnosis criteria. Moreover, the handgrip strength test may be an interesting alternative to the arm curl and the 30-s chair stand tests in the 55–65 age group.

It is important to mention that the effect size of the differences found between fibromyalgia patients and controls were smaller in the older age group. Aging leads to a decline in health status [52]. However, the reductions in physical, psychological and social dimensions in fibromyalgia patients are lower in elderly than in young and middle-aged patients [10], which may explain that the oldest group reported lower effect sizes than the younger groups. Additionally, we reported that fitness cut-off points discriminated the physical symptoms better than psychological symptoms, which is consistent with a previous study by Segura-Jiménez et al. [35].

Finally, we analyzed which ACR fibromyalgia criteria (1990c vs. m-2010c) better discriminate the fibromyalgia symptomatology. The effect size observed for the tender points were quite larger with the 1990c than the m-2010c, which was expected. However, the effect sizes in the rest of symptoms were larger in favour of the m-2010c. The 1990c is predominantly based on the tender points, while the m-2010c amended preliminary diagnoses, taking into account the complex and multidimensional nature of the disease, gives relevance to the systemic symptom-based condition rather than the previous peripheral pain-defined condition. In line with our present results, Segura-Jiménez et al. [37] reported that the m-2010c was more strongly associated with the impact of fibromyalgia, health-related quality of life, general fatigue and depression, than the 1990c. Although, they recommended the combination of both criteria because this approach showed higher sensitivity and accuracy for the fibromyalgia diagnosis than both criteria by separate [37]. Likewise, they observed that the combination of the 1990c and the m-2010c seems useful to identify different subgroups of fibromyalgia patients [38].

The present study reinforces the importance of implementing fitness testing (i. e., cut-off points) as a complementary tool for the diagnosis and monitoring of fibromyalgia in clinical setting [3–5, 26]. This evaluation does not provide diagnoses per se, and should not replace the ACR fibromyalgia criteria; however, it might be used as a screening element to discriminate the severity of major fibromyalgia symptoms and health-related quality of life. Particularly, the arm curl and the 30-s chair stand tests, which are those that best discriminated these symptoms, have simple procedures, inexpensive equipment, do not require any particular training, it can be performed in any room without special requirements, and the time required for each test is only 30-s sec. Future studies are necessary in order to assess the ability of fitness testing in the response of pharmacological or non-pharmacological interventions aimed to improved the fibromyalgia symptoms.

Limitations and strengths of the study

This study had some limitations. First, the cross-sectional design of the study precludes determining causality. Second, the study was performed only with women, and future studies should focus on men with fibromyalgia. It would be also interesting to replicate this study with other pain conditions such as rheumatoid arthritis, in order to corroborate the ability of fitness testing to discriminate between diverse pain-related diseases. Third, most of the fibromyalgia symptom variables were assessed using self-reported instruments. Although inadvertent (e. g., inaccurate recall) or intentional (e. g., influenced by social desirability), misreported answers are feasible. Nevertheless, it must to be noted that all of the questionnaires used have shown to be reliable and valid in this population. Finally, the fitness cut-off points may erroneously classify people with fibromyalgia when they are healthy, and vice-versa. On the other hand, the sample size included in this study is relatively large, and recruitment was conducted in all the provinces of southern Spain (Andalusia) and according to proper sample size calculation to achieve an optimal power. Finally, the consequent sample size was large enough to allow us analyzing the results by age groups.

Conclusions

The use of fitness cut-off points can be valuable to discriminate the severity of major fibromyalgia symptoms and health-related quality of life, and therefore, may be used as a complementary diagnosis tool for clinicians. The arm-curl and the 30-s chair stand cut-off points were the ones that better discriminated the severity of the symptoms in all age groups. Given that the m-2010c discriminated the polysymptomatic distress condition of fibromyalgia better than the 1990c, we suggest that the combination of the m-2010c together with the arm-curl and 30-s chair stand tests can be used in clinical settings as a quick diagnosis.

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Conflict of interests

The authors have no conflicts of interest to declare.

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