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ORIGINAL ARTICLE

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Longitudinal association of sedentary time and physical activity with pain and quality of life in fibromyalgia

Blanca Gavilán-Carrera[1,2,3,4] | **Manuel Delgado-Fernández**[3,4] | **Inmaculada C. Álvarez-Gallardo**[5,6] | **Pedro Acosta-Manzano**[3,4,7] | **Milkana Borges-Cosic**[5,8] | **Fernando Estévez-López**[9] | **Alberto Soriano-Maldonado**[10,11] | **Ana Carbonell-Baeza**[6,12] | **Virginia A. Aparicio**[4,13,14] | **Víctor Segura-Jiménez**[2,5,6,15]

[1]Departamento de Medicina Interna, Hospital Universitario Virgen de las Nieves, Granada, Spain

[2]Instituto de Investigación Biosanitaria ibs.GRANADA, Granada, Spain

[3]PA-HELP "Physical Activity for Health Promotion, CTS-1018" research group. Department of Physical Education and Sports, Faculty of Sports Science, University of Granada, Granada, Spain

[4]Sport and Health University Research Institute (IMUDS), University of Granada, Granada, Spain

[5]GALENO research group, Department of Physical Education, Faculty of Education Sciences, University of Cádiz, Cadiz, Spain

[6]Instituto de Investigación e Innovación Biomédica de Cádiz (INiBICA), Cadiz, Spain

[7]Institute of Human Movement Science, Sport and Health, University of Graz, Graz, Austria

[8]Department of Physical Education, Faculty of Education Sciences, University of Cádiz, Puerto Real, Spain

[9]Department of Social and Behavioral Sciences, Harvard T. H. Chan School of Public Health, Massachusetts, Boston, USA

[10]Department of Education, Faculty of Education Sciences, University of Almería, Almería, Spain

[11]Sport Research Group (Cts-1024), Cernep Research Center, University of Almería, Almería, Spain

[12]MOVE-IT Research Group and Department of Physical Education, Faculty of Education Sciences, University of Cádiz, Puerto Real, Spain

[13]Department of Physiology, School of Pharmacy, University of Granada, Granada, Spain

[14]Institute of Nutrition and Food Technology (INYTA), Biomedical Research Centre (CIBM), University of Granada, Granada, Spain

[15]UGC Neurotraumatología y Rehabilitación, Hospital Universitario Virgen de las Nieves, Granada, Spain

Correspondence
Manuel Delgado-Fernández, Faculty of Sport Sciences, Carretera de Alfacar, S/N 18071 Granada, Granada, Spain.
Email: manueldf@ugr.es

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Objective: To analyze changes over time and the predictive value of baseline and changes of sedentary time (ST) and physical activity (PA) on pain, disease impact, and health-related quality of life (HRQoL) at 2- and 5-year follow-up in women with fibromyalgia.

Methods: This is a longitudinal and exploratory study with three time points. A total of 427 women with fibromyalgia (51.4 ± 7.6 years) were followed after 2 (n = 172) and 5 years (n = 185). ST and PA (light and moderate-to-vigorous [MVPA]) were assessed using triaxial accelerometers. Pain, disease impact, and HRQoL were measured using: pressure pain threshold, the pain subscale of the revised fibromyalgia impact questionnaire (FIQR), the bodily pain subscale of the 36-item short-form health survey (SF-36), a visual analog scale (VAS), the FIQR, and the SF-36 physical and mental components.

Development Fund; European Social Fund

Results: Over 5 years, pressure pain threshold, ST, light PA, and MVPA variables were worsened, while FIQR and SF-36 variables were improved (*Cohen's d* < 0.1–0.3). Baseline ST or light PA were not associated with future outcomes, whereas greater MVPA at baseline was associated with better SF-36 bodily pain at 5-year follow-up ($\beta = 0.13$). Reducing ST and increasing light PA were associated with better bodily pain ($\beta = -0.16$ and 0.17, respectively) and SF-36 physical component ($\beta = -0.20$ and 0.17, respectively) at 5-year follow-up. Increasing MVPA was associated with less pain (pressure pain threshold, VAS, and FIQR-pain) and better SF-36 physical component at 2- and 5-year follow-up (β's from −0.20 to 0.21).
Conclusions: Objectively measured variables slightly worsened over years, while for self-reported outcomes there was a trend for improvement. Reductions in ST and increases in light PA and MVPA were associated with better HRQoL at 5-year follow-up, and increases in MVPA were additionally associated with better pain and HRQoL at 2-year follow-up.

KEYWORDS
accelerometry, chronic pain, GT3X, sitting, well-being

1 | INTRODUCTION

Fibromyalgia is considered a central sensitivity syndrome principally characterized by chronic widespread pain,[1] and a wide-ranging variety of symptoms. Most recent studies analyzing the clinical course of the disease suggest that fibromyalgia symptoms seem to be persistent and fluctuate over time,[2–5] with a slight trend toward improvement.[2,4] Management of this heterogeneous disease[6] remains a challenge, but there is a general agreement on the importance of patient education and nonpharmacological therapies in the initial stage of treatment.[7]

Sedentary time (ST) and daily physical activity (PA) are fundamental modifiable health behaviors. In fibromyalgia, lower ST and greater levels of PA are associated with better health outcomes including pain,[8–10] disease impact,[8,11] or general health-related quality of life (HRQoL),[11,12] among others.[8,13,14] However, psychological barriers such as fear of movement are highly prevalent in this population.[15] Indeed, patients have low levels of light[16] and moderate-to-vigorous PA (MVPA),[16–18] spending most of their day in sedentary behaviors.[16] A growing body of literature in adult population evidenced the detrimental effects of ST on health[19] and reducing ST has become a public health priority.[19] However, evidence examining how the worrying levels of ST and PA in fibromyalgia evolve over time or, their influence on health outcomes, is scarce.

A short-term follow-up (12 weeks) study showed that fibromyalgia patients that increased and sustained higher volumes of moderate PA appear to experience less pain compared to those not increasing moderate PA.[20] Maintenance of adequate PA levels has been shown to be predictive of pain, fatigue, and physical fitness in fibromyalgia patients at 4.5-year follow-up.[21] Another study, however, suggested that exercising regularly did not influence health parameters at 26-year follow-up in this population.[3] The evidence available so far relied on self-reported measures (which typically have poor validity[22]), mainly analyzed the predictive value of baseline PA, and completely omitted the potential role of ST. A better understanding of whether these modifiable behaviors are associated with patients' future health, and whether changes in both ST and PA are associated with changes in patients' health will enhance disease-specific recommendations for ST and PA in this population.

This study aimed to examine: (i) changes in ST, light PA, MVPA, pain, disease impact, and HRQoL at 2- and 5-year follow-up, (ii) the predictive value of baseline ST, light PA, and MVPA levels on pain, disease impact, and HRQoL at follow-up, and (iii) the associations of changes of ST, light PA, and MVPA with pain, disease impact, and HRQoL at follow-up. As an ancillary aim, because the relationship between PA and health status could be bidirectional,[23] it was additionally explored whether pain, disease impact, and HRQoL predicted future levels of ST, light PA, and MVPA.

2 | METHODS

2.1 | Participants

These data are derived from the al-Ándalus project, which aimed to improve the diagnosis and characterization of

fibromyalgia and to identify prognostic factors of the disease. In this project a province-proportional recruitment of fibromyalgia patients from Southern Spain was planned.[24] In 2012, (baseline) patients were contacted through fibromyalgia associations, email, and social media. In 2014 and 2017, the same cohort was contacted for follow-up evaluations. Inclusion criteria for the current study were (i) to be previously diagnosed by a rheumatologist and meet the modified 2011 American College of Rheumatology (ACR) fibromyalgia criteria (Widespread Pain Index [WPI] ≥7 and the Symptom Severity [SS] ≥5, or the WPI is 3–6 and the SS ≥ 9),[25] (ii) not to have either acute, terminal illness, or severe cognitive impairment (Mini Mental State Examination [MMSE] score < 10[26]), and (iii) to be ≤65 years old.

All women provided written informed consent. The study was approved by the Ethics Committee of the Hospital Virgen de las Nieves, Granada (Spain).

2.2 | Procedures

A similar assessment process was carried out at three time points. On day 1, the MMSE was assessed and participants filled out self-reported sociodemographic data and drug consumption questionnaires. Tender points, anthropometry, and body composition were also assessed. Questionnaires related to disease impact, pain, and HRQoL were given to patients to be completed at home. Two days later, patients returned to the laboratory, where questionnaires were collected and checked by the researchers. After that, participants received instructions on how to complete the sleep diary, and the accelerometers were provided to them. The accelerometers and sleep diaries were returned to the research team 9 days later.

2.3 | Measures

2.3.1 | Physical activity and sedentary time

Participants wore a triaxial accelerometer GT3X+ (Actigraph) on the hip for 9 consecutive days, 24 h/day except for water-based activities. Data were collected using the default mode filter option, at a rate of 30 Hz and stored at an epoch length of 60 s.[27,28] Data from day 1 (to avoid reactivity) and day 9 (the day of device return) were excluded from the analyses. A total of 7 continuous days with at least 10 valid hours/day were required for inclusion. Data download, reduction, cleaning, and analyses were conducted using the manufacturer's software (ActiLife desktop, version 6.11.7).

Accelerometer wear time was calculated by subtracting sleeping time (reported in sleep diaries by patients) and non-wear periods. Non-wear periods were considered to be any bouts of 90 continuous minutes (30-min small-window length and 2-min skip tolerance) of 0 counts.[29] PA intensity levels were calculated based upon recommended PA vector magnitude cut points: light (200–2689 counts per minute{cpm}), moderate (2690–6166 cpm), and vigorous (>6167 cpm). ST was estimated as the time accumulated below 200 cpm during periods of wear time.[27,28] Participants presented extremely low values of vigorous PA (0.4 min/day); therefore, vigorous PA was excluded from all of the analyses and MVPA (>2690 cpm) was used instead.

2.4 | Pain-related measures

2.4.1 | Pressure pain threshold

The 18 tender points proposed in the 1990 ACR criteria for the classification of fibromyalgia[30] were evaluated using a standard pressure algometer (FPK 20; Wagner Instruments). Two alternative measurements at each tender site were performed, and the mean score was recorded. The total number of positive tender points was recorded, considering a positive tender point when the patient felt pain at pressure ≤4 kg/cm^2. The pressure pain threshold was defined as the average pressure threshold across the 18 tender points.

2.4.2 | Pain intensity

Pain intensity was assessed with a visual analog scale (VAS-pain). This tool consists of a 10 cm horizontal line on which participants mark pain intensity at the present moment between the extremes: 0 (representing no pain) and 10 (representing the worst pain ever experienced). Clinical pain intensity was also assessed with an item from the revised version of the Fibromyalgia Impact Questionnaire (FIQR-pain).[31] Participants were asked to rate their level of pain in the past 7 days on a numeric rating scale (range 0–10), where higher values represent higher pain intensity.

2.4.3 | Pain magnitude and interference on quality of life

Pain magnitude and interference over the past 4 weeks were assessed with the Bodily Pain section from the Short Form 36 health survey (SF-36).[32] The scores range

from 0 to 100, where a higher score represents lower pain.

A global measure of pain was calculated, as described elsewhere,[33] as the mean of the following z-scores [(value-mean)/SD]: (i) VAS-pain, (ii) pressure pain threshold (using inverted score), (iii) FIQR-pain, and (iv) SF-36 bodily pain (using inverted score). Greater scores in the global measure of pain indicated higher pain experienced.

2.4.4 | Disease impact

The FIQR was used, in which overall disease impact is assessed through a wide range of symptoms and comorbidities.[31] This is a valid self-administered questionnaire consisting of 21 items (rated 0–10). FIQR total score ranges from 0 to 100 with higher scores indicating a greater impact of fibromyalgia.

2.4.5 | Health-related quality of life

The Spanish version of the SF-36[32] was used to assess HRQoL. The SF-36 is a generic instrument that has been demonstrated to have good reliability and validity in chronic pain patients.[34] It contains 36 items grouped into 8 dimensions and 2 summary components: the physical and the mental components. Only the 2 summary components were used to describe HRQoL for the present study, scoring from 0 (worst possible health status) to 100 (the best possible health status).

2.5 | Other variables

2.5.1 | Anthropometry and body composition

A portable eight-polar tactile-electrode impedance analyzer (InBody R20, Seoul, Korea) was used to measure weight (kg) and estimate fat percentage. Participants were asked not to shower, not to practice intense PA, and not to ingest large amounts of fluid and/or food in the 2 h before the measurement. Patients were required to remove all clothing (except underwear) and metal objects during the assessment.

2.5.2 | Socio-demographic and clinical data

All participants filled out a socio-demographic and clinical data questionnaire to gather information related to age, marital status, educational level, occupational status, analgesics, antidepressants, and sleeping medication consumption. Participation in physical therapy and psychological therapy (yes/no) was also registered.

2.6 | Statistical analyses

To examine the longitudinal changes in all study variables, paired t-tests were performed for Δ baseline to 2-year follow-up; Δ 2- to 5-year follow-up; and Δ baseline to 5-year follow-up. Cohen's d was used to calculate the standardized effect size and was interpreted as small (~0.2), medium (~0.5), or large (~0.8 or greater).

To analyze the predictive value of ST, light PA, and MVPA at baseline on pain, disease impact, and HRQoL at follow-up, separate linear regression models were built introducing: (i) pain, disease impact, or HRQoL (outcomes) at each time point (2- or 5-year follow-up) as the dependent variable and (ii) baseline values of the outcome and the predictor of interest (ST, light PA, or MVPA) as independent variables using the *enter* method. Age, fat percentage, antidepressant, analgesics, sleeping medication (yes/no), participation in physical therapy, or psychologist (yes/no) were included as covariates by introducing them as independent variables using the *stepwise* method. To analyze how changes over time in ST, light PA, and MVPA were associated with pain, disease impact, and HRQoL, this variable was subsequently added to the model. Therefore, 2 types of models were created introducing the following independent variables (predictors):

- Model 1 = outcome at baseline + ST, light PA, or MVPA at baseline (i.e., % of accelerometer wear time in ST, light PA, or MVPA) + covariates.
- Model 2 = model 1 + changes over time in ST, light PA, or MVPA.

As lower physical and mental health may also lead to reduced PA,[23] we additionally studied the opposite direction of the association. The percentage of accelerometer wear time in ST, light PA, and MVPA were entered as the dependent variables (outcomes) and 2 types of models were created introducing the following independent variables (predictors):

- Model 1 = outcome at baseline + health parameter of interest at baseline (i.e., pain, disease impact, or HRQoL) + covariates.
- Model 2 = model 1 + changes over time in the health parameter of interest.

No multicollinearity problems were found in the data (Variance Inflation Factor <1.5 in all models) and other assumptions of linear regression were met (linear relationship, normality, no autocorrelation, and homoscedasticity). Statistical analyses were performed using the Statistical Package for Social Sciences (IBM SPSS, version 22; Armonk, NY, USA). A two-tailed level of significance was set at $p < 0.05$ for all analyses.

3 | RESULTS

The flow diagram of participants is shown in Figure 1. Among the initially eligible participants with valid data at baseline ($n = 427$), a total of 172 and 185 participants attended 2- and 5-year follow-up, respectively. Table 1 provides an overview of participants' characteristics at each time point.

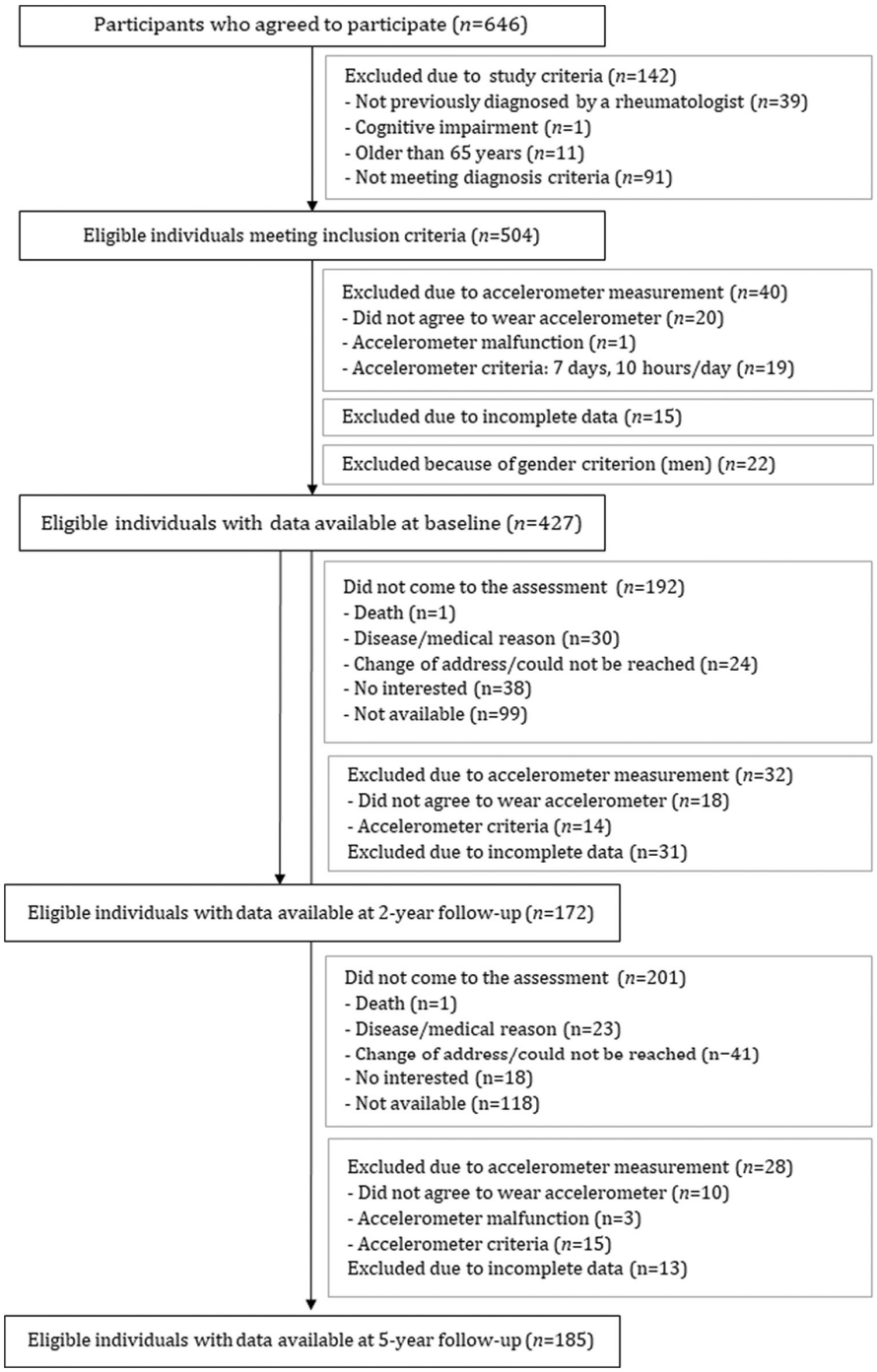

FIGURE 1 Flowchart diagram of participants included in the study.

TABLE 1 Descriptive characteristics of the participants at baseline, 2- and 5-year follow-up.

	Baseline		2-Year follow-up		5-Year follow-up	
	n = 427		*n* = 172		*n* = 185	
	Mean	SD	Mean	SD	Mean	SD
Age (years)	51.4	7.7	54.1	7.3	56.1	7.0
Weight (kg)	71.3	13.9	71.2	14.2	70.7	13.8
Body mass index (kg/m^2)	28.5	5.5	28.9	5.6	28.5	5.5
Fat percentage (%)	40.1	7.7	41.1	7.0	42.5	6.8
Total number of tender points (0–18)[a]	15.0	4.8	17.4	2.1	16.7	3.3
Disease impact, FIQR total (0–100)[a]	66.1	16.1	61.9	18.5	60.3	19.6
Pain-related variables						
Visual analog scale (0–10)[a]	6.3	2.3	5.9	2.4	5.9	2.5
Pressure-pain threshold (kg/cm^2)[b]	50.1	22.5	34.6	14.6	44.1	16.1
FIQR-pain (0–10)[a]	7.6	1.9	7.3	2.2	7.0	2.2
SF-36 bodily pain (0–100)[b]	20.2	14.3	25.4	18.1	24.3	17.4
Health-related quality of life						
SF-36 physical component (0–100)[b]	29.3	7.0	30.9	7.2	30.8	7.4
SF-36 mental component (0–100)[b]	34.8	11.0	36.0	11.9	37.9	12.6
Accelerometry variables						
Sedentary time (min/day)	465.0	105.7	455.0	104.5	481.5	101.1
Light PA (min/day)	414.0	95.4	422.4	100.5	399.6	100.5
MVPA (min/day)	43.3	29.8	42.5	28.5	38.3	26.9
	n	%	*n*	%	*n*	%
Marital status						
Married	321	75.2	133	77.3	143	77.3
Not married	106	24.8	39	22.7	42	22.7
Educational status						
Non-university	365	85.5	147	85.5	157	84.9
University	62	14.5	25	14.5	28	15.1
Occupational status						
Working	112	26.2	48	27.9	49	26.5
Not working	315	73.8	123	71.5	135	73.0
Medication for pain						
Pain (yes)	387	90.6	158	91.9	161	87.0
Depression (yes)	261	61.1	94	54.7	91	49.2
Sleeping (yes)	315	73.8	115	66.9	111	60.0
Treatment						
Physiotherapy (yes)	83	19.4	38	22.1	33	17.8
Phsychological (yes)	82	19.2	34	19.8	30	16.2
Time since diagnosis						
<1 year	29	6.8	10	5.8	10	5.4
Between 1 and 5 years	141	33.0	59	34.3	58	31.4
More than 5 years	249	58.3	100	58.1	112	60.5

Abbreviations: FIQR, Fibromyalgia Impact Questionnaire Revised; PA, physical activity; SF-36, 36-item Short-Form Health Survey; MVPA, moderate-to-vigorous physical activity.

[a]Greater scores indicate worse health status or higher pain.

[b]Greater scores indicate better health status or lower pain.

The signification values are provided in the *p* column.

Figure 2 shows the mean values of the outcomes and predictors in the study at each time point. Over 5 years, changes toward deterioration were found for fat percentage, the number of total tender points, and pressure-pain threshold (d between <0.1 and 0.3, all $p < 0.001$). Changes toward improvement were found for VAS-pain, FIQR-pain, FIQR total, SF-36 bodily pain, SF-36 physical component, and SF-36 mental component (d between 0.2 and 0.3, all $p < 0.01$). Over 5 years, ST increased ($d = 0.3$) and light PA ($d = 0.1$) and MVPA ($d = 0.3$) were reduced (all, $p < 0.01$).

Tables 2 and 3 show how ST and PA intensity levels (predictors) are associated with future disease impact, pain-related measures, and HRQoL (outcomes). No associations were found between ST or light PA at baseline with any outcomes at 2- or 5-year follow-up. Greater MVPA at baseline was associated with better SF-36 bodily pain scores at 5-year follow-up ($B = 0.73$, 95% CI = 0.05–1.41, $p = 0.037$).

Reducing ST was associated with better scores in SF-36 bodily pain ($B = -0.35$, 95% CI = −0.66, −0.04, $p = 0.028$) and SF-36 physical component ($B = -0.20$, 95% CI = −0.33, −0.07, $p = 0.003$) at 5-year follow-up. Increasing light PA was associated with better SF-36 bodily pain ($B = 0.42$, 95% CI = 0.08, 0.76, $p = 0.016$) and SF-36 physical component ($B = 0.17$, 95% CI = 0.03, 0.32, $p = 0.0019$) at 5-year follow-up. No associations were found between changes in ST or light PA and any outcome at 2-year follow-up, or other pain-related variables, disease impact, or SF-36 mental component at 5-year follow-up.

Increasing MVPA was associated with less pain in the VAS ($B = -0.20$, 95% CI = −0.35, −0.05, $p = 0.009$), the FIQR pain subscale ($B = -0.20$, 95% CI = −0.35, −0.05, $p = 0.009$), and the global pain index ($B = -0.04$, 95% CI = −0.08, −0.01, $p = 0.004$) and greater scores in the SF-36 physical component ($B = 0.66$, 95% CI = 0.20, 1.12, $p = 0.005$) at 2-year follow-up. Also, increasing MVPA was associated with better pressure pain threshold ($B = 1.19$, 95% CI = 0.18, 2.19, $p = 0.021$) and SF-36 physical component ($B = 0.60$, 95% CI = 0.17, 1.04, $p = 0.007$) at 5-year follow-up. No associations were found between changes in MVPA and other pain-related variables, disease impact, or SF-36 mental component at 2- or 5-year follow-up.

Tables S1–S3 show how pain-related measures, disease impact, and HRQoL (predictors) are related to future ST and PA (outcomes), revealing a bidirectional association between the variables. Figure S1 includes a summary of the exploratory associations found between ST, light PA, MVPA with pain, disease impact, and HRQoL in each direction.

4 | DISCUSSION

The findings of this study are that objectively measured variables (i.e., pressure pain threshold, ST, and PA) slightly changed toward less favorable values, whereas for self-reported outcomes (i.e., disease impact, reported pain, and HRQoL), there was a trend for improvement over a 2- and 5-year follow-up. Baseline levels of ST and PA did not generally predict future health outcomes, although higher MVPA at baseline was associated with better SF-36 bodily pain at 5-year follow-up. Reducing ST and increasing light PA was related to better HRQoL (SF-36 bodily pain and physical component) at 5-year follow-up. Overall, increasing MVPA was related to less pain and better physical HRQoL at 2- and 5-year follow-up. These results reinforce the potential role of daily activity, especially of moderate-to-vigorous intensity, as a predictor of health in fibromyalgia. Pain and HRQoL were also associated with future levels of ST and PA, revealing a bidirectional association between the studied variables. People with fibromyalgia with low PA and poor health could be at risk of further declines, stressing the relevance of strategies to jointly increase activity levels and manage symptomatology.

Several studies have previously assessed how fibromyalgia symptomatology evolvesover time.[2,4,35–39] Although symptoms are commonly persistent, a slight trend toward improvement in different self-reported outcomes has been described in previous longitudinal studies[2,4,35,36] over different periods of time (from 2 to 11 years). Other investigations reported no substantial change in health parameters[2,37–39] in a 6- to 11-year period, and fewer reported a worsening of pain.[36] Our findings demonstrated that symptom severity stay high over time and that the magnitude of the changes across different evaluations was small. Variables related to perceived health status (patient-reported outcomes) were slightly improved while other objectively measured health outcomes were slightly worsened. These findings could support the idea that patients tend to adapt and learn how to cope with the disease.[36]

FIGURE 2 Mean and standard deviation of the variables included in the study at baseline, 2-year, and 5-year follow-up. Changes over time were studied for: Δ baseline to 2-year follow-up, Δ 2- to 5-year follow-up; Δ baseline to 5-year follow-up. Cohen's d (d) was used to calculate the standardized effect size and was interpreted as small (~0.2), medium (~0.5), or large (~0.8 or greater). acc, accelerometer; FIQR, Fibromyalgia Impact Questionnaire; PA, Physical activity; PPT Pressure Pain Threshold; SF-36, 36-item Short-Form Health Survey; VAS, Visual Analog Scale.

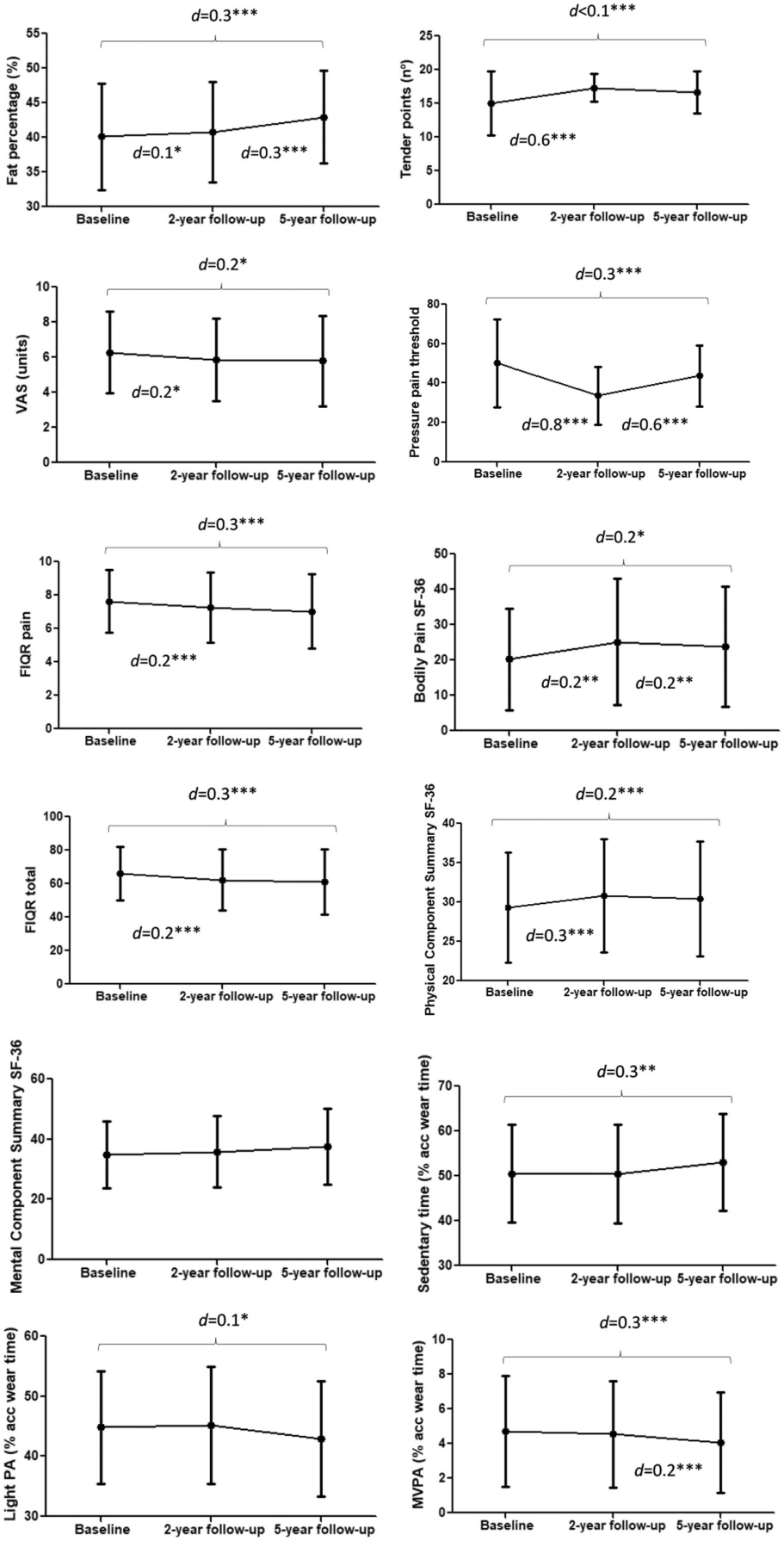

TABLE 2 Longitudinal association between sedentary time and physical activity (predictors) with pain-related measures (outcomes) in women with fibromyalgia.

	2-Year follow-up ($n = 172$)						5-Year follow-up ($n = 185$)					
	β	B	(95% CI)		p	Adj. R^2	β	B	(95% CI)		p	Adj. R^2
Pain: Visual analog scale												
Sedentary time (baseline)	0.00	0.00	−0.03	0.03	0.963	0.24	0.07	0.01	−0.02	0.04	0.351	0.11
Δ Sedentary time	−0.03	−0.01	−0.06	0.04	0.663	0.24	0.06	0.02	−0.03	0.07	0.466	0.11
Light PA (baseline)	−0.03	−0.01	−0.04	0.02	0.662	0.24	−0.07	−0.02	−0.05	0.02	0.347	0.11
Δ Light PA	0.10	0.03	−0.02	0.08	0.178	0.24	−0.03	−0.01	−0.07	0.04	0.687	0.11
MVPA (baseline)	0.11	0.08	−0.02	0.19	0.109	0.25	−0.03	−0.02	−0.13	0.09	0.680	0.11
Δ MVPA	**−0.19**	**−0.20**	**−0.35**	**−0.05**	**0.009**	**0.28**	−0.10	−0.10	−0.27	0.06	0.232	0.11
Pain: Algometer score												
Sedentary time (baseline)	−0.09	−0.09	−0.27	0.09	0.338	0.20	−0.06	−0.09	−0.28	0.09	0.334	0.24
Δ Sedentary time	−0.01	−0.03	−0.32	0.27	0.853	0.19	−0.07	−0.15	−0.46	0.15	0.320	0.24
Light PA (baseline)	0.05	0.07	−0.13	0.28	0.481	0.20	0.06	0.10	−0.11	0.32	0.334	0.24
Δ Light PA	−0.02	−0.05	−0.37	0.26	0.747	0.19	0.03	0.07	−0.27	0.41	0.678	0.24
MVPA (baseline)	0.08	0.41	−0.25	1.07	0.224	0.20	0.03	0.15	−0.51	0.82	0.651	0.24
Δ MVPA	0.14	0.89	−0.07	1.86	0.068	0.21	**0.17**	**1.19**	**0.18**	**2.19**	**0.021**	**0.24**
FIQR pain												
Sedentary time (baseline)	0.03	0.01	−0.02	0.03	0.637	0.28	−0.04	−0.01	−0.03	0.02	0.556	0.28
Δ Sedentary time	0.03	0.01	−0.03	0.05	0.623	0.27	0.08	0.02	−0.02	0.06	0.255	0.28
Light PA (baseline)	−0.04	−0.01	−0.04	0.02	0.544	0.28	0.04	0.01	−0.02	0.04	0.545	0.28
Δ Light PA	0.02	0.01	−0.04	0.05	0.787	0.27	−0.05	−0.02	−0.06	0.03	0.484	0.27
MVPA (baseline)	0.02	0.01	−0.08	0.10	0.808	0.28	0.01	0.01	−0.08	0.10	0.829	0.27
Δ MVPA	**0.18**	**−0.17**	**−0.31**	**−0.04**	**0.011**	**0.28**	−0.13	−0.12	−0.25	0.02	0.088	0.28
SF-36 bodily pain												
Sedentary time (baseline)	0.05	0.08	−0.15	0.30	0.507	0.23	−0.08	−0.13	−0.33	0.07	0.194	0.29
Δ Sedentary time	−0.07	−0.18	−0.54	0.18	0.327	0.23	**−0.16**	**−0.35**	**−0.66**	**−0.04**	**0.028**	**0.30**
Light PA (baseline)	−0.05	−0.09	−0.34	0.16	0.494	0.23	0.05	0.08	−0.15	0.31	0.480	0.28
Δ Light PA	0.04	0.10	−0.29	0.48	0.626	0.23	**0.17**	**0.42**	**0.08**	**0.76**	**0.016**	**0.31**
MVPA (baseline)	−0.01	−0.08	−0.90	0.74	0.852	0.23	**0.13**	**0.73**	**0.05**	**1.41**	**0.037**	**0.30**
Δ MVPA	0.13	1.06	−0.14	2.25	0.084	0.22	0.02	0.14	−0.90	1.18	0.786	0.29

TABLE 2 (Continued)

	2-Year follow-up						5-Year follow-up				
	($n = 172$)						($n = 185$)				
	β	*B*	(95% CI)		*p*	Adj. R^2	*β*	*B*	(95% CI)		*p*	Adj. R^2
Global pain												
Sedentary time (baseline)	0.02	0.00	0.00	0.01	0.782	0.32	0.01	0.00	0.00	0.01	0.866	0.38
Δ Sedentary time	0.03	0.00	−0.01	0.01	0.640	0.32	0.11	0.01	0.00	0.02	0.087	0.37
Light PA (baseline)	−0.03	0.00	−0.01	0.00	0.641	0.32	0.00	0.00	−0.01	0.01	0.951	0.38
Δ Light PA	0.03	0.00	−0.01	0.01	0.671	0.32	−0.08	−0.01	−0.02	0.00	0.240	0.38
MVPA (baseline)	0.03	0.01	−0.02	0.03	0.614	0.32	−0.02	0.00	−0.02	0.02	0.680	0.38
Δ MVPA	**−0.20**	**−0.04**	**−0.08**	**−0.01**	**0.004**	**0.35**	−0.11	−0.02	−0.05	0.00	0.097	0.37

Note: *β*, standardized regression coefficient; Δ, change. Linear regression models were built with the outcome at follow-up as a dependent variable. Baseline values of the outcome and the predictor of interest were included using the enter method. Age, fat percentage, antidepressant, analgesics, sleeping medication (yes/no), participation in physical therapy, and psychologist (yes/no) were included as a potential confounder using the stepwise method. Models including Δ of the predictor of interest were additionally adjusted by baseline predictor. The percentage of wear time in each PA variable was used.

Abbreviations: MVPA, moderate-to-vigorous PA; PA, physical activity.

The signification values are provided in the *p* column.

So far, no previous studies have analyzed changes in ST and PA over time in fibromyalgia or other rheumatic condition. Only one previous follow-up study described that 79% of fibromyalgia patients followed at 6–8 years reported being engaged in PA 1 day or more per week.[39] Importantly, these rates of PA could be overestimated due to the use of questionnaires[18,40] and the insufficiently detailed questions not including duration or intensity of the activity. Our findings, based on device-measured data, confirmed that the high levels of ST[16] and low levels of PA[16–18] described in observational studies[16–18] seem to continue and slightly change toward a less favorable profile over the years.

Three previous studies examined the longitudinal relationship between self-reported PA and pain in fibromyalgia.[3,20,21] Patients that increased and sustained moderate PA experienced less pain according to a short-term follow-up of 12 weeks.[20] Another longitudinal study (4.5-year follow-up) suggested that maintaining adequate levels of PA (intense PA ≥30 min, ≥3 days/week) was associated with less future VAS-pain.[21] Finally, in a 26-year follow-up, regular participation in PA did not influence health parameters in fibromyalgia.[3] This study used, for the first time, device-measures of ST and PA to examine the longitudinal association of these behaviors with pain outcomes in fibromyalgia. Previous research using accelerometers have been limited to cross-sectional[8,10] and lifestyle intervention[41] studies suggesting a relationship between ST,[8,10] light,[8,41] and moderate[8] PA with pain-related outcomes in this disease. According to our findings, MVPA was the intensity level linked to more pain-related outcomes in both time points. The importance of MVPA over other levels of PA is consistent with current PA guidelines for the general population.[42] Although reducing ST and increasing light PA were less closely related to pain outcomes in this study, these should be considered goals of interest in the context of chronic diseases,[43] as they are easier to achieve and more sustainable behaviors that could lead to eventual increases in MVPA.[43]

Research on how ST or PA levels are longitudinally related to HRQoL is limited in fibromyalgia. The literature available in other populations is heterogeneous in terms of subjects' characteristics, ST/PA and HRQoL assessment, or length of follow-up. Self-reported levels of ST at baseline have been associated with future HRQoL in older adults followed for 3[50] and 6 years.[44] Device-measured steps and MVPA, and self-reported leisure PA at baseline have been related to higher functioning in older adults with chronic pain at 2-year follow-up[45] and HRQoL (6-year follow-up) in older adults.[44] In contrast with these findings, changes over time in ST and PA,

TABLE 3 Longitudinal association between sedentary time and physical activity (predictors) with disease impact and quality of life (outcomes) in women with fibromyalgia.

	2-Year follow-up ($n = 172$)						5-Year follow-up ($n = 185$)					
	β	*B*	(95% CI)		*p*	Adj. *R2*	*β*	*B*	(95% CI)		*p*	Adj. *R2*
FIQR												
Sedentary time (baseline)	0.01	0.01	−0.18	0.20	0.915	0.47	−0.04	−0.07	−0.27	0.12	0.471	0.46
Δ Sedentary time	0.04	0.10	−0.20	0.40	0.513	0.47	0.06	0.15	−0.15	0.46	0.325	0.46
Light PA (baseline)	−0.01	−0.02	−0.23	0.19	0.829	0.47	0.05	0.10	−0.13	0.32	0.396	0.46
Δ Light PA	−0.02	−0.05	−0.38	0.27	0.743	0.47	−0.04	−0.12	−0.46	0.22	0.497	0.46
MVPA (baseline)	0.02	0.11	−0.58	0.79	0.755	0.47	0.00	−0.03	−0.71	0.66	0.940	0.46
Δ MVPA	−0.07	−0.58	−1.58	0.42	0.255	0.47	−0.08	−0.68	−1.70	0.35	0.195	0.46
SF-36 physical component												
Sedentary time (baseline)	−0.08	−0.05	−0.15	0.04	0.261	0.23	−0.09	−0.06	−0.14	0.02	0.159	0.30
Δ Sedentary time	−0.09	−0.09	−0.24	0.05	0.214	0.22	**−0.20**	**−0.20**	**−0.33**	**−0.07**	**0.003**	**0.33**
Light PA (baseline)	0.09	0.07	−0.04	0.17	0.212	0.23	0.09	0.07	−0.02	0.17	0.142	0.30
Δ Light PA	0.02	0.02	−0.14	0.17	0.807	0.23	**0.16**	**0.17**	**0.03**	**0.32**	**0.019**	**0.32**
MVPA (baseline)	0.00	0.00	−0.34	0.33	0.987	0.22	0.03	0.07	−0.23	0.36	0.657	0.30
Δ MVPA	**0.21**	**0.66**	**0.20**	**1.12**	**0.005**	**0.26**	**0.19**	**0.60**	**0.17**	**1.04**	**0.007**	**0.32**
SF-36 mental component												
Sedentary time (baseline)	0.11	0.12	−0.02	0.26	0.090	0.32	0.03	0.03	−0.11	0.17	0.693	0.33
Δ Sedentary time	0.03	0.05	−0.17	0.27	0.663	0.32	−0.05	−0.07	−0.30	0.15	0.508	0.32
Light PA (baseline)	−0.10	−0.12	−0.28	0.03	0.116	0.32	−0.05	−0.06	−0.22	0.10	0.443	0.33
Δ Light PA	−0.03	−0.05	−0.29	0.19	0.704	0.31	0.07	0.12	−0.12	0.37	0.319	0.33
MVPA (baseline)	−0.07	−0.28	−0.79	0.23	0.278	0.31	0.08	0.33	−0.15	0.81	0.178	0.32
Δ MVPA	−0.04	−0.19	−0.93	0.54	0.603	0.31	−0.04	−0.20	−0.94	0.53	0.583	0.32

Note: *β*, standardized regression coefficient; Δ, change. Linear regression models were built with the outcome at follow-up as a dependent variable. Baseline values of the outcome and the predictor of interest were included using the enter method (dependent variable). Age, fat percentage, antidepressant, analgesics, sleeping medication (yes/no), participation in physical therapy, and psychologist (yes/no) were included as a potential confounder using the stepwise method. Models including Δ of the predictor of interest were additionally adjusted by baseline predictor. The percentage of wear time in each PA variable was used.

Abbreviations: MVPA, moderate-to-vigorous PA; PA, physical activity.

The signification values are provided in the *p* column.

rather than baseline levels, predicted future HRQoL in our study sample. A similar trend has been described in older adults as changes in self-reported leisure-time PA (but not baseline values) were associated with better SF-36 physical components in women at 10-year follow-up.[46] Some studies also support that adult[47] and menopause women[48] who increased self-reported PA over years improved their HRQoL.[47,48] Future longitudinal and intervention studies are needed to better understand the potential of reducing ST and increasing PA for HRQoL improvements in fibromyalgia.

4.1 | Mechanisms linking ST and PA with pain and HRQoL in fibromyalgia: a bidirectional association?

Higher levels of PA in fibromyalgia have been linked to the central nervous system mechanism of pain processing (greater response in pain regulatory regions of the brain and decrease in brain regions implicated in the sensory/discriminative aspects of pain).[9] In addition, other factors related to lower pain experience (reduced fear of movement and catastrophizing or increased self-efficacy)[49] could be derived from increased PA. It can be hypothesized that MVPA is related to levels of physical fitness in fibromyalgia,[21] which is in turn related to the SF-36 Physical Component.[50,51] Reduced ST is probably related to increased PA[11] and, therefore, some of the aforementioned mechanisms connecting PA to pain and HRQoL could be shared among behaviors. ST itself could additionally contribute to impaired pain regulation[10] and partially explain our findings for SF-36 bodily pain. Also, sedentary periods are characterized by skeletal muscle inactivity[52] and are related to reduced aerobic capacity and muscle strength.[53] All this accelerates deconditioning that occurs with aging[53] and has a negative impact on physical HRQoL.

ST or PA did not predict disease impact or SF-36 mental component. However, better SF-36 mental component scores at baseline were associated with lower ST and higher light PA at 5-year follow-up. It could be argued that mental health predicts movement rather than movement predicts mental health. However, the activity performed during the time spent in different activity categories could be also relevant to mental health[54]: sedentary but cognitively stimulating activities will have a different impact on cognitive performance compared to totally passive sedentary activities.[54] In the present findings, changes in health outcomes over time were also associated with less ST and more PA, confirming the bidirectional relationship between variables already suggested in the literature for other populations.[23]

This study has several limitations that must be acknowledged. The loss of study participants at follow-up and the inclusion of the maximum number of participants available at each time point could affect the generalizability of findings. In addition, there are a considerable number of factors that influence disease pain, disease impact, and HRQoL that could be mediating the relationship under analysis. The strengths of this study include the use of accelerometer measures of PA which allowed us to quantify ST and PA more accurately compared to self-reported measures[22] and use a strict criterion of 7 days 10 h. In addition, this is the first study exploring bidirectional associations. Also, a relatively large sample size of women with fibromyalgia representative from southern Spain[24] was examined and followed at two different points in time.

4.2 | Perspectives

The present study provides a novel insight into basic and clinical interest to guide new lines of research for health promotion based on ST and PA as safe and low-cost strategies in fibromyalgia. To date, there are no disease-specific recommendations that establish a certain duration and intensity of daily PA to achieve health benefits. Our findings support further experimental research that explore the impact of increasing long-term PA, especially of moderate-to-vigorous intensity, as a health goal for patients. Given that the relationship between ST, PA, and health outcomes in fibromyalgia was found to be bidirectional, these exploratory findings support future research focused on the synergistic role of strategies aim at symptom management in conjunction with those aimed at increasing daily activity. In this sense, intervention studies that include education, increasing self-efficacy, reducing perceived barriers toward PA,[56] or participation in exercise programs are promising non-pharmacologic strategies that are warranted. Finally, because many variables might influence pain and HRQoL in fibromyalgia (for instance, weight status or body composition[55]), future intervention studies are needed to ascertain the potential of these variables beyond its mediator role here study.

4.3 | CONCLUSIONS

Objectively measured outcomes changed toward less favorable values, while self-reported outcomes slightly tend to improve over years. Baseline levels of ST and PA did not generally predict future health outcomes, although higher MVPA at baseline was associated less limitations due to pain at 5-year follow-up. Reducing

ST and increasing light PA were associated with better HRQoL (pain dimension and physical component) at 5-year follow-up, while increasing MVPA was related to better pain outcomes and physical HRQoL at 2-and 5-year follow-up. These findings support the message of "sit less, move more and more intense" for better prognosis of key health outcomes in fibromyalgia. As health outcomes did also predict ST and PA, the relationship between the variables might be bidirectional. People with fibromyalgia with low PA and poor health could be at risk of further declines. Future studies are needed to explore the impact of strategies aimed at jointly increasing PA along with symptom management.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Blanca Gavilán-Carrera https://orcid.org/0000-0002-9223-7181
Inmaculada C. Álvarez-Gallardo https://orcid.org/0000-0002-1062-8251
Pedro Acosta-Manzano https://orcid.org/0000-0002-4494-2353
Fernando Estévez-López https://orcid.org/0000-0003-2960-4142
Alberto Soriano-Maldonado https://orcid.org/0000-0002-4626-420X
Ana Carbonell-Baeza https://orcid.org/0000-0003-1762-2925
Virginia A. Aparicio https://orcid.org/0000-0002-2867-378X
Víctor Segura-Jiménez https://orcid.org/0000-0001-8655-9857

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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