

# Impact of adding a cognitive task while performing physical fitness tests in women with fibromyalgia

## A cross-sectional descriptive study

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### Abstract

Fibromyalgia symptoms cause a significant reduction in the ability to perform daily life activities. These activities often require the ability to perform more than 1 task at the same time.

The aim was to investigate how the addition of a cognitive task modifies the performance in physical fitness tests in fibromyalgia and healthy controls.

A total of 61 women participated in this study, 31 of them diagnosed with fibromyalgia by a rheumatologist. They performed 3 physical fitness tests (arm curl, handgrip, and 10-steps stair tests) in 2 conditions:

- regular (single task [ST]) and
- while thinking in 3 words that were given before each test and had to be recalled and verbalized after the execution of each test (dual task).

The dual task cost was calculated as the difference between the performances in the regular and dual-task (DT) conditions.

Healthy controls obtained significantly better results than fibromyalgia in both, dual and single-task conditions. Women with fibromyalgia significantly decreased the performance in the 10-steps stair test when a cognitive task was added. Between-group differences in the dual-task costs (DTC) were not found.

Women with fibromyalgia showed lower physical performance than healthy controls in both, single and dual task conditions. In addition, differences between single and dual task conditions were observed in the 10-steps stair test in women with fibromyalgia. This could be related with a reduction in the ability to perform daily life activities. However, results regarding DTC indicate that both groups may be similarly influenced by the addition of a secondary cognitive. Thus, further research with different difficulty levels of DT conditions is needed in fibromyalgia.

**Abbreviations:** BMI = body mass index, DT = dual-task, DTC = dual-task cost, EQ-5D-5L = 5-level EQ-5D version, FIQ = fibromyalgia impact questionnaire, GDS = Geriatric Depression Scale, HRQoL = Health-Related Quality of Life, ICC = Intraclass Correlation Coefficient, SPSS = Statistical Package for Social Sciences, ST = single task, VAS = visual analog scale.

**Keywords:** cognitive function, cognitive performance, dual-task, fibromyalgia

### 1. Introduction

Fibromyalgia is a chronic syndrome characterized by widespread pain. Fatigue, stiffness, sleep disturbance, affective, and cognitive problems<sup>[1]</sup> are the most frequent associated symptoms, reducing

the ability to perform daily life activities<sup>[2]</sup> and diminishing the quality of life of fibromyalgia patients.<sup>[3]</sup>

Daily life activities are not commonly presented as a single task (ST), but requiring the ability to perform additional tasks at the

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same time (dual-task [DT]), such as walking while talking.<sup>[4]</sup> Thus, DT is defined as the execution of 2 actions at the same time; that is, performing motor-cognitive, cognitive-cognitive, or motor-motor tasks simultaneously. Interestingly, Lacour, Bernard-Demanze, Dumitrescu<sup>[5]</sup> reported 3 different DT performance models:

- 1) The cross-domain competition model, where posture control and cognitive activity compete for attentional resources in dual-task conditions<sup>[6]</sup>;
- 2) The U-shaped interaction model, where physical performances can be improved or diminished depending on the difficulty of the secondary task; and
- 3) The task prioritization competition model, where it is predicted that older adults prioritize postural stability and balance to cognitive performance in dual-task conditions.

Furthermore, a reduced ability to perform DT and the consequent increased dual-task cost (DTC) has been associated with normal aging and also with Alzheimer's disease and mild cognitive impairment.<sup>[7–10]</sup> Some studies have investigated this in chronic pain.<sup>[11–13]</sup> Hamacher et al<sup>[11]</sup> studied the effect of adding a cognitive task in gait variability, concluding that chronic pain reduced motor-cognitive DT performance. Sherafat et al<sup>[12]</sup> studying the effect of adding a secondary task on postural and cognitive performance, concluded that postural task performance is attenuated by cognitive load. Regarding gait and biomechanical parameters, adding a cognitive task reduced both postural sway and trunk stiffness, which could be due to the distracting effect of the secondary task.<sup>[13]</sup> To the best of our knowledge, only 4 studies<sup>[14–17]</sup> have investigated DT in fibromyalgia patients. Two studies reported significant influence of adding a dual-task, showing a decrease in physical and cognitive performance.<sup>[14,15]</sup> Sempere-Rubio et al<sup>[15]</sup> showed that postural control worse during dual-task condition. Interestingly de Gier et al<sup>[14]</sup> stated that baseline pain may determine the physical performance the patient will do. The other 2 articles, did not report significant differences between single and dual-task condition. One of them,<sup>[17]</sup> studying the hypervigilance for somatosensory signals under single and dual-task condition, and another<sup>[16]</sup> reporting insufficient postural control in fibromyalgia patients compared with controls, but without significant differences between single and dual-task conditions.

Given the lack of scientific knowledge about the influence of adding a DT in fibromyalgia patients, the present study aims to investigate how the addition of a cognitive task modifies the performance in physical fitness tests in fibromyalgia and healthy controls.

## 2. Materials and methods

### 2.1. Study design

This cross-sectional study compares between 2 groups (women with fibromyalgia and women without fibromyalgia) performing physical fitness tests with and without a secondary cognitive task.

### 2.2. Participants and settings

The Extremadura Association of Fibromyalgia (AFIBROEX) in Cáceres (Spain) recruited women with fibromyalgia by telephone calls. All had been diagnosed by a rheumatologist, according to the American College of Rheumatology's criteria.<sup>[1]</sup> Participants with neurological diseases, psychiatric diagnose (i.e. schizophre-

nia or substance abuse) or neurodegenerative diseases were excluded. Women without fibromyalgia symptoms also participate in the present study as healthy controls, who lacked pain in the 6 months before enrollment and who were matched in terms of sex and age to the fibromyalgia participants were also selected (see Fig. 1).

All participants were verbally informed about the details of the study and they gave written informed consent to participate in the study. All procedures were approved by the University research ethics committee of the University of Extremadura (approval number: 62/1017) and were carried out in accordance with the Declaration of Helsinki.

A total of 61 women, divided into 2 groups (fibromyalgia and healthy controls), participated in this cross-sectional study (see Table 1).

### 2.3. Outcome measurements

A standardized interview was fulfilled by the participants, assessing different data such as age, body mass index (BMI) or pain using a visual analog scale (VAS). Moreover, standardized tests were also completed by the participants.

The 15-items Geriatric Depression Scale (GDS)<sup>[18]</sup> is an instrument designed as a self or interviewer-administered test, addressing depressive symptoms with a simple yes/no format. This questionnaire allows us to classify which participants are suffering from depression symptoms. It was administered in the Spanish version.<sup>[19]</sup>

The 5-level EQ-5D version (EQ-5D-5L) is a widely used preference-based Health-Related Quality of Life (HRQoL) questionnaire<sup>[20]</sup> that consists of 5 dimensions (mobility, self-care, usual activities, pain or discomfort, and anxiety or depression), with 5 possible levels of problem.

Furthermore, participants also completed the Fibromyalgia Impact Questionnaire (FIQ)<sup>[21]</sup> in the Spanish version.<sup>[22]</sup> It is a specific measure to assess pain and disease impact in this population. This is a 10-item instrument with 3 domains: function, overall impact, and symptoms.

After these questionnaires were completed, participants performed 3 fitness tests: arm curl test, handgrip with their dominant hand, and walking up stairs.

The arm curl test quantifies the number of repetitions that the patient is able to lift a hand weight (2.3 kg) in 30 seconds. After familiarization, 1 trial with the dominant hand was performed.<sup>[23]</sup> Also, handgrip strength was measured using a hand dynamometer (Takei TKK 5401 Digital Handgrip Dynamometer, Tokyo Japan). Participants had to squeeze the dynamometer with an optimal grip-span. The better of 2 attempts for the dominant hand was used in the analyses.<sup>[23]</sup> In women with fibromyalgia, a previous study reported excellent reliability for the arm curl test and the handgrip strength, with 0.92 (0.88–0.95) and 0.95 (0.92–0.97) as Intraclass Correlation Coefficient (ICC) respectively.<sup>[24]</sup>

Additionally, the 10-step stair climbing test was employed. Participant had to climb as fast as possible 10-step stair. This test was previously used as a physical test in fibromyalgia patients<sup>[25–27]</sup> with excellent reliability (ICC=0.972).<sup>[27]</sup>

Participants performed these physical tests starting randomly with the ST or DT conditions, after a familiarization for each of the test. The simultaneous task consisted of remembering 3 random unrelated words.<sup>[28]</sup> These words were repeated 3 times before test and the participant had to recall it immediately before they finished each fitness test. Participants were encouraged to

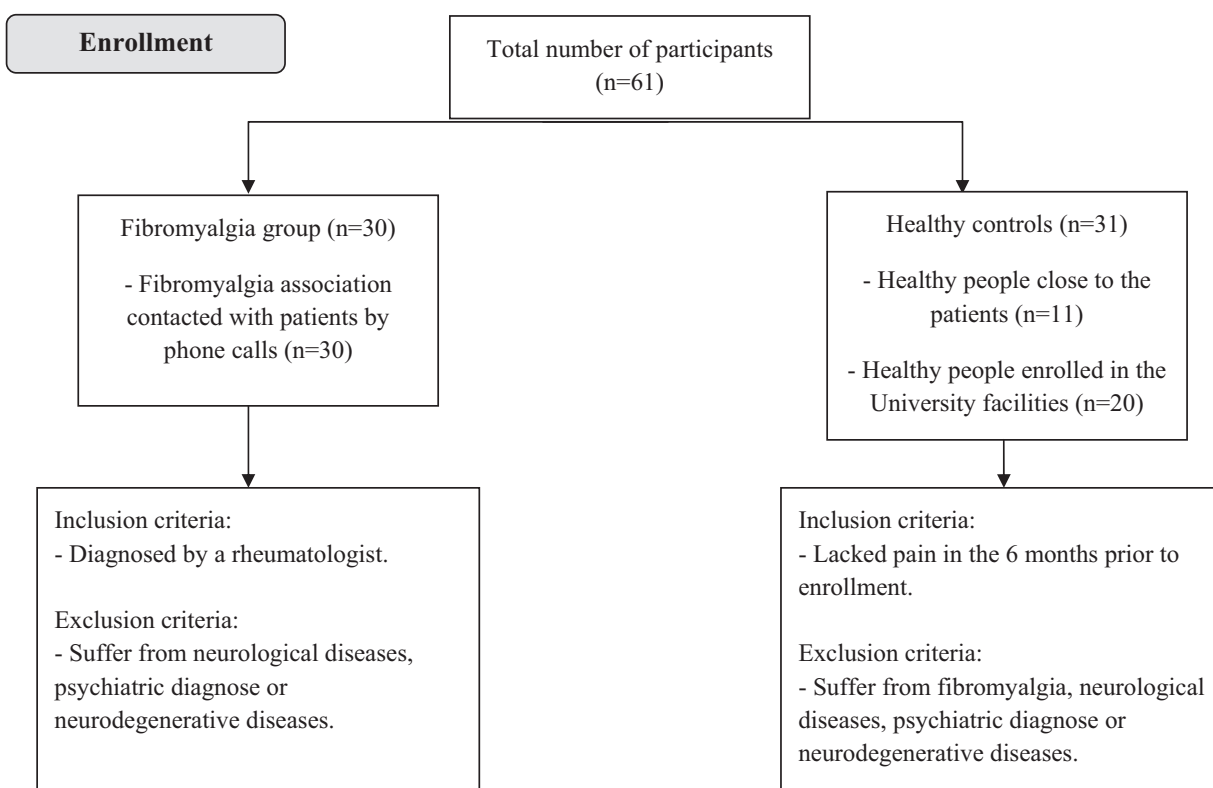


Figure 1. Flow chart of participant selection processes.

think in the words at the same time they were doing the fitness tests. The numbers of correct and wrong answers were registered. This allowed us to quantify not only the physical, but also the cognitive performance in the tests. A participant who correctly recalled all the words obtained a maximum score of 9 (i.e., 3 tests and 3 words for each test).

2.4. Statistical analysis

The Statistical Package for Social Sciences (SPSS) statistical package (version 20.0; SPSS, Inc., Chicago, IL) was used to analyze the data. Parametric and non-parametric test were conducted based on the results of Shapiro–Wilk and Kolmogorov–Smirnov tests.

Table 1

Demographic, pain and fitness test comparisons between patients with fibromyalgia and the healthy controls.

Variable	Fibromyalgia group (Mean ± SD)	Distribution of fibromyalgia group	Healthy controls (Mean ± SD)	Distribution of healthy group	Degrees of freedom	Value of contrast (t or Z)	P value	Effect size
Sample size	30		31					
Age (years)	55.27 ± 9.49	0.049	50.84 ± 8.51	0.032	—	−1.495	.135	−0.19
BMI (kg/m <sup>2</sup> )	27.08 ± 4.17	0.359	24.70 ± 3.96	0.945	58	2.268	.027	0.59
GDS	5.40 ± 2.73	<0.001	3.03 ± 2.09	0.342	—	−3.467	.001*	−0.44
EQ-5D-5L	0.68 ± 0.15	<0.001	0.96 ± 0.06	0.061	—	−6.531	<.001*	−0.84
VAS of pain (0–10)	59.03 ± 18.68	<0.001	12.22 ± 17.83	0.247	—	−5.893	<.001*	−0.75
FIQ	48.82 ± 15.74	0.231	—	—	—	—	—	—
ST Arm curl (rep)	16.28 ± 4.71	0.057	21.17 ± 4.27	0.369	59	−4.251	<.001*	−1.09
DT Arm curl (rep)	15.93 ± 3.53	0.625	21.39 ± 4.59	0.501	59	−5.193	<.001*	−1.33
ST Handgrip (kg)	24.04 ± 4.70	0.407	25.92 ± 3.76	0.028	—	−1.710	.087	−0.22
DT Handgrip (kg)	23.79 ± 3.76	0.170	25.81 ± 3.79	0.029	—	−2.078	.038	−0.27
ST 10- steps stairs (s)	4.93 ± 1.12	0.016	3.77 ± 0.61	0.228	—	−4.343	<.001*	−0.57
DT 10-steps stairs (s)	5.09 ± 1.89	0.024	3.82 ± 0.70	0.305	—	−4.472	<.001*	−0.57
Arm curl DTC	0.35 ± 2.03	0.162	−0.21 ± 2.37	0.069	59	0.989	.327	0.25
Handgrip DTC	0.25 ± 2.68	0.885	0.11 ± 2.98	<0.001	—	−0.852	.394	−0.11
Steps stairs DTC	−0.16 ± 0.36	0.025	−0.05 ± 0.28	0.008	—	−0.808	.419	−0.10

Independent t test or Mann–Whitney U was conducted depending on the distribution (variables with a P value lower than .05 were considered for a non-parametric analysis). Effect sizes correspond to Cohen's d (parametric) and r (non-parametric) where appropriate.

\* Significant differences even applying Bonferroni correction for multiple comparisons.

BMI=body mass index, DT=dual-task, EQ-5D-5L=EuroQol-5 dimensions-5 levels, FIQ=fibromyalgia impact questionnaire, GDS=geriatric depression Scale, kg=kilogram, rep=repetitions, s=seconds, SD=standard deviation, ST=single-task, VAS=visual analog scale.

Independent *t* test or Mann–Whitney *U* test was conducted to examine differences between groups (fibromyalgia vs Pain-free controls) in the fitness tests, age, BMI, GDS, EQ-5D-5L, VAS for pain, and FIQ. Additionally, DTC was calculated for each test (DTC=single task—DT result). Between-group comparison in DTC allowed us to check for interaction effects between DT and groups.

Furthermore, paired samples *t* test or Wilcoxon signed-rank test were conducted to examine differences between the 2 conditions, with and without cognitive task in the fitness test.

Effect sizes, Cohen's *D*, and *r* were calculated for parametric and non-parametric tests respectively.<sup>[29]</sup> Alpha level was corrected using Bonferroni adjustment to avoid the increase of type I error.

### 3. Results

Thirty-one women with fibromyalgia and thirty pain-free controls completed the study.

Independent *t* test showed that healthy controls obtained significant better results than fibromyalgia group in both, ST and DT (see Table 1). In the arm curl test, healthy controls obtained significantly more repetitions in DT (*P* value < .001) and ST (*P* value < .001) than fibromyalgia group. Also, in handgrip test, fibromyalgia group showed less strength than healthy subjects in DT (*P* value = .038), but not in ST (*P* value = .087). Furthermore, in 10-step stair test, healthy controls climbed the stairs significantly faster than fibromyalgia group in both, DT (*P* value < .001) and ST (*P* value < .001). In addition, interaction between DT condition and group was analyzed comparing between-group differences in DTC. This revealed no significant differences in any of the tests (arm curl, handgrip and 10-step stair tests). In line with these results, groups did not statistically differ in age *P* value = .135 (see Table 1).

Paired samples *t* test comparing differences between DT and ST in both groups revealed a significant increase in the 10-step stair in fibromyalgia group (*P* = .004) (see Table 2). No significant differences were found in the other fitness tests.

### 4. Discussion

The present study investigated how the addition of a cognitive task modifies the performance in physical fitness test in

fibromyalgia and healthy controls. Differences between groups were observed in the fitness tests in both DT and ST conditions.

Results showed differences between healthy controls and fibromyalgia patients. Significantly better results were obtained by healthy controls in arm curl and 10-step stair tests in DT and ST conditions, and also in handgrip in DT condition. These results, along with the corresponding effect sizes, may confirm that fibromyalgia patients have diminished physical fitness and this reduction is even higher when a cognitive task is added. This might be closely related with the reduction in the ability to perform daily life activities showed in people suffering with fibromyalgia.<sup>[2]</sup> Although previous research showed reduced physical performance in this population compared with healthy controls in walking up stairs while carrying a load<sup>[25]</sup> and sit-to-stand from a chair<sup>[30]</sup> (both tests highly related with daily live activities), this is the first study where performance in DT is compared between fibromyalgia and healthy controls. Furthermore, previous studies in chronic pain have reported similar results, such as Sherafat et al<sup>[12]</sup> who reported that chronic low back pain patients showed poorer performance in this type of tasks compared with healthy controls. In this regard, Van Daele et al<sup>[13]</sup> in chronic low back pain patients, observed less postural sway and less trunk stiffness while sitting on an unstable seat as a consequence of DT.

Regarding within groups differences between DT and ST, our study showed that only in 10-step stair test in fibromyalgia patients physical performance was significantly reduced by DT interference. Previous studies have reported that DT diminished physical performance in both healthy<sup>[31]</sup> and chronic pain patients.<sup>[32]</sup> Our results are consistent with those observed by de Gier et al<sup>[14]</sup> who observed physical performance reduction caused by adding a secondary task. Furthermore, Hemmati et al<sup>[32]</sup> showed that physical performance was impaired under DT conditions in low back pain patients. Similar results were also reported by Klotzbier and Schott<sup>[33]</sup> in a study where younger, older adults and mild cognitive impairment patients were evaluated under DT conditions. Authors reported interference (a reduction in the performance) by the secondary task in the condition with low cognitive load.<sup>[30]</sup> These results could be explained by the cross-domain competition model, where physical performance and cognitive activity compete for

**Table 2**

**Comparison between dual and single-task conditions in fibromyalgia women and healthy controls.**

Fitness test	Group	Dual-Task condition (Mean ± SD)	Single-Task condition (Mean ± SD)	Distribution of the sample	Within group comparison			Effect Size
					Degrees of Freedom	Value of the contrast (t or Z)	<i>P</i> value	
Arm Curl (reps)	Fibromyalgia (n=30)	15.93 ± 3.53	16.28 ± 4.71	0.162	29	0.942	.354	−0.08
	Healthy (n=31)	21.39 ± 4.59	21.17 ± 4.27	0.069	30	−0.493	.05	
Handgrip (kg)	Fibromyalgia (n=30)	23.79 ± 3.76	24.04 ± 4.70	0.885	29	0.505	.617	−0.06
	Healthy (n=31)	25.81 ± 3.79	<0.001	—	−0.833	0.405	−.15	
10- step stair (s)	Fibromyalgia (n=30)	5.09 ± 1.89	4.93 ± 1.12	0.025	—	−2.870	.004*	−0.52
	Healthy (n=31)	3.82 ± 0.70	3.77 ± 0.61	0.008	−1.600	0.109	−.29	

Wilcoxon signed-rank test or *t* test were developed depending on the distribution (variables with a *P* value lower than .05 were considered for a non-parametric analysis). Effect sizes correspond to Cohen's *D* (parametric) and *r* (non-parametric) where appropriate.

\*Significant even applying Bonferroni correction for multiple comparisons.

kg = kilogram; rep = repetitions; s = seconds.



attentional resources.<sup>[5]</sup> Thus, when 2 tasks demand attention, performance of at least one of them is reduced.<sup>[5,6,34,35]</sup> Given that most activities of daily living imply the simultaneous performance of physical and cognitive tasks, the evaluation of DT is of interest to researchers and clinicians.

One potential limitation of our study was the low-complexity cognitive task used, which could limit the presence of significant between groups differences in DTC. This may cause certain ceiling effect in that variable, which may influence the results of this study. Thus, results involving that variable should be interpreted with caution. In addition, duration of the fitness tests may be relevant to assess the influence of a memory-based cognitive task. All 3 tests used in this study lasted 30 seconds or less, thus, future studies should evaluate longer tests to investigate the interference of memory-related tasks on physical performance. Moreover, cognitive function in single-task condition was not assessed and could have helped to determine if subjects with fibromyalgia adopt a cross-domain competition model or a prioritization model as older adults do.<sup>[5]</sup> Thus, future studies should evaluate both cognitive and motor functions in single-task condition to determine whether people with fibromyalgia adopt 1 or another model. Lastly, our sample was only composed by women, thus we cannot generalize the results to male fibromyalgia patients.

## 5. Conclusions

Women with fibromyalgia showed lower performance in physical fitness tests under single and dual-task conditions compared with pain-free women. In addition, differences between single and dual-task were observed in the 10-step stair test in fibromyalgia group. However, taking into account the between-group comparisons of the DTC, fibromyalgia women, and healthy controls are influenced by DT in the same way.

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