Agreement between self-reported sleep patterns and actigraphy in fibromyalgia and healthy women

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Received on December 26, 2014; accepted in revised form on February 5, 2015.

Clin Exp Rheumatol 2015; 33 (Suppl. 88): S58-S67.

Key words: accelerometry, agreement, sleep quality, sleep duration, impact of fibromyalgia

Funding: this study was supported by the Spanish Ministry of Science and Innovation (I+D+I DEP2010-15639, grants: BES-2011-047133, RYC-2010-05957), the Consejería de Turismo, Comercio y Deporte (CTCD-201000019242-TRA), the Spanish Ministry of Education (AP-2009-3173, AP-2010-0963), Granada Research of Excellence Initiative on Biohealth (GREIB), Campus BioTic, University of Granada, Spain and the European University of Madrid, Escuela de Estudios Universitarios Real Madrid (2010/04RM).
Competing interests: none declared.

ABSTRACT

Objective. *To examine the agreement between objective (accelerometer) and subjective measures of sleep in fibromyalgia women (FW) and healthy women (HW). To identify explanatory variables of the discrepancies between the objective and subjective measures in FW and in HW.*

Methods. *127 diagnosed FW and 53 HW filled the Fibromyalgia Impact Questionnaire (FIQ) and wore the SenseWear Pro Armband (SWA) for 7 days in order to assess sleep over the last week. Participants completed the Pittsburgh Sleep Quality Index (PSQI) when the SWA was returned.*

Results. *The SWA showed greater total duration (74 vs. 88 min/day) and average duration (7 vs. 9 min) of wake after sleep onset in FW compared with HW. The PSQI showed poorer sleep quality in all the variables studied in FW than in HW (all, $p<0.001$), except time in bed. There was a lack of inter-method agreement for total sleep time, sleep time without naps and sleep latency in FW. Age and educational status explained the inter-method mean difference in sleep time in FW. High discrepancy in sleep time between the SWA and the PSQI was related to higher FIQ scores ($p<0.05$).*

Conclusion. *The objective measure only showed higher frequency and average duration of wake after sleep onset in FW compared with HW. The agreement between the SWA and the PSQI measures of sleep were poor in the FW group. Age, educational level and the impact of fibromyalgia might be explanatory variables of the inter-method discrepancies in FW.*

Introduction

Fibromyalgia is associated to musculoskeletal and widespread pain (1, 2) in addition to an extensive variety of symptoms (2-4). Sleep disturbances, like wake after sleep onset, is one of the most prominent and concerning of fibromyalgia complaints (2, 5). Sleep quantity and quality is transcendent for health and it has been related to somatic symptoms and mood disturbances (6, 7), cardiovascular, metabolic (8) and neurologic disorders (9). A high risk for all-cause mortality (10) has been observed in those individuals sleeping less than 7 hours/day. Fibromyalgia symptoms lead to a poor overall sleep quality in fibromyalgia individuals (5), which in turn leads to a further worsening of symptoms. Thus, sleep problems can trigger an exacerbation of fibromyalgia symptoms (11).

Polysomnography is one of the best methods to precisely measure the different sleeping stages. This neurophysiologic technique is considered the gold standard and it studies the sleep by recording multiple physiological parameters (12). Although advances in technology have allowed the emergence of ambulatory polysomnography systems which can be used within individual's natural living context, its ecological validity is usually questioned (13) due to the obtrusive measurement equipment attached to the sleeper. Alternatively, the movement sensors (so called, accelerometry) have been proposed as an unobtrusive and objective measure to assess the sleeping behaviour (14). Ambulatory accelerometry is a low cost alternative to polysomnography (€300 *vs.* €10.000). It offers a feasible and ecologically valid method to monitor sleeping behaviour (13), showing reasonable validity and reliability in healthy individuals with good sleep patterns (14, 15).

High costs of accelerometer devices do not always allow the possibility to use them on research. Thus, self-reported questionnaires are alternatively

used. The Pittsburgh Sleep Quality Index (PSQI) questionnaire is possibly the most highly used questionnaire to measure sleep quantity and quality in clinical populations (16). The PSQI provides a reliable and valid measure of sleep quality, and discriminates between "good" and "bad" sleepers. This questionnaire was translated into Spanish (17) and has been previously administered to patients with fibromyalgia (5, 11, 18, 19).

Short sleep duration and poor overall sleep quality, are widely considered as fibromyalgia symptoms in the body of literature (5, 11, 20). However, the majority of studies use self-report methods of sleep (5, 18, 21, 22), that is a subjective perception of sleep. Setting a valid questionnaire is important to accurately assess possible sleep disturbances in fibromyalgia population and to detect possible sleep patterns changes after an intervention programme. The literature shows that subjective and objective sleep usually differ in different clinical populations (23). Common fibromyalgia symptoms such as morning stiffness, tiredness and fatigue might also lead fibromyalgia population to experience a distorted perception of sleep. Therefore, it is of importance to know whether fibromyalgia individuals accurately self-report their sleep. This fact would let us better understand the usefulness of self-report measures of sleep in this population. We aimed to examine the agreement between a subjective (PSQI) and an objective (SWA) measure of sleep in fibromyalgia women (FW) and in healthy women (HW). We also aimed to identify explanatory variables of the discrepancies between the PSQI and the SWA in FW and in HW.

Material and methods

Participants

We contacted 271 potentially eligible fibromyalgia patients and healthy individuals from two local Association of fibromyalgia from Granada and Seville (Southern Spain) by local advertisement via flyers, radio and newspaper. Participants were informed about the aims and study procedures. A total of 198 participants (139 fibromyalgia patients and 59 healthy controls) accepted to participate in the study and gave their written informed consent. Four men were excluded due to the small sample size. Fibromyalgia women were excluded if they did not meet the 1990 American College of Rheumatology criteria (2), had acute or terminal illness, and had severe dementia (Mini Mental State Examination <10) (24). The final study sample consisted of 127 FW and 53 HW that were included in the data analysis. The study protocol was reviewed and approved by the Ethics Committee of the *Hospital Virgen de las Nieves* (Granada, Spain). The flow chart of participants is presented in Figure 1.

Procedures

The participants were cited for 2 appointments. Tender points count was assessed during the first visit. The Mini Mental State Examination, demographic data and the Fibromyalgia Impact Questionnaire (FIQ) were completed in the assessment setting. Participants were asked to wear the SWA for 7 consecutive complete days (24 hours/day), starting the same day they received the monitor. They were instructed to wear the SWA on their arm attached by an elastic belt. For security reasons, they were asked to take them off while bathing. Participants had the second visit (1-week interval) to return the SWA to the research team and fill the PSQI.

Measures

The tender points count. We used the 1990 American College of Rheumatology criteria (2) for classification of fibromyalgia using a standard pressure algometer (FPK 20; Wagner Instruments, Greenwich, CT, USA). The total count of positive tender points was recorded for each participant.

The Mini Mental State Examination (24) was used to assess the cognitive capacity and the severity of dementia for the exclusion criteria.

The Fibromyalgia Impact Questionnaire comprises 10 subscales of dis-

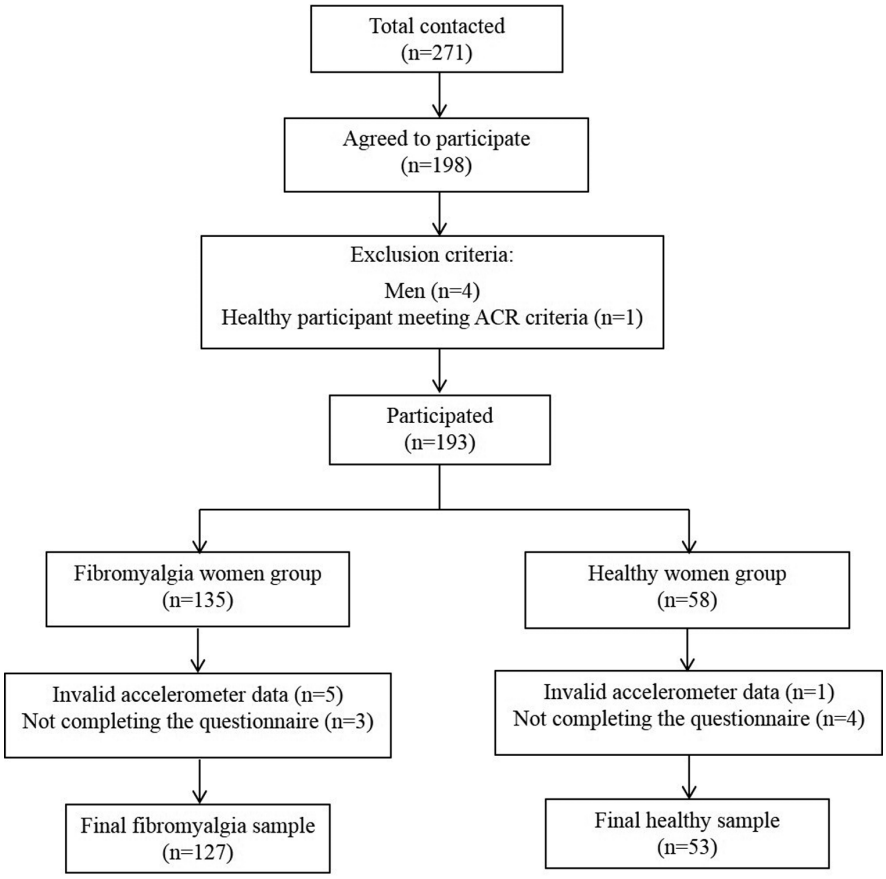


Fig. 1. Flow chart of participants.

abilities and symptoms (physical function, work missed day, job ability, feel good, pain, fatigue, sleep, stiffness, anxiety and depression) and has previously used and validated for Spanish fibromyalgia patients (25). The total score ranges from 0 to 100. A higher score indicates a greater impact on the person's life.

The Pittsburgh Sleep Quality Index questionnaire (16) was used to assess sleep quality and disturbances over l-month time interval. Nineteen individual items generate seven "component" scores: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. The sum of scores for these seven components yields one global score. The Spanish version of the PSQI has shown good reliability, convergent and discriminant construct validity (26).

The SenseWear Pro Armband™. The wearable body-monitoring device (SenseWear Pro_3 Armband [BodyMedia Inc, Pittsburgh, PA]) assesses energy expenditure and sleep patterns (27–29). The SWA incorporates an ample variety of measured parameter (accelerometer, galvanic skin response, skin temperature, near-body temperature) and demographic characteristics (gender, age, weight, height) into proprietary algorithms to estimate energy expenditure. The dual axis accelerometer produces valuable information about the user's body position, which is important enhancing the sleep patterns detection. Furthermore, the SWA incorporate data from the multiple sensors to enhance accuracy. The SWA has shown moderate to high sensitivity and specificity to identify sleep and wakefulness (27, 28, 30) and it has shown to be valid for determining sleep when compared with polysomnography in healthy subjects and patients with obstructive sleep apnoea (14). Sleep patterns, energy expenditure and circadian rhythms have been previously studied using this particular device in patients with acute coronary syndrome (31) and healthy men (32).

Following the manufacturer's recommendations, this device was worn on the right upper arm over the triceps muscle at the midpoint between the acromion and olecranon processes. Energy expenditure was computed at 1-minute intervals. Minute by minute data obtained using the SWA were downloaded using software developed by the manufacturer (SenseWear Professional software version 6.1[a]). We excluded from the analyses data with less than 7 days of collection and a threshold of 95% "on-body" time was used to include an individual in the data analysis. We calculated night-time sleep (defined as sleep that occurs from 21:00 until waking up at morning) apart from naps (sleep outside of night-time) in order to properly compare with the PSQI, which solely asks about nightly sleep. We calculated using the SWA data:

- Total sleep time (TST): minutes classified as sleep.
- Sleep latency: duration from onset of time supine until time asleep derived from accelerometry for at least 3 consecutive minutes.
- Disturbances: wake after sleep onset (frequency, total duration and average duration).
- Deep sleep and light sleep: they were calculated based on the frequency of roll-overs (*unconscious motions during sleep such as rotational body movements*), which increase during light sleep (non-REM sleep) and decrease during deep sleep (REM sleep).
- Sleep Quality Score: deep sleep duration / TST.

Statistical analysis

Descriptive analysis was used to assess clinical and socio-demographic variables. We used parametric tests after confirming the normality of data.

The differences in sleep patterns between FW and HW were analysed by one-way analysis of covariance (ANCOVA) for continuous variables, where age, educational status, occupational status, FIQ and tender points count were entered as covariates. Chi-square was used for categorical variables.

To assess the systematic differences between the sleep variables assessed by means of the objective (SWA) and the subjective method (PSQI), the paired sample t-test was used. An exploratory analysis was performed using ANCOVA with the inter-method difference of sleep variables as dependent variable, no fixed factor entered in the model, and age, educational level and occupational status as covariates. The agreement between the SWA and PSQI was assessed following the Bland-Altman plot (33). The mean difference, 95% confidence intervals (CIs), and limits of agreement (mean difference ± 1.96 standard deviation (SD) of the difference) were calculated. The association between the mean difference and the mean magnitude was assessed by linear regression analysis (*i.e.* heteroscedasticity) after inverting negative data.

We used ANCOVA to test the differences between the systematic bias of the inter-method agreement between FW and HW. Socio-demographic characteristics, FIQ and tender points were entered as covariates in a model extended approach.

Due to the large discrepancies from TST (up to 4 hours) noted between the SWA and the PSQI, we divided the participants into 2 categories: participants with <1 hour of sleep time discrepancy and participants with ≥1 hour of sleep time discrepancy between both methods. The aim was to identify fibromyalgia symptoms (explanatory variables) associated with ≥1 hour of discrepancy. We conducted a one-way analysis of variance with participants <1 hour and ≥1 hour of sleep time discrepancy as dependent variable and possible explanatory variables as fixed factor. These analyses were performed for FW and HW separately.

All analyses were performed using the Statistical Package for Social Sciences (IBM SPSS Statistics for Windows, version 20.0, Armonk, NY). Results were considered statistically significant when $p<0.05$.

Results

The clinical and socio-demographic characteristics of FW and HW are shown in Table I. The overall mean time needed to complete the PSQI was 8 minutes.

Table II presents sleep quality descriptive data of FW and HW groups from the SWA and the PSQI. FW showed greater values than HW in objectively

Table I. Clinical and socio-demographic characteristics of the study samples.

Variables	Fibromyalgia group (n=127) mean (SD)	Healthy group (n=53) mean (SD)	p-value
Tender points count	17.3 (1.7)	3.8 (2.5)	<0.001
Mini Mental Statement Examination total score	28.6 (1.4)	28.9 (1.0)	0.208
Fibromyalgia Impact Questionnaire total score	59.5 (20.0)	19.8 (18.8)	<0.001
	n (%)	n (%)	
Age (years)			
20-34	6 (4.7)	4 (7.5)	0.002
35-50	54 (42.5)	36 (67.9)	
51-64	67 (52.8)	13 (24.5)	
Marital status			
Married	106 (83.5)	44 (83.0)	0.566
Unmarried	10 (7.9)	5 (9.4)	
Separated/ Divorced	7 (5.5)	4 (7.5)	
Widowed	4 (3.1)	0 (0.0)	
Educational status*			
Unfinished studies	3 (2.4)	7 (13.2)	0.001
Primary school	30 (23.8)	4 (7.5)	
Secondary school	66 (52.4)	33 (62.3)	
University degree	27 (21.4)	9 (17.0)	
Occupational status**			
Working	45 (38.5)	25 (47.2)	0.023
Unemployed	50 (42.7)	27 (50.9)	
Retired	17 (14.5)	0 (0.0)	
Other	1 (4.3)	1 (1.9)	

* One / **Fourteen missing data in the fibromyalgia group.

measured disturbances total duration (88 *vs*. 74 min/day, p=0.043), disturbances average duration (9 *vs*. 7 min, p=0.022), disturbances without naps total duration (85 *vs*. 71 min/day, p=0.033) and disturbances without naps average duration (9 *vs*. 7 min, p=0.026). FW showed significantly worse self-reported sleep values than HW in all the variables of the PSQI (all, p<0.001), except in time spent in bed (p=0.054). The findings persisted after additionally adjusting for age, educational status and occupational status. However the results materially changed when further adjusting for FIQ score or the tender points count: i) no differences in the SWA sleep variables between FW and HW (all, p>0.05), ii) significant differences in sleep variables assessed by means of the PSQI were observed excepting to latency and time spent in bed (see Table II).

Sleep time and sleep latency according to the SWA and the PSQI for both FW and HW are shown in Figure 2. The PSQI showed lower estimations of TST (p<0.001) and higher estimations of sleep latency (p<0.001) when compared with the SWA data in FW. There were no systematic differences in TST and sleep latency between the SWA and the PSQI, when age and educational level were entered as covariates (p>0.05) in FW. No systematic differences in any variable between the SWA and PSQI estimates were identified in HW.

The Bland-Altman plots for inter-method agreement between the SWA and the PSQI in FW and HW are presented in Figure 3. The mean difference (SD) for the TST, the sleep time without naps and sleep latency from the SWA and the PSQI in FW was 60±108, 33±104 and -25±34 min/day, respectively (all, p<0.001). In HW these values corresponded to 4±100, -22±83 and -4±16 min/day, respectively (all, p>0.05). The limits of agreement between the SWA and the PSQI were higher in FW compared with HW in all the variables studied. Further analysis of the Bland-Altman plots showed the presence of heteroscedasticity for the TST, the sleep time without naps and sleep latency in FW (R^2=0.13, R^2=0.13, R^2=0.81, respectively; all p<0.001). In HW, the heteroscedasticity was only shown in the sleep latency plot (R^2=0.52, p<0.001).

The inter-method agreement (systematic bias) between FW and HW for TST, sleep time without naps and sleep latency were statistically different (all, p<0.01). The difference between groups did not materially changed (all, p<0.01) after adjusting for socio-demographic variables (age, marital status, educational status and occupational status). There were no differences between groups (all, p>0.05) when further adjusting for FIQ total score and/or tender points (data not shown).

In FW, discrepancy ≥1 hour was related to FIQ physical function subscale (mean difference: 1.0; 95% CI for difference: 0.3, 1.8; p=0.009), FIQ feel good subscale (1.7; 0.5, 2.9; p=0.005) and FIQ total score (7.8; 0.8, 14.8; p=0.029). In HW, discrepancy ≥1 hour was related to higher frequency (4.1; 2.2, 6.0 times; p<0.001), total duration (38,3; 20.0, 56.6 min/day; p<0.001), and average duration (1.2; 0.1, 2.4 min; p=0.035) of disturbances, lower deep sleep (-34,9; -62.8, -6.8 min; p=0.016) and lower sleep quality score (-0.08; -0.13, -0.03; p=0.003) assessed with the SWA (Fig. 4).

Discussion

In the present study, the objective measure of sleep showed significantly larger activity patterns while sleeping in FW compared with HW, but not in the remaining variables. A deep study of the results suggests that FW might underestimate their TST and overestimate the sleep latency when self-reporting. The age, educational status and impact of fibromyalgia might influence the way of self-reporting in FW. Furthermore, great objectively measured sleep awakenings and poor sleep quality are also key factors which might alter the subjective sleep perception in HW.

The present study showed no differences in objectively measured sleep time between FW and HW, which concur with other studies using accelerometry (21, 34) and polysomnography (12). Both groups slept less than 7 hours/day, as well as previously shown in studies with accelerometry (21, 34). When comparing the SWA sleep data between FW and HW, we solely found differ-

Table II. Comparison of sleep data from the SenseWear Pro Armband (SWA) and the Pittsburgh Sleep Quality Index questionnaire (PSQI) between fibromyalgia and healthy women.

	Fibromyalgia group (n=127)	Healthy group (n=53)	P	P_1	P_2	P_3
SWA						
Percentage of usage (%/day)	97.6 (2.7)	97.9 (2.0)	0.457	0.692	0.669	0.471
Sleep (min/day)	399 (83)	407 (60)	0.549	0.754	0.181	0.210
Latency (min/day)	16 (9)	15 (8)	0.503	0.290	0.783	0.441
Disturbances total duration (min/day)	88 (43)	74 (38)	0.043	0.045	0.845	0.523
Disturbances frequency (nº/day)	11 (4)	11 (4)	0.952	0.888	0.722	0.454
Disturbances average duration (min)	9 (6)	7 (2)	0.022	0.022	0.256	0.991
Deep sleep (min/day)	151 (60)	164 (53)	0.171	0.458	0.665	0.723
Light sleep (min/day)	250 (57)	245 (44)	0.529	0.669	0.174	0.228
Sleep Quality Index	0.4 (0.1)	0.4 (0.1)	0.077	0.293	0.941	0.733
Sleep without naps (min/day)	372 (78)	380 (55)	0.495	0.818	0.490	0.212
Disturbances without naps total duration (min/day)	85 (42)	71 (37)	0.033	0.029	0.615	0.710
Disturbances without naps frequency (nº/day)	11 (4)	10 (4)	0.891	0.717	0.861	0.733
Disturbances without naps average duration (min)	9 (7)	7 (2)	0.026	0.025	0.288	0.930
Deep sleep without naps (min/day)	144 (60)	158 (51)	0.155	0.440	0.743	0.641
Light sleep without naps (min/day)	230 (51)	224 (44)	0.513	0.527	0.572	0.287
Sleep Quality Index without naps	0.4 (0.1)	0.4 (0.1)	0.058	0.201	0.838	0.893
PSQI						
Sleep (min/day)	339 (86)	403 (79)	<0.001	<0.001	0.027	0.026
Latency (min/day)	41 (34)	18 (17)	<0.001	<0.001	0.092	0.463
Time in bed (min/day)	485 (80)	458 (87)	0.054	0.132	0.853	0.368
PSQI Total Score (0-21)	13.0 (3.9)	6.1 (3.8)	<0.001	<0.001	<0.001	0.026
Sleep efficiency (%)	70.9 (17.2)	88.5 (12.4)	<0.001	<0.001	0.007	0.092
Sleep quality (0-3)	5/16/61/18	25/47/25/3	<0.001			
Sleep latency (0-3)	7/27/33/33	42/23/26/9	<0.001			
Sleep duration (0-3)	12/15/53/20	28/32/34/6	<0.001			
Sleep efficiency (0-3)	22/23/20/35	70/19/4/7	<0.001			
Sleep disturbances (0-3)	0/15/50/35	6/53/34/7	<0.001			
Sleep medication (0-3)	24/6/10/60	75/8/4/13	<0.001			
Daytime dysfunction (0-3)	5/45/34/16	49/43/8/0	<0.001			

A model extended approach was used to test the effect of different covariates. P; unadjusted. P_1; age, educational status and occupational status. P_2: age, educational status, occupational status and Fibromyalgia Impact Questionnaire. P_3: age, educational status, occupational status and tender points count. Categorical variables were analysed using chi-square. Values represent mean (standard deviation) for continuous variables and percentages for categorical variables.

ences in disturbances total duration (min/day) and disturbances average duration (min) in both with and without naps. Therefore, although FW and HW showed similar number of disturbances per day, these disturbances lasted longer in FW. Our finding concurs with a recent polysomnography study in fibromyalgia (35) which reflects signs of disturbed sleep with significantly increased levels of activity at night in fibromyalgia compared with controls. The same results were shown in other research which compared the levels of activity and sleep patterns in groups of patients with fibromyalgia (34), although they used a different accelerometer model than ours. In that study both the fibromyalgia group and the fibromyalgia and depression group, revealed greater objectively night-time activity levels compared with the control group (34). Furthermore, the group of fibromyalgia and comorbid depression showed significantly reduced sleeping time during night compared with the fibromyalgia-only group and control group (34), indicating thus the significant and added impact of depression on sleep. When we further adjusted for fibromyalgia impact and tenderness the differences in disturbances total duration (min/day) and disturbances average duration (min) between FW and HW were not observed. This suggests that fibromyalgia severity might be positively related to greater wake after sleep onset at night.

Fibromyalgia individuals usually report poorer sleep quantity and quality than healthy individuals (5, 18, 21, 22). This is consistent with our results, since FW reported poorer sleep values than HW in all the variables studied, except for the bed-time. This indicates that although both study groups reported similar sleep duration, the subjective experience of sleep quantity and quality is poorer in FW. The findings from the PSQI are consistent with previous studies in middle-aged fibromyalgia patients (5, 18, 19). Only one of these studies failed to show differences between the healthy and the fibromyalgia group in sleep duration (5) using the PSQI. Interestingly, this finding is in concordance with those of the present study assessed with the SWA, indicating that sleep quality, rather than quantity, should be the focus of research in fibromyalgia population (5).

Mean values of TST and sleep latency from the objectively measured data (SWA) and the self-reported data (PSQI) were different in FW. Further analysis showed that age and educational status were explanatory variables of systematic bias found between the SWA and PSQI in FW. It has been previously stated that aging reduces the accuracy of self-reporting (36). Furthermore, educational status is usually lower in fibromyalgia when compared with control individuals (37), as shown in the present study, which might partially explain the difficulties when self-reporting sleep patterns.

A recent study showed that Actigraphy might overestimates TST and underestimates sleep onset latency in individuals with insomnia (38). This may be explained because individuals are motionless but awake, thus identifying sleep in an erroneous way (38). Alternatively, FW could misestimate TST, since they might attribute their symptoms severity to poor sleep. In fact, FW trend to misestimate the quantity and quality of their sleep the most when their sleep is restless, they feel it was difficult to fall asleep, and when they are tired at the time of reporting (39). Also, fibromyalgia patients with higher dysfunctional beliefs usually report poorer sleep (40). Otherwise, we compared objective data

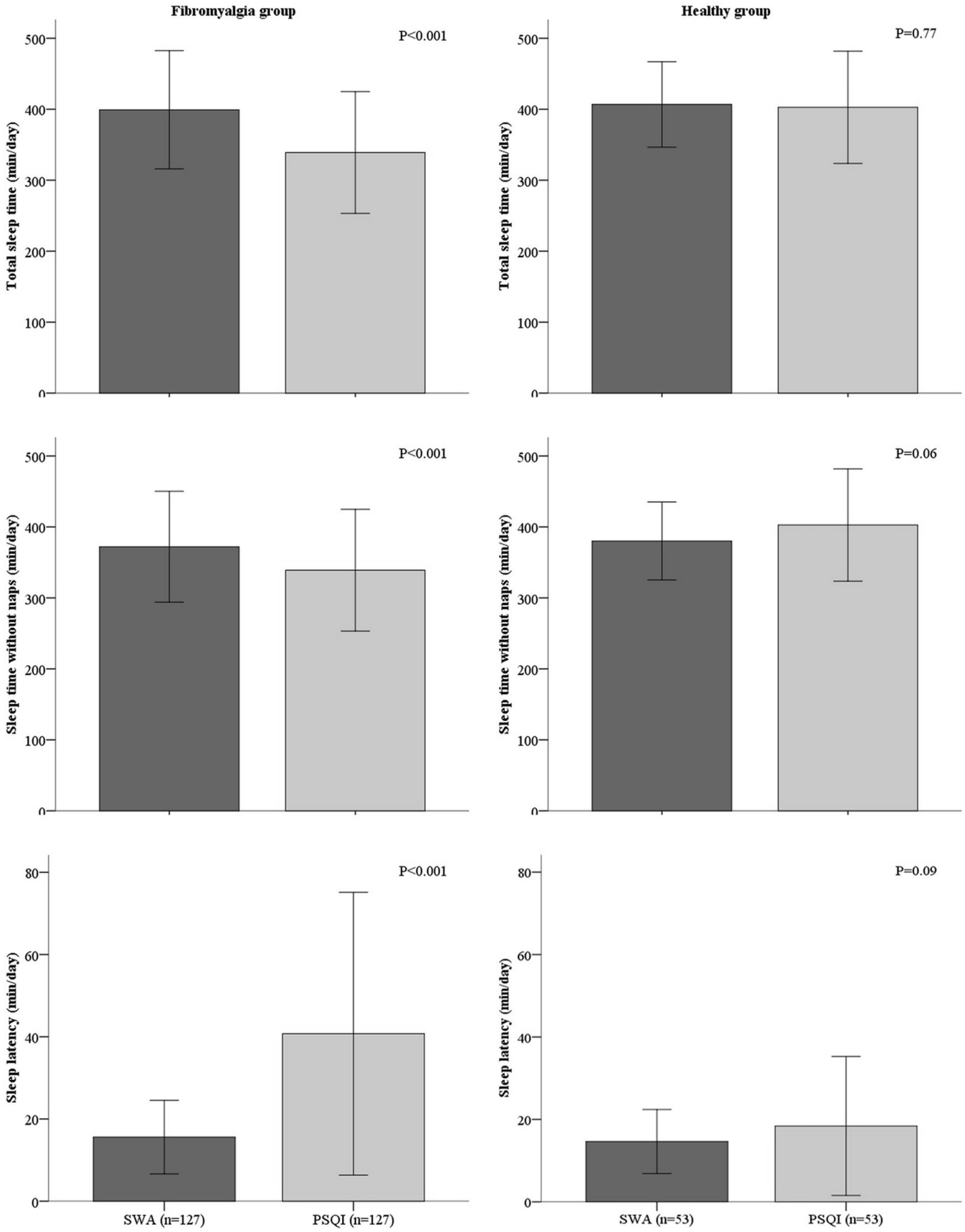


Fig. 2. Comparison of sleep time and sleep latency data from the SenseWear Pro Armband (SWA) and the Pittsburgh Sleep Quality Index questionnaire (PSQI) in fibromyalgia and healthy women, using paired samples *t*-test. No differences observed when age and educational level were entered as covariates in fibromyalgia women (P>0.05), using ANCOVA.

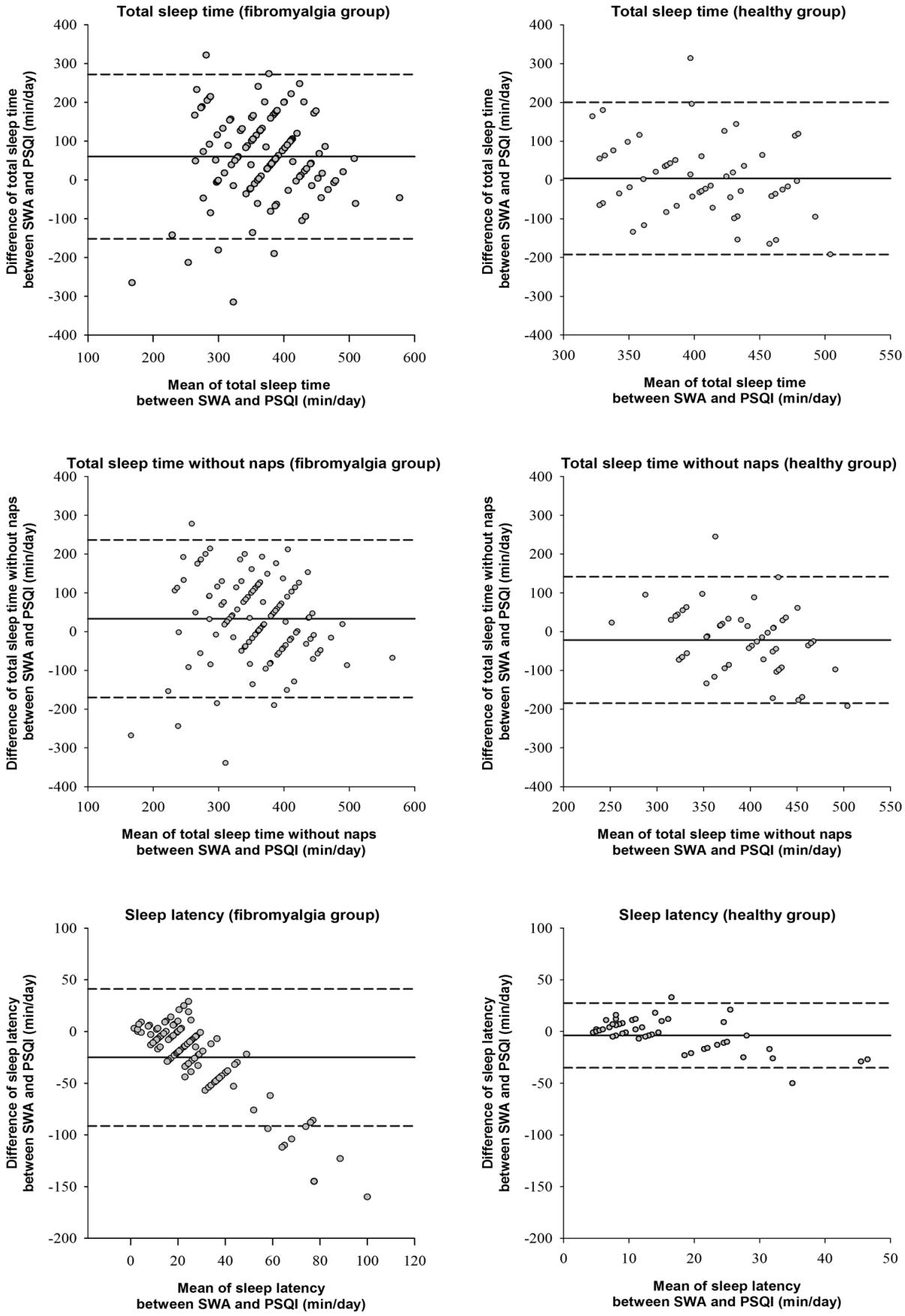
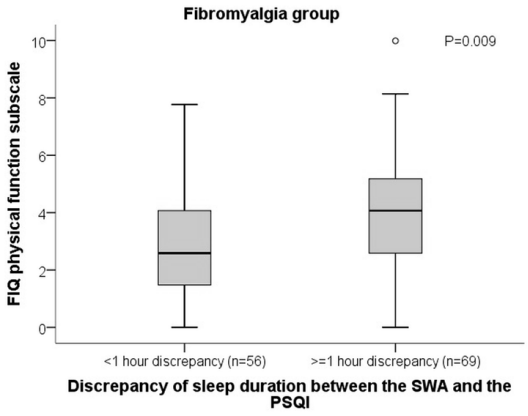
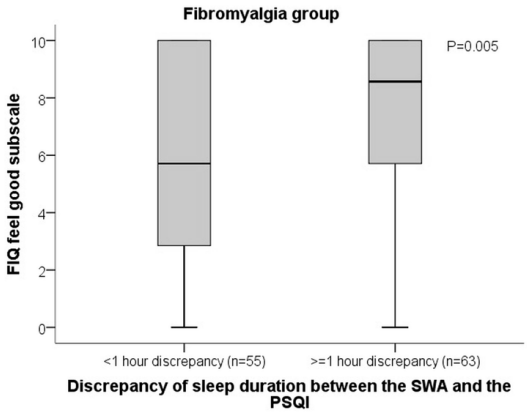
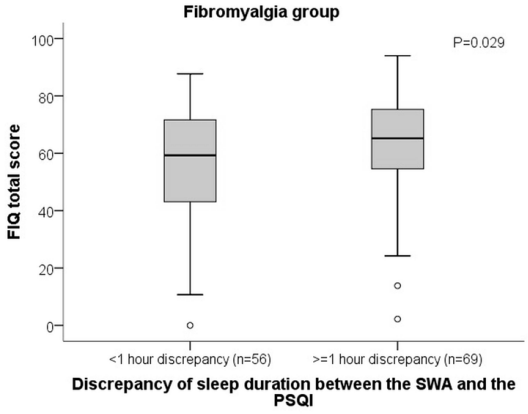
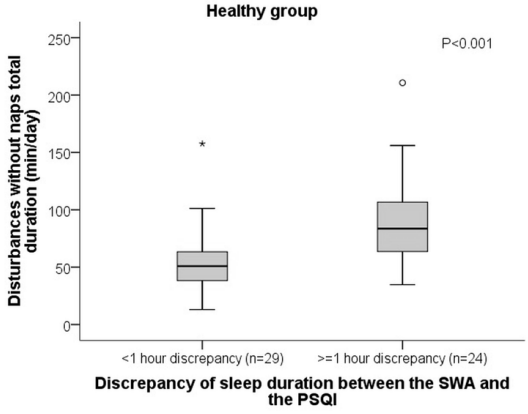


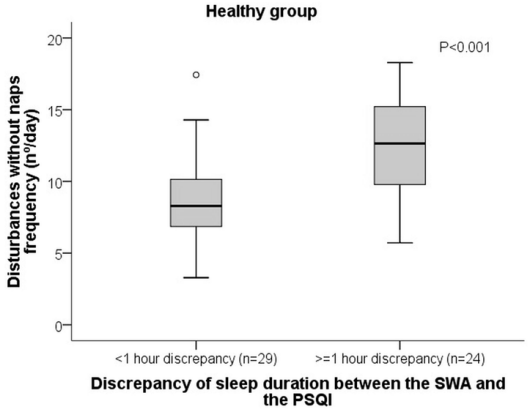
Fig. 3. Bland-Altman plots for inter-method agreement between the SenseWear Pro Armband (SWA) and the Pittsburgh Sleep Quality Index (PSQI) in fibromyalgia and healthy women. The centre line represents the mean difference, whereas the dashed lines represent the limits of agreement (mean ± 1.96 SD).

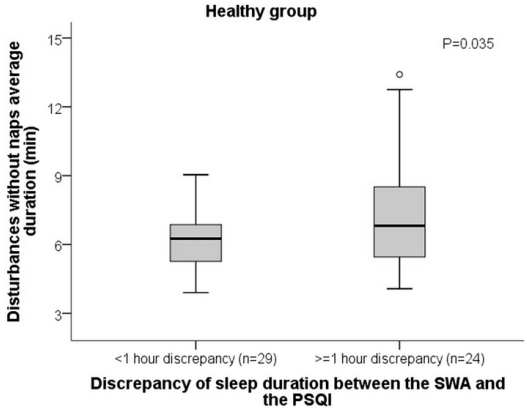


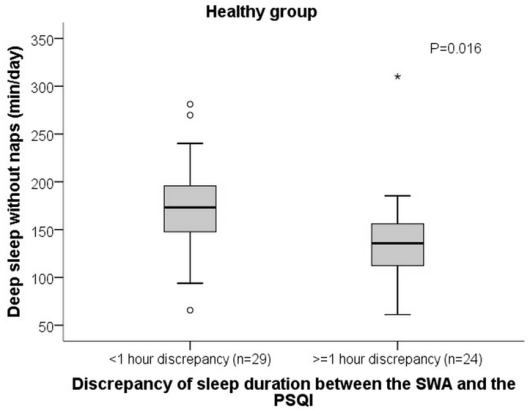












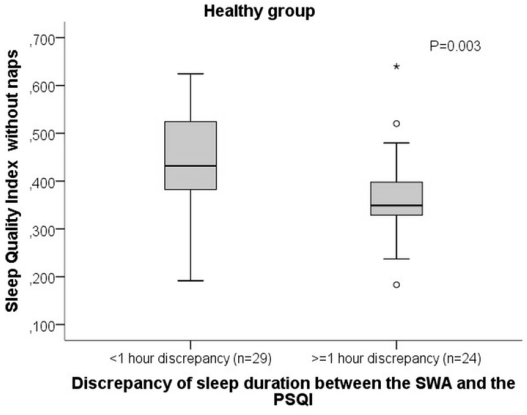


Fig. 4. Explanatory variables of the discrepancy in the estimation of sleep duration between the SenseWear Pro Armband (SWA) and the Pittsburgh Sleep Quality Index (PSQI) in fibromyalgia and healthy women.
Box diagram shows the mean, the 1st and 3rd quartiles and the 95% confidence intervals.
One-way analysis of variance was used to test the differences.
FIQ = Fibromyalgia Impact Questionnaire.

collected over 7 days with a self-report measure collected at only one point in time, which might lead to discrepancies due to measurement issues rather than participants reporting. To corroborate the aforementioned hypothesis, we also compared TST and sleep latency between the SWA and the PSQI in HW. Results showed a high ability of the SWA to detect the TST and sleep latency when compared with those reported with the PSQI in HW. This results are in concordance with a recent study reporting that TST is accurately determined by accelerometry in healthy individuals (13). Therefore, given the good inter-method agreement at the group level in the HW and previous findings in the body of literature (39, 40), our results suggests that FW might trend to misestimate their sleep parameters. This is consistent with previous polysomnography studies which found differences between self-reported and objectively measured sleepiness in FW (12, 35).

There was a lack of inter method-agreement in the Bland-Altman plot study of TST and sleep time without naps in FW. Although there was a good agreement at the group level between the SWA and the PSQI in HW, the high limits of agreement revealed discrepancies between both assessment methods at the individual level. When comparing sleep time without naps, limits of agreement diminished with regard to TST in both FW and HW. This is understandable since the PSQI only asks for nightly sleep and the inter-method agreement improves when we do not consider napping with the SWA. A good inter-method agreement regarding to the sleep latency was found for HW, but not for FW. The presence of heteroscedasticity in the sleep latency graph proves that the higher the time to fall asleep reported by FW the higher the discrepancies between both methods. This is consistent with a previous study which support the overestimation of sleep latency in insomnia patients (41). However, Actigraphy has been proposed as a potential instrument in correcting subjective distorted perceptions about sleep, since those individuals receiving feedback as a tool to enhance the subjective perception of sleep are more accurate in their sleep latency reports (41).

To corroborate if there was any explanatory variable of the high discrepancy of sleep time between both methods, and similarly to a previous study in fibromyalgia (39), we divided the group in 2 categories according to the sleep mean difference absolute minutes per day: those having <1 hour of discrepancy and those with ≥1 hour of discrepancy. The results showed poorer reported values of FIQ physical function and feel good subscales, and FIQ total score in FW with ≥1 hour of discrepancy. The results also revealed higher disturbances and poorer sleep quality (by means of the SWA) of those HW who had higher discrepancy between both methods. Therefore the high discrepancies between both methods could be partially explained by an inaccuracy of FW who report a higher impact of fibromyalgia on health (39, 40), and by HW who have greater objectively sleep disturbances (13, 42, 43) and worse sleep quality. This is consistent with studies in healthy adults (13) and in the elderly (42, 43), which found an association of greater actigraphic wake after sleep onset with poorer sleep quality as measured by the PSQI (42, 43).

The main limitation of the present study is that causality cannot be ascertained: we cannot affirm whether the impact of fibromyalgia might influence the way of self-reporting sleep, or sleep disturbances might influence the way of self-reporting functioning. Additionally, it is important to note that the FIQ is also a measure of self-report, the same as the PSQI. Furthermore, night-to-night variability makes it difficult to integrate information over a month. We emphasise the use of polysomnography, accelerometry and reported questionnaires simultaneously in future studies with large fibromyalgia and control samples in their usual environmental context, in order to further examine the present study findings. We must also bear in mind that accelerometry measures body movement. Although the SWA uses sophisticated algorithms to accurately estimate sleep parameters, this device does not measure the same parameters as polysomnographic assessment. Even so, it is important to note that our study findings with the SWA are very similar to those of Roehrs *et al*. using polysomnography (35). It is important to mention that a recent study has determined that the SWA is poorly valid to measure sleep onset latency, however, is highly valid to measure sleep time, sleep efficiency and wake after sleep onset (30). We do not know whether wearing the accelerometer device at night modified the habitual sleep patterns of individuals involved in the study. Medication use and primary sleep disorders were not controlled and could have affected the results of the study, but otherwise it allows generalisation to common fibromyalgia population.

Alternatively, the relatively large FW sample size is one of the strengths of the present study. The period wearing the accelerometer by participants was 7 days. Population with a high night-to-night variability in sleep patterns have been suggested to wear the accelerometer for a period of at least one week (15) in order to provide reliable estimates of sleep. The possibility to study the sleep patterns at the own participants' environmental context provides an ecological validity to the study, since they do not have to get costumed to a laboratory setting. Future studies should study the agreement of sleep data from objective and subjective measures in fibromyalgia men.

In conclusion, the present study showed longer objectively assessed sleep perturbations in FW compared with HW. This entails that sleep quality, rather than quantity, should be the focus of research in fibromyalgia. A lack of agreement between the SWA and the PSQI was found in FW, especially in those with low educational status, increasing age and high impact of fibromyalgia. This findings are preliminary and must be considered with caution. Future studies using the gold standard would verify whether FW truly underestimate their sleep parameters.

Acknowledgments

We thank the AGRAFIM (association of fibromyalgia from Granada, southern Spain) individuals involved in the field work for their collaboration and interest.

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