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Fibromyalgia and Sedentarism: Which Came First, the Chicken or the Egg?

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Abstract: Fibromyalgia is a chronic disease that causes widespread pain throughout the body, as well as fatigue and a variety of other accompanying symptoms. Physical activity is one of the most useful non-pharmacological treatments for pain and symptom reduction. Therefore, the main objective of this research was to analyse the objective levels of sedentary lifestyle and physical activity, as well as the study of heart rate variability as a predictor of health. A total of 21 women previously diagnosed with fibromyalgia (FM) and 10 healthy women of the same age range participated in the study. Accelerometry was used for the determination of physical activity and sedentary lifestyle as well as the study of heart rate variability (HRV) at rest for the assessment of cardiovascular health. The results show that participants with fibromyalgia have higher levels of sedentary lifestyles and worse cardiovascular health outcomes compared to healthy participants not diagnosed with fibromyalgia. In conclusion, it is observed that the analysis of heart rate variability is a good predictor for the determination of cardiovascular health in patients diagnosed with fibromyalgia. A debate is open to whether sedentary lifestyles and being overweight accentuate the fibromyalgia disease or whether it is the disease itself that favors increased physical inactivity, reflected in inferior cardiovascular health. Future research is needed to deepen this analysis in order to improve the quality of life of these patients.

Keywords: fibromyalgia; heart rate variability; physical activity; sedentary lifestyle

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1. Introduction

Fibromyalgia (FM) is a chronic disease associated with other comorbidities, with a predominant diagnosis of fatigue, pain, inflammatory dysregulation, and muscle weakness, whose treatment is yet to be determined, as well as the major cause [1]. Regarding the prevalence of the disease, there are differences depending on methodology, diagnostic criteria, and geographical location [2]. According to the World Fibromyalgia Association, around 6.3% of the world's population has been diagnosed as having FM, being much more prevalent in women. Nevertheless, since there are currently no recognised objective biomarkers that can be used to diagnose this disease, the identification is predominantly based on subjective clinical criteria [3,4]. This is the main reason why FM is commonly co-diagnosed with other syndromes such us chronic fatigue syndrome, depression syndrome, or anxiety disorders [1].

In this context, the prescription of specific treatments or therapeutic interventions is a real problem. Due to the large number of symptoms and comorbidities, pharmacological

treatments do not always provide adequate wellbeing and patients avoid the side-effect profiles [5]. As an alternative to pharmaceutical treatment, physical activity has been used extensively. Moreover, it has been found to be one of the most effective agents for symptom reduction and wellbeing promotion [6–9]. The problem lies in the lack of adherence of FM patients to long physical exercise programs, either because fatigue makes it impossible to perform regular physical exercise or because the performance of physical exercise increases perceived fatigue levels, which may create a vicious circle that is difficult to overcome. However, due to the great diversity of symptoms in people diagnosed with fibromyalgia, there is no consensus on what, how, and when physical activity should be performed [10]. Although aquatic exercise has classically been considered the most appropriate for reducing inflammation and improving symptoms and quality of life [6,7], other current studies have shown that strength training is one of the most effective methods for improving these health patients [11–13] without focusing too much on daily cardiovascular health. In addition, sedentary lifestyles predominate in this type of patient to avoid worsening of symptoms and increased pain [9,14].

The examination of variations in the time intervals between heartbeats or heart rate variability (HRV) is demonstrated to reveal significant indicators pertaining to cardiac autonomic regulation [15]. The indices in consideration are deemed predictive of morbidity and death due to their frequent alteration in individuals suffering from chronic degenerative diseases [16]. HRV has been widely used as a tool for managing cardiovascular function in different chronic diseases [17] and inflammatory markers in cardiovascular illness [18,19].

Cytokine-mediated inflammation and stress response are part of the FM pathophysiology [6,20–23]. According to Tracey (2002) [24], there is also a connection between the brain, vagus nerve, and immune system called the "cholinergic anti-inflammatory pathway". For this reason, the study of the parasympathetic activity [19] is of great importance in the fibromyalgia condition, indicating that the study of biomarkers such as HRV are crucial for the improvement of these patients.

It is important to open the debate about whether sedentary lifestyles cause fibromyalgia syndrome impairment or whether it is the fibromyalgia symptoms themselves that favor sedentary behaviors. In this context, there is limited research on the study of heart rate variability in people diagnosed with fibromyalgia. Therefore, the main objective of this research was to determine whether heart rate variability is a good predictor of cardiovascular health in people diagnosed with fibromyalgia, as well as the influence of physical activity levels and sedentary lifestyle on this chronic disease.

2. Materials and Methods

2.1. Participants

A total of 31 women participated in the study, of whom 21 were previously diagnosed with fibromyalgia (FMG, fibromyalgia group) by a specialist rheumatologist or internal medicine physician and 10 were healthy women of the same age range (HRG, healthy reference group). Inclusion criteria included: (i) women between 40 and 67 years of age; (ii) women diagnosed with FM (according to ACR diagnostic criteria) [25], and only the FMG; and (iii) participants in the HR group should not have been diagnosed with any inflammation or rheumatic disease. Participants were excluded if they: (i) were taking any medication for cardiovascular health or any other medication that could alter the results of the measurements. All FM participants belonged to a fibromyalgia association EXISTIMOS ® in Badajoz, Extremadura (Spain). All participants were covered by the Spanish national health care system. Table 1 shows the descriptive data of the participants.

Table 1. Descriptive data of the participants.

Variable	HRG (n = 10)	FMG (n = 21)	Statistical Significance
Gender (%)	Women (100%)	Women (100%)	
Age (years)	55.80 ± 7.03	59.13 ± 8.23	$p = 0.276$
BMI (kg/m^2)	25.35 ± 2.48	28.60 ± 5.24	$p = 0.087$

BMI: body mass index; FMG: fibromyalgia group; HRG: healthy reference group. Results are shown as the mean ± standard deviation.

2.2. Procedures

Prior to the study, participants signed an informed consent form (registration number 13/2020), which had been approved beforehand by the University of Extremadura committee (no. reg. 73/2021), in compliance with the Council of Europe Directives and the Declaration of Helsinki. The accelerometers were distributed one week before the measurements, at the time of signing the consent form. Seven days later, heart rate variability variables were measured, as well as perceived pain levels using a previously validated questionnaire. Body composition measurements were recorded with the BIA Tanita DC-360 digital scale (Tanita, Tokyo, Japan), with measurement frequencies between 6.25 kHz and 50 kHz. The formula weight/height^2, expressed in kg/m^2, was used to compute body mass index (BMI). All of the individuals were fasting, wearing light clothing, and measured barefoot.

All participants attended the laboratory on the same day early in the morning so as not to affect circadian rhythms. In addition, participants were asked not to consume caffeine or alcohol for at least 12 h prior to the measurement or engage in intense exercise within 24 h prior to measurements. Participants were instructed to report if they had slept worse than normal so that, in that case, the HRV measurement would be taken on a different day. These controlling variables were controlled to avoid their direct effect on HRV.

2.3. Determination of Physical Activity Time and Sedentary Lifestyles through Accelerometry

The Actigraph wGT3X-BT, a small and lightweight accelerometer that measures movement in three directions (4.6 cm × 3.3 cm × 1.5 cm, 19 g), was utilized in this study. The device offered us relevant data on the time in minutes of sedentary behavior and about the time and intensity of physical activity performed during those days of measurement (time of light and moderate intensity—as for high intensity, there was no record). Participants wore the accelerometer on their non-dominant wrist for seven consecutive days, except during activities that could affect its performance, secured by an elastic band. The data produced by the accelerometer were analyzed using Actilife 6 software, by ActiGraph, LLC., located in Pensacola, FL, USA.

2.4. Determination of Resting Heart Rate Variability Measurements

The subjects were left in the supine position for 10 min while the R–R intervals readings were taken. To make sure that a resting heart rate was reached, only the last five minutes' worth of data were examined. This 5 min period study is consistent with the methodology outlined by Camm et al., 1996 [26]. The recording of R–R intervals was carried out utilizing a Polar H7 pulse sensor from Polar Electro Ltd., based in Kempele, Finland. We used the Kubios HRV 3.0 software to examine HRV variables. This program was also used to apply filters in order to eliminate any artifacts that might have been present. The average heart rate (HR), average R–R interval time in milliseconds (R–R), standard deviation of R–R intervals (SDNN), and the root mean square of successive differences between R–R intervals (RMSSD) were among the characteristics analyzed in the temporal domain.

2.5. Determination of Perceived Pain Using the Brief Pain Inventory (BPI)

The brief pain inventory (BPI) is a questionnaire used as a generic pain questionnaire for chronic pain conditions. There are two fundamental levels of pain: intensity and interference with the patient's regular activities. A higher perception of pain is closely connected with higher scores (scales from 0, "no pain", to 10, "the worst pain"). When used in ordinary clinical practice settings, the Spanish version of the BPI has demonstrated its validity (the internal consistency of the dimensions was good; pain dimension Cronbach's α coefficient = 0.87 and 0.89 for the dimension of interference in the activities) in assessing pain severity and its effect on everyday activities [27].

2.6. Statistical Analysis

The statistical analysis was conducted using IBM statistics SPSS v20.0 program. The data's normality was confirmed using the Shapiro–Wilk test. To ascertain the impact of the measurements on the result, an independent-samples Student's *t*-test was utilized. The significant level was considered when $p < 0.05$ and the values were reported as mean and standard deviation. Effect size (ES) was calculated using Cohen's d and interpreted as very low ($d < 0.2$), low ($0.2 < d < 0.5$), medium ($0.5 < d < 0.8$), and high ($d > 0.8$).

3. Results

The results on physical activity and sedentary behaviors are shown in Table 2, observing statistically significant differences in the sedentary time between the FMG and the HRG ($p = 0.034$). In addition, it can be seen that the time spent in moderate physical activity in one week of measurement is greater in the healthy reference participants, being statistically highly significant ($p = 0.011$), and this does not occur in the time spent in light physical activity.

Table 2. Determination of physical activity levels and sedentary lifestyles in fibromyalgia and healthy women.

	HRG (n = 10)		FMG (n = 21)		Statistical Significance	ES
Variable	**Mean**	**SD**	**Mean**	**SD**		
Sedentary time (min)	4238.28	576.70	4810.33	919.48	$p = 0.034$ *	0.74
Light physical activity (min)	3064.00	529.48	3291.42	491.19	$p = 0.38$	0.44
Moderate physical activity (min)	1889.85	840.16	1067.42	541.58	$p = 0.011$ *	1.16

ES: effect size; FMG: fibromyalgia group; HRG: healthy reference group; min: minutes. Results are shown as the mean ± standard deviation. * $p < 0.05$ compared to HRG.

According to the results of perceived pain (BPI), Figure 1 shows, as expected, that the healthy reference group has statistically significantly lower levels of pain compared to the group diagnosed with fibromyalgia ($p = 0.007$).

In reference to the results on the HRV variables (Table 3), it was observed that there are no significant differences in heart rate but there are statistically significant differences both in SDNN and RMSSD variables ($p < 0.05$), being lower in the FM group, indicating the worse cardiovascular condition compared to the healthy reference group.

Table 3. Determination of heart rate variability in fibromyalgia and healthy women.

	HRG (n = 10)		FMG (n = 21)		Statistical Significance	ES
Variable	**Mean**	**SD**	**Mean**	**SD**		
R–R (ms)	825.91	120.59	812.18	83.19	$p = 0.78$	0.13
SDNN (ms)	35.12	12.10	23.37	10.11	$p = 0.032$ *	1.05
HR (bpm)	73.99	10.86	74.63	7.88	$p = 0.95$	0.06
RMSSD (ms)	22.53	10.79	13.49	7.13	$p = 0.027$ *	0.98
pNN50 (%)	5.38	6.27	1.13	2.71	$p = 0.14$	0.87

ES: effect size; FMG: fibromyalgia group; HRG: healthy reference group; HR: heart rate; SDNN: standard deviation of consecutive R–R intervals; pNN50: relative value of consecutive intervals that differ by more than 50 ms; RMSSD: root mean square of successive differences of consecutive R–R intervals. Results are shown as the mean ± standard deviation. * $p < 0.05$ compared to HRG.

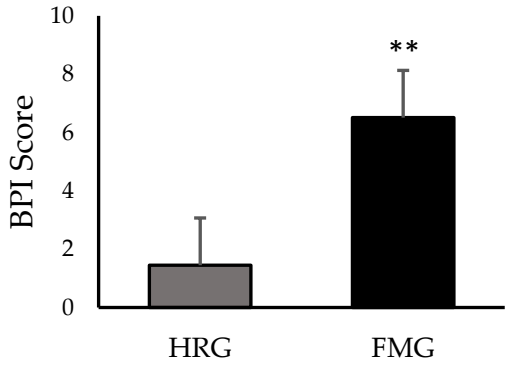

Figure 1. Perceived levels of pain in women diagnosed with FM (FMG; n = 21) and healthy women as a reference group (HRG; n = 10), using the brief pain inventory (BPI) questionnaire. Each column represents the mean ± SD of the BPI score determination in each group. ** $p < 0.01$ with respect to the HRG.

4. Discussion

There is a large body of scientific evidence to suggest that exercise and physical activity are key to improving symptoms in people diagnosed with FM [6,10,13,28], many of which include reduction in pain, improvement in perceived levels of anxiety and depression, as well as general quality of life [9,22,29]. However, FM women have relatively poor exercise adherence rates and maintain more sedentary lifestyles compared to healthy women [30]. This occurs not only because of the exacerbation of symptoms but also because of the contradicting advice concerning the activity these patients receive from the experts who are part of their treatment team [31,32]. This coincides with our results, showing that, together with higher pain levels, the group of women diagnosed with fibromyalgia have higher levels of sedentary lifestyles and, as expected, lower levels of moderate-intensity physical activity.

Medically unexplained symptoms of pain and bodily dysfunction, such as in fibromyalgia, are unresolved issues that predominate in primary care [33] and are very complex to manage because the specific causes of the condition are not clear. In addition, the syndrome is associated with other comorbidities such as metabolic disorders, functional somatic syndromes, and mental disturbances [9,34,35]. Although pain is the main cause cited by patients as having an impact on daily activities and quality of life, fatigue is reported as a cause of difficulty in adhering to physical activity programmes. Nevertheless, to the best of our knowledge, it is necessary to understand the potential presence of a vicious circle, in which high levels of perceived fatigue prevent the performance of regular physical exercise or physical exercise increases excessively perceived fatigue levels, all of this resulting in an exacerbated sedentary behavior in FM patients.

Sedentary behavior has also a variety of pathophysiological repercussions, including cardiovascular and metabolic disorders [36]. In addition, immunoneuroendocrine disorders (i.e., the interaction between stress and inflammatory responses) are clearly demonstrated as part of the aetiology of the disease [6,20,22]. As the response to inflammation is also related to the physiological regulation of the autonomous nervous system (ANS) [24], the HRV biomarker is of particular interest in this study.

Patients with autoimmune rheumatic disease can experience cardiovascular and neurological symptoms [37]. Over time, autonomic dysfunction has been reported in a variety of disorders, including irritable bowel syndrome [38,39], chronic fatigue syndrome, and migraine headaches [40], these being frequent symptoms in people diagnosed with FM. Several studies have examined autonomic nervous balance in fibromyalgia patients [41,42]. Fibromyalgia patients experience a disruption in their normal circadian rhythms and exhibit a constant hyperactivity of the sympathetic nervous system throughout the day [43]. However, these people also have a reduced sympathetic nervous system response to stress, which could explain the severe fatigue, morning stiffness, and other problems associated with hypotension. Other symptoms of fibromyalgia, such as anxiety, numbness in the limbs, urinary problems, and irritable bowel syndrome, may also be caused by this dysfunction of the autonomic nervous system [37].

Furthermore, it has been demonstrated that more variance between consecutive waves correlates with increased parasympathetic activity, indicating a better cardiovascular health [44]. This is in line with our results showing that the FMG has a statistically significant lower heart rate variability, indicating a decrease in parasympathetic activity-related cardiovascular health in these patients. These results are consistent with previous investigations stating that FM patients also have lower total heart rate variability (HRV) during short [45] and long (24 h) periods [46].

The variable SDNN shows the long-term variations of R–R waves and lower values on this variable are a proof of a higher stability on the heartbeat behavior [15]. Even though the HR was not changing between groups, the long-term variations of R–R intervals in the FMG group show that this group suffers from this cardiac impairment. Whatever the direction of the cause, sedentarism-based fibromyalgia or fibromyalgia-based sedentarism, this impairment is objective in this illness group compared to healthy population.

Furthermore, the reduction in RMSSD in the FMG group supports the above-mentioned fact. The RMSSD of consecutive R–R intervals is shown to be a descriptor of instantaneous variations on cardiac behavior, thus, reductions in this variable are symptoms of abundant steady rhythm which are commonly associated to worse performance of biological systems [47]. As described for SDNN, independent of which the cause may be, fibromyalgia associated to sedentarism or sedentarism associated to fibromyalgia shows an obvious impairment on cardiac health.

It is worth noting that these types of changes are not observed in traditional HR analysis, with no differences between groups, whereas HRV analysis has been shown to allow a more in-depth observation of the real behavior of the heartbeat and can be a very useful tool, especially in people with chronic diseases.

This study has limitations, including the small number of participants. Additionally, HRV was only determined once. Future research could perform consecutive HRV measurements to investigate correlations and obtain more accurate results.

5. Conclusions

The main finding of this research was that women with fibromyalgia do not show different values on heart rate compared to healthy women. These findings could lead to assume that patients presenting this illness do not suffer from cardiac impairment due to physiological changes provoked by this situation. However, analyzing heartbeat behavior more deeply, women presenting this situation do show a significant impairment in cardiac modulation seen in both SDNN and RMSSD.

Heart rate variability is a reliable and affordable method of assessing pain-related sedentary behavior associated with parasympathetic activity in cardiovascular health [15]. Therefore, its use in a population diagnosed with fibromyalgia could be very relevant for prevention and health improvement. Furthermore, the aim of this study is to create a debate about whether a sedentary lifestyle can be one of the major causes of the onset of fibromyalgia syndrome, among others; or if, on the contrary, it is the symptoms that this condition entails (pain, fatigue, stress, and depression) that cause a less active life. Here is the question: which came first, the chicken or the egg? What is clear is that this type of patient needs to lead an active life, with exercise programs adapted to their needs and to achieve adherence that has a long-term objective and not just for a limited period of time.

It is crucial to investigate which forms of physical activity may be beneficial in improving symptoms and preventing the onset of fibromyalgia and the use of HRV as a complementary tool to assess it could be very useful.

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Informed Consent Statement: Written informed consent has been obtained from the patients to publish this paper.

Data Availability Statement: The raw data supporting the conclusions of the manuscript will be made available by the authors, without undue reservation, to any qualified researcher.

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