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Article

Effects of Meditation on Mental Health and Cardiovascular Balance in Caregivers

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Abstract:

Background: Caring for a loved one can be rewarding but also associated with substantial caregiver burden, developing mental outcomes and affecting happiness. Eventually, these physical and psychological disorders can lead to an imbalance of the autonomic nervous system. Meditation has been found to offer multiple benefits to relieve these disorders and reduce the risk of cardiovascular disease. The aim of this study was to determine the effects of a four-week 16-hour presential meditation program on physiological and psychological parameters and vagal nerve activity in high-burden caregivers, comparing the results with those not receiving this program. **Methods:** A non-randomized repeated-measures controlled clinical trial was conducted, dividing participants between intervention and control groups by convenience allocation because random assignment was ethically inappropriate. **Results:** After the meditation program, the experimental group showed a significant reduction in anxiety levels ($F= 24.92$, $p<0.001$), a non-significant amelioration of depression levels ($F= 1.75$, $p=0.19$), and significantly improved heart rate variability ($F= 8.40$, $p<0.05$) and SDNN ($F=15.59$, $p<0.05$). **Conclusions:** Meditation can be a useful therapy to enhance the mental health and autonomic nervous system balance of informal caregivers, improving symptoms of physical and mental overload.

Keywords: meditation; vagal nerve activity; high-burden caregivers; mental health.

1. Introduction

The term informal caregivers is applied to family members or close relatives providing partial or full care to dependent individuals with difficulties in self-care, facilitating their well-being and helping them to perform different tasks and activities [1]. Caring for a loved one can be rewarding but can also be associated with significant caregiver burden. In broad terms, this refers to stress due to caregiving that arises from an interplay among various predisposing factors, including contextual circumstances, direct primary stressors, indirect secondary stressors, and appraisal [2]. The physical health of caregivers can be a predictor of both care burden and depression, given that caregivers with poorer health may perceive a greater burden and be more prone to depression after a long period of caregiving; it is therefore necessary to adjust results for burden and depression in order to establish their relative impact [3].

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Depression has been reported in at least one-third of caregivers of persons with dementia, a higher prevalence than observed in the general population or in the caregivers of persons with other physical or psychological diseases [4]. Researchers have also described a correlation between the anxiety of caregivers over an uncertain future and burnout [5]. However, although there is some evidence that caregiver burden can generate unhappiness [6], there has been no research on the effect of interventions on their self-perception of happiness. Besides the psychological consequences of the caregiver burden, it has been associated with worse self-care, including a less healthy diet, fewer preventive medical visits, and lower physical activity levels, increasing the risk of cardiovascular and other diseases [7]. It has also been proposed that stress generated by the caregiver-patient relationship increases the likelihood of coronary disease [8].

All of the disorders derived from the physical and emotional overload of caregivers can produce an imbalance of the autonomic nervous system (ANS), formed by the sympathetic and parasympathetic nervous systems [9]. The main component of the parasympathetic nervous system is the vagus nerve, which regulates mood status, immune response, digestion, and heart rate, among other key functions. Heart rate variability (HRV) results from interaction between the ANS and the cardiovascular system and reflects vagal activity, serving as a noninvasive biomarker of health and emotional regulation [10]. HRV is measured by calculating the time period between consecutive R waves (RR interval). Differences between successive heartbeats can be established with reference to time (time-domain analysis) or frequency (frequency-domain analysis [11].

An increase in HRV has been linked to adaptive emotional regulation strategies [12,13]. Practices that focus on the interactions among brain, body, mind, and behavior, such as yoga, have been reported to improve well-being and cardiac balance in informal caregivers [14,15]. "Meditation" is another ancient approach to the cultivation of well-being [16]. Numerous types of meditation are taught, often derived from different Eastern religious and spiritual traditions, but they all emphasize the regulation of attention and emotion, consciousness of the body, and self-awareness [17]. Mediation can be practiced by focusing on an object or event (Focused Attention) or, in a more advanced modality, without recourse to this tactic (Open Monitoring) [18]. Meditation has been reported to offer multiple psychoneurophysiological benefits, including: reduction in stress and inflammation [19]; increase in attentional networks at neural level [20], enhancement of explicit functions of parts of the right hemisphere [21], and the alleviation of psychological distress in cancer patients [22]. The American Heart Association considers meditation as an adjunct to guideline-directed cardiovascular risk reduction [23].

With this background, the objective of the present study was to determine the effects of a four-week presential meditation program of 16 hours on physiological and psychological parameters and vagal nerve activity in high-burden caregivers, comparing the results with those of controls not receiving this program.

2. Materials and Methods

A non-randomized repeated-measures controlled clinical trial was conducted, with the convenience allocation of participants into an intervention or control group. It was not possible to randomly assign the participants for ethical reasons. The study was registered at ClinicalTrials.gov (NCT04570826).

Setting and Selection of Participants

Relevant associations in the city and province of Granada city were contacted by the researchers in person or by telephone to recruit informal caregivers for the study. Inclusion criteria for participation

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were: care for at least two years of a dependent family member or close relative living in the same dwelling; and a caregiver burden of >55 points on the Zarit Burden Scale [24]. Exclusion criteria were: history of cardiovascular disease; and previous experience in mind-body practices. Written informed consent was obtained from all participants in the study, which was approved by the local research ethics committee (CEI-GR C-9) and followed the principles of the Declaration of Helsinki. Convenience sampling was used to assign caregivers to the control or experimental groups. Figure 1 depicts the flow of participants through the study. A single researcher (L.D.R.) contacted participants by telephone to collect data on their medical history and demographic characteristics including age, gender, ethnicity, marital status, educational level, occupation, alcohol and smoking habits, menopause status, time performing caring activity, relationship with care-receiver, weight, and height.

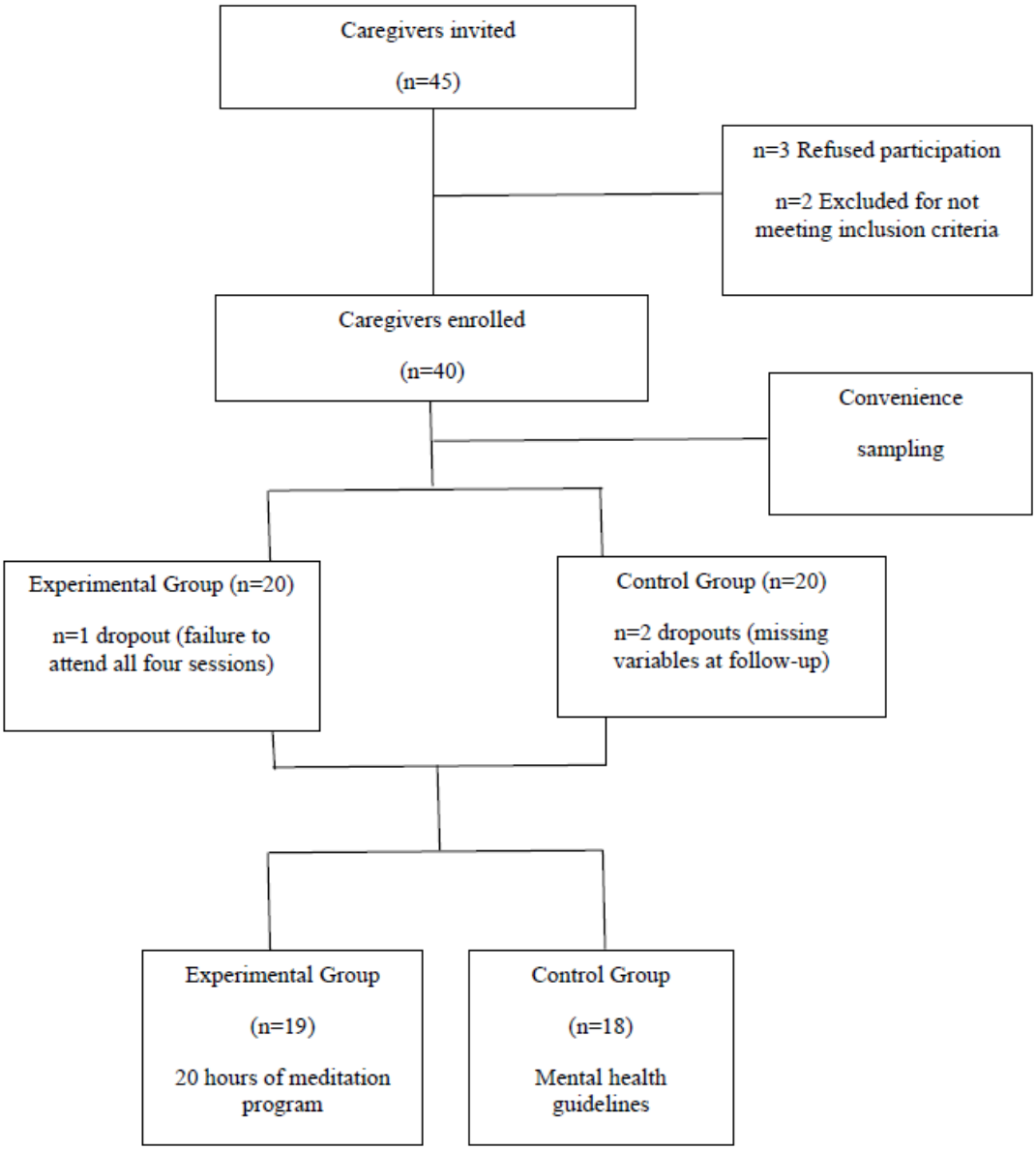

Figure 1. Flow of participants

Control Group

The control group received scientific descriptions of meditation in writing.

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Experimental Group

The experimental group participated in a one-month meditation program of eight 2-hour sessions.

Meditation Training Program

A meditation trainer with more than 10 years of experience ran a Focused Attention Meditation program in a room at the School of Health Sciences of the University of Granada. Over a four-week period, two 2-hour sessions were conducted each Friday afternoon, with a 30-min interval between them. In brief, the aims were to: to learn a comfortable posture when sitting or lying down; to focus attention on the breathing and allow distractions to come and go naturally, without judging. Each 2-hour session started with a 15-min class on the scientific evidence supporting the exercises, followed by 25 minutes of exercises to promote mobility, flexibility, balance, strength and endurance, and then by 25 minutes of costal, diaphragmatic and clavicular breathing exercises to develop lung capacity, ending with 25 minutes of body awareness exercises, observing sensations, thoughts and perceptions with gratitude and compassion. Although free to repeat the exercises at home, no participant was able to do so, citing time constraints.

Sample size calculation

EPIDAT 4.1 software (Xunta de Galicia, Spain) was used to estimate the sample size for a statistical power of 80% with α = .05, based on previously published data [25]. A minimum sample size of 23 participants per group was calculated.

Outcome measures

All outcome measures were determined before (week 0) and after (week 5) the meditation program. At both time points, data were gathered by a single researcher (L.D.R.).

Happiness level, measured as scores on the validated self-administered Lima happiness questionnaire, which contains 27 items grouped into 4 subscales (Positive sense of life, Satisfaction with life, Personal fulfillment, and Joy of life), with responses on a 5-point Likert scale (1 = strongly agree, 2 = agree, 3 = neither agree nor disagree, 4 = disagree, and 5 = strongly disagree). Total scores of 27-87 = very low, 88-95 = low, 96-110 = medium, 111-118 = high, and 119-135 = very high levels of happiness.

Hospital Anxiety and Depression Scale (HADS) score. This validated self-administered instrument is designed for general medical outpatients to detect the possible presence of anxiety and depression. It contains 7 items for anxiety and 7 for depression, with responses on a 4-point Likert scale (0-3) in relation to feelings and emotions during the previous week [26].

Short-term HRV: The method published by Kappussami (2020) [27] was used, following recommendations of the Task Force of the European Society of Cardiology and North American Society of Pacing and Electrophysiology (Task Force, 1996). First, participants lay in supine position in a quiet room (at 22–25 °C) for 10 min of rest with normal breathing paced by metronome at 0.2 Hz. Next, ECG signals were acquired for 5 min using a Holter monitor with modified lead II channel system (Norav Holter NR302, Braemar, Brunsville, MN). HRV was calculated from ECG records as the time interval between consecutive heartbeats (RR interval). The following parameters were determined in the time domain: standard deviation of mean normal-to-normal (NN) interval (SDNN), square root of the mean squared differences of successive NN intervals (RMSSD), and number of all NN intervals divided by the maximum of all NN intervals (HRV index). The following spectral components were determined in the frequency domain: low-frequency (LF) band (0.04–0.15 Hz), as measure of sympathetic and parasympathetic activities; high-frequency (HF) band (0.15–0.40 Hz), associated with vagal–parasympathetic activity; and LF/HF ratio, indicating the sympathovagal

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balance. The spectral analysis was performed with NH301-4 software (Norav, version 2.70) using fast Fourier transform algorithms. The sampling rate was 256 samples per second and the frequency filter was set at 0.05 to 60 Hz. Because of the low sampling rate, an interpolation algorithm was used to improve R-peak detection and the frequency filter was set at 0.05–60 Hz.

Blood pressure/heart rate: Blood pressure and heart rate were measured at 0 and 5 weeks between 9 a.m. and 12 noon using an Omron HEM-7320-Z validated automatic oscillometer, placing the cuff at 2 cm above the elbow and instructing the participant not to speak or move during the measurement.

Statistical analysis

IBM-SPSS 26.0 was used for the statistical analysis. Results were expressed as means with standard deviation for continuous variables and percentages with 95% confidence intervals for categorical variables. After verifying the normality of the data distribution with the Kolmogorov-Smirnov test, an analysis of covariance (ANCOVA) was performed, with pre-post differences as dependent variables, group as fixed factor (Meditation and Control), and baseline levels of variables as covariates. The Bonferroni correction was used for post-hoc pairwise comparisons, and <.05 was considered statistically significant.

3. Results

Forty informal caregivers who met the eligibility criteria were initially enrolled in the study. The program was not completed by three participants, leaving a final study sample of 37 caregivers, 28 females and 9 males, with a mean (SD) age of 44.03 (7.30) years, mean height of 165.72 (6.85) cm, mean weight of 69.64 (13.43) kg and, therefore, a mean BMI of 25.26 (4.09) kg/m2. All participants except one were Caucasian, 73.7% were married, >50 % had completed higher education, 78.4% were employed, 56.8% were nonsmokers, 60% did not consume alcohol, 70.2 % had been caring for a relative for > 6 years, and 54.1 % were parents of the care-receivers. The only statistically significant difference in the above variables between the experimental (n=19) and control (n=18) groups was in educational level, with higher education being completed by 31.6% of the experimental group versus 72.2% of controls (Table 1). According to the ANCOVA results, the global happiness score ($F= 297.42$, $p<0.001$) and the scores for all the following subscales were significantly higher in the experimental group than in the control group at 5 weeks: positive sense of life ($F= 74.61$, $p<0.001$), satisfaction with life ($F= 111.62$, $p<0.001$, personal realization ($F= 41.64$, $p<0.001$), and happiness of living ($F= 234.57$, $p<0.001$) (Table 2). Anxiety levels were also significantly reduced in the experimental group ($F= 24.92$, $p<0.001$) (Figure 2). An improvement in depression levels in the experimental versus control group did not reach statistical significance ($F= 1.75$, $p=0.19$). HRV results revealed significant between-group differences in HRV Index ($F= 8.40$, $p<0.05$), SDNN ($F=15.59$, $p<0.05$) and RMSSD ($F=10.72$, $p<0.05$) in the time domain, and in the HF ($F=4.82$ $p<0.05$) in the frequency domain, which were all improved in the experimental group after the meditation program (Table 3). Significantly decreased systolic ($F=50.68$, $p<0.001$) and diastolic blood ($F= 38.14$, $p<0.001$) pressures and resting heart rate ($F= 12.62$, $p<0.05$) were also observed in the experimental group at 5 weeks. No covariates influenced in these results

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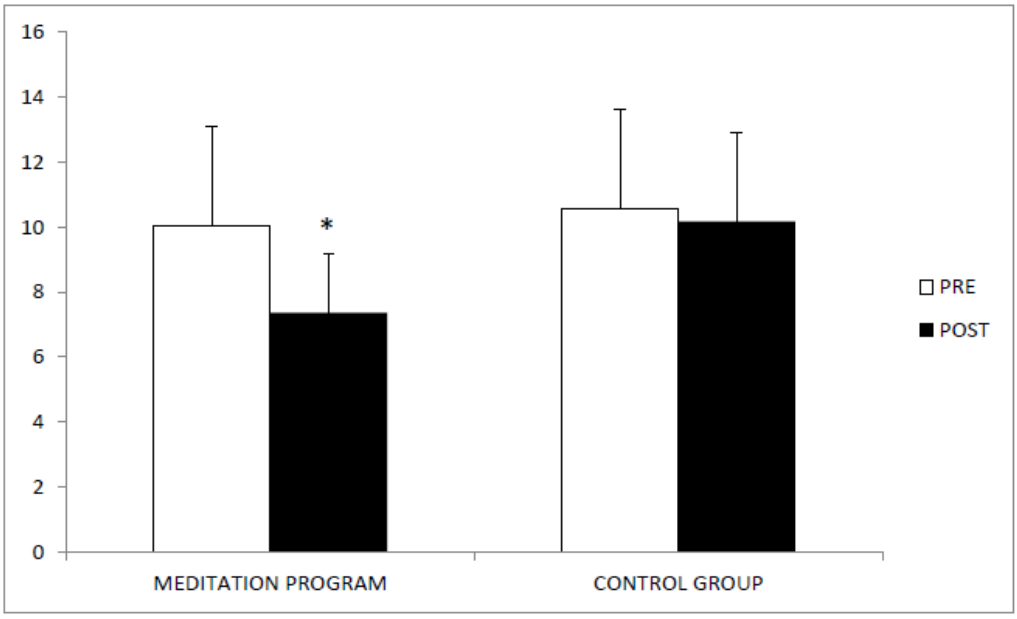

Figure 2. Comparison of Anxiety values before and after treatments

Table 1. Caregiver characteristics and comparisons between study groups

Variables	Meditation Program (n=19)	Control Group (n=18)	p
Age (y) Mean (SD) **	44.42±8.17	43.61±6.46	
	[33-64]	[34-56]	**0.74**
Gender (%)*			
Female	73.7	77.8	
Male	26.3	22.2	**0.77**
Ethnicity (%)*			
Caucasian	94.7	100	
Black	5.3	0.0	
Gypsy	0.0	0.0	**0.32**
Arab	0.0	0.0	
Marital status (%)*			
Single	5.3	0.0	
Married	73.7	72.2	
Divorced	15.8	16.7	**0.71**
Widow	5.3	11.1	
Educational level (%)*			
Primary studies	26.3	0.0	
Secondary studies	42.1	27.8	**0.01***
Higher Education	31.6	72.2	

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Occupational status (%)*			
Homemaker	31.6	11.1	
Employed	68.4	88.9	
Unemployed	0.0	0.0	**0.13**
Retired	0.0	0.0	
Smoking status (%)*			
Non-smoker	57.9	55.6	
Smoker	15.8	22.2	
Ex-smoker	26.3	22.2	**0.87**
Alcohol status(%)*			
Don´t consume	68.4	50.0	
Consume monthly	10.5	22.2	**0.47**
Consume weekly	21.1	27.8	
Consume daily	0.0	0.0	
Menopausal status (%)*			
NO	84.2	94.4	
YES	15.8	5.6	**0.31**
Duration of caring (%)*			
1-5 years	26.3	33.0	
6-10 years	47.4	38.9	**0.85**
>11 years	26.3	27.8	
Caregiver relationship with care receiver (%)*			
Partner	5.3	5.6	
Parent	52.6	55.6	**0.98**
Child	42.1	38.9	
**Weight (Kg) Mean (SD) ** **	70.60±12.78 [53-110]	68.63±14.38 [56-105]	**0.66**
Height (cm) Mean (SD)**	165.78±7.08 [155-180]	165.66±6.80 [158-179]	**0.95**
Body Mass Index Mean (Kg/m^2) (SD)**	25.73±4.77 [20.20-39.56]	24.76±3.30 [21.01-32.77]	**0.48**

Note: Values are expressed as means ± standard deviation (95% confidence interval).

Chi-square test* and Student *t*-test** for between-group comparisons;*p<0.05

TABLE 2. Comparison of happiness values before and after program.

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Outcomes	Meditation Program (n=19)	Control Group (n=18)	F	P-value
Happiness				
Positive sense of life	24.05±5.21	21.22±5.08		
Baseline	33.00±4.57	22.05±5.59	74.61	**0.000***
Post-treatment				
Satisfaction with life	20.47±3.20	20.55±3.85		
Baseline	28.21±1.68	21.00±3.51	111.62	**0.000***
Post-treatment				
Personal realization	19.26±2.66	19.00±2.27		
Baseline	24.47±1.86	20.05±2.33	41.64	**0.000***
Post-treatment				
Happiness of living	15.84±1.60	16.05±1.95		
Baseline	22.89±1.24	16.66±1.81	234.42	**0.000***
Post-treatment				
Global Score	79.78±7.00	76.83±7.70		
Baseline	108.57±5.84	80.33±8.28	297.42	**0.000***
Post-treatment				

Note: ANCOVA for comparisons between interventions * $p<0.05$

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TABLE 3. Comparison of outcomes values before and after treatments

Note: ANCOVA for comparisons between interventions * p<0.05

Outcomes	Meditation Program (n=19)	Control Group (n=18)	F	P-value
Heart rate (beat*min^{-1})				
Baseline	75.95±8.78	73.89±6.41		
Post-treatment	70.58±6.57	72.94±6.66	12.62	**0.001***
Systolic Pressure Blood (mm Hg)				
Baseline	140.36 ±13.15	139.83±6.79		
Post-treatment	128.26±11.10	138.72±7.80	50.68	**0.000***
Diastolic Pressure Blood (mm Hg)				
Baseline	74.05±9.57	73.16±3.22		
Post-treatment	68.31±7.77	72.05±3.36	38.14	**0.000***
HEART RATE VARIABILITY				
SDNN				
Baseline	45.08±28.83	52.47±16.04		
Post-treatment	90.33±50.65	55.65±16.42	13.59	**0.001***
RMSSD				
Baseline	41.78±30.16	49.64±17.39		
Post-treatment	91.04±63.81	54.58±17.85	10.72	**0.002***
HRV índex				
Baseline	4.93±2.56	6.02±1.55		
Post-treatment	6.72±2.70	5.91±1.34	8.40	**0.006***
LF				
Baseline	171.08±60.09	137.82±41.97		
Post-treatment	169.00±69.33	144.64±46.41	0.25	0.61
HF				
Baseline	141.86±61.25	140.88±31.49		
Post-treatment	167.34±65.13	137.90±31.48	4.82	**0.035***
LF/HF Ratio				
Baseline	1.39±0.76	1.04±0.45		
Post-treatment	1.38±1.44	1.10±0.52	0.06	0.80

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4. Discussion

To our best knowledge, this is the first controlled clinical trial to demonstrate an improvement in the mental health and cardiovascular balance of high-burden informal caregivers after a one-month meditation program of eight 2-hour sessions in comparison to a control group. After the program, the caregivers evidenced a decrease in blood pressure, resting heart rate, and anxiety and an increase in happiness score and HRV. No statistically significant between-group differences were observed in LF band or LF/HF ratio or in depression levels.

These data contribute evidence on the effectiveness of complementary therapies to enhance the mental health of healthy individuals by promoting well-being and improving their psychological function [27]. With regard to the impact on anxiety, a recent meta-analysis supported the usefulness of yoga or meditation as a complementary or solo treatment of anxiety or depression [28]. It has previously been found that a 12-month yoga programs or an 8-week meditation programs can reduce anxiety and depression and diminish physical and psychological distress [15, 14, 29].

Besides reducing anxiety levels, the participants receiving the meditation program experienced an improvement in happiness as measured by the Lima Scale from a very low initial score to a medium score. They reported a more positive perception of their sense of life, satisfaction with life, personal realization, and happiness of living. Klamut MK (2002) [30] has described happiness as a state of inner peace and satisfaction with life, characterized by benevolence towards oneself and others; sensitivity to the beauty of nature, culture, and art, and a harmonious coexistence with the environment. In a study of 46 caregivers of patients with Alzheimer's disease, Danukalov et al (2017) [25] observed that an eight-week yoga and meditation program improved their quality of life and vitality and enhanced their capacity for attention and self-compassion, which have demonstrated potential benefits for mental and physical health [31]. Other authors have closely associated genuine and enduring happiness with compassion and empathy, related to a selfless mode based on the dissolution of the limits perceived between the body and the rest of the world [32,33].

In the present study, higher scores for Satisfaction with Life were correlated with a higher HRV, and the presence of anxiety was correlated with a lower HRV, demonstrating a positive relationship between mental well-being and HRV. In this regard, the HRV is influenced by functions of the prefrontal cortex, whose activity has been associated with long-term happiness [34]. In the time domain, SDNN, RMSSD, and HRV index values were significantly higher after the meditation program in comparison to controls. Similar findings have been reported after a six-month yoga breathing program in healthy adolescents [27] and after myofascial therapy or Reiki sessions in breast cancer survivors with cancer-related fatigue (increased SDNN and RMSSD), in stress responders (increased SDNN), and in burned-out healthcare professionals (increased SDNN) [12,13]. In the frequency domain, HF band values were significantly higher in caregivers who underwent the meditation program, indicating activation of the parasympathetic nervous system, as previously observed after manual treatment or music therapy [35,36]. A meditation session in healthy individuals [37] and an eight-week yoga program in women with high depressive symptoms Chu (2015) [38] were found to exert positive effects on sympathovagal balance, increasing the HF and reducing the LF and LF/HF ratio. However, the comparison of HRV findings among studies is hampered by differences in measurement techniques and study parameters.

The positive effects of meditation on HRV, blood pressures, and HR have previously been described [39,40,12]. However, this is the first controlled clinical case to demonstrate that the mental health and cardiovascular balance of high-burden caregivers can be improved by a meditation program, with a significant reduction in resting heart rate and in systolic and diastolic blood pressures.

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Study limitations include the small sample size and the lack of randomization, reducing the statistical power and the possibility of extrapolating results. The program was also relatively short (4 weeks), and a larger sample size and longer program may have confirmed an improvement in depression and certain HRV parameters that did not reach statistical significance in the present investigation.

5. Conclusions

Meditation can be a useful therapy to enhance the mental health and ANS balance of informal caregivers, improving symptoms of physical and mental overload.

Author Contributions:

Díaz Rodríguez L, Sánchez-García JC and De la Fuente-Solana Emilia I : Conceptualization, methodology design, writing—review and editing.

Vargas-Román K, Cañadas-De la Fuente GA, Blanque-García R: investigation, data curation, formal analysis.

All authors have read and agreed to the published version of the manuscript

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