ORIGINAL RESEARCH

Correlation Between Chronic Neck Pain and Heart Rate Variability Indices at Rest: A Cross-sectional Study

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ABSTRACT

Objective: The purpose of this study was to correlate the heart rate variability (HRV) indices with variables of pain that were experienced by individuals with chronic neck pain.
Methods: This was a blinded cross-sectional study. Individuals with chronic neck pain (n = 15) and healthy participants (n = 15), both sedentary and between 18 and 45 years of age, were included. The neck pain was assessed with the Numerical Rating Scale at rest and during cervical movements, Neck Disability Index, Catastrophic Thoughts about Pain Scale, and Tampa Scale of Kinesiophobia. The HRV indices (linear and nonlinear) were used for assessment of autonomic function at rest (in supine, sitting, and standing positions).
Results: We observed significant correlations between the NRS, Neck Disability Index, and Catastrophic Thoughts about Pain Scale with the linear and nonlinear HRV indices ($P < .05$, $r \geq 0.362$), so that the worst HRV indices are associated with conditions of more intense and disabling neck pain.
Conclusion: The HRV indices were significantly associated with pain intensity, disabilty, and catastrophizing in individuals with chronic neck pain. (J Manipulative Physiol Ther 2019;42:219-226)
Key Indexing Terms: *Neck Pain; Musculoskeletal Pain; Autonomic Nervous System*

INTRODUCTION

Chronic neck pain is a musculoskeletal disorder characterized by continuous or recurrent pain lasting for at least 3 months[1,2] It has a multifactorial etiology and is associated with risk factors such as psychosocial stressors, specific neck and shoulder injury, and repetitive physical loads.[3-5] It has been estimated that 22% to 70% of the population will experience neck pain at some point in their life, which can lead to disability and result in high costs for the health care system.[6,7]

Some studies have investigated the behavior of the autonomic nervous system and the implications to the cardiovascular system in participants with chronic pain, specifically with low back pain.[8-10] Among the methods for assessing the autonomic nervous system, heart rate variability (HRV) has commonly been used.

Heart rate variability is a noninvasive technique that is capable of providing important clinical information on the sympathetic and parasympathetic modulation of the heart.[4,5,11] Heart rate variability generally provides descriptions of fluctuations in heartbeat intervals (R–R intervals) and heart rate (HR), thus reflecting autonomic control.[12] Hautala et al[10] suggested that chronic pain conditions were associated with altered autonomic nervous system functions, which were assessed using HRV indices such as fibromyalgia, regional complex pain syndrome, and low back pain.

A limited number of studies have been published on HRV and pain in patients with chronic neck pain. Hallman

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et al[5] observed a high HR and reduced HRV in workers with chronic neck and shoulder pain, especially during sleep, and suggested that this was due to the low practice of physical activity during leisure time. Hallman et al[4] also observed an abnormal sympathetic baroreceptor response to daily physical activity in participants with chronic neck pain. In addition, Kang et al[3] identified an association between HRV reduction and the subjective perception of disability in patients in this population.

Therefore, considering the previous studies conducted by Hallman et al,[4] Hallman et al,[5] and Kang,[3] there are some gaps in the literature that the present investigation aims to clarify, including the measurement of chronic neck pain considering psychosocial aspects (ie, catastrophizing and kinesiophobia) and the use of a greater number of HRV indices in the analysis of autonomic activity.

The purpose of this study was to correlate HRV indices with variables of pain that were experienced by individuals with chronic neck pain. The hypothesis of this study was that chronic pain is significantly associated with changes in HRV.

Methods

Ethics Aspects

This was a blind cross-sectional study, and the researcher responsible for the collection and analysis of HRV data was unaware of whether or not the participant had chronic neck pain. Participants were recruited from communities near Tiradentes University Center (Maceió, AL, Brazil) through verbal dissemination of information, posters, and the internet. Data collection was performed at the Clinical School of Physiotherapy after the study procedures were approved by the Committee of Ethics in Research (protocol number 60587416.0.0000.5641).

Participants

A sample size calculation was performed using Ene version 3.0 (Autonomous University of Barcelona, Spain) in accordance with a study by Zou et al.[13] The calculation was based on the detection of moderate associations ($r = 0.50$) between variables. Considering a statistical power of 80% and an alpha of 5%, the number of participants required was estimated to be 30.

The study used 2 distinct sample sets: individuals with chronic neck pain and healthy participants. Participants were included in the first group regardless of their sex and they were sedentary, were between 18 and 45 years of age, and had chronic neck pain (>90 days) nonspecific and nonirradiated to the upper limbs.[14] Neck pain was identified as a Neck Disability Index (NDI) score of ≥5 points and a Numerical Rating Scale (NRS) score of ≥3 points at rest or during active cervical movement.[15]

Volunteers who presented with a history of cervical trauma; cervical radiculopathy; surgery to the head, face, cervical spine, and upper and lower limbs; cervical hernia; degenerative disease of the spine; physiotherapeutic treatment (past 3 months); analgesic use, anti-inflammatory use, or muscle relaxant use (previous week); or any rheumatological, metabolic, or cardiovascular disease were all excluded from the study.

Healthy individuals without neck pain were recruited regardless of their sex. They were sedentary and between 18 and 45 years of age. The exclusion criteria used was the same as that used for participants with chronic neck pain.

Individuals who reported not performing any type of regular physical activity in the last 12 months were considered to be sedentary. The Baecke questionnaire was also applied to quantify habitual physical activity.[16]

Evaluation of Chronic Neck Pain

The NRS is a simple scale ranging from 0 to 10, where 0 represents "no pain" and 10 represents the "worst pain you can imagine." Each participant defined a number to grade their pain.[17] The intensity of pain was evaluated with the participant in a resting condition (NRSr) and after active cervical spine movements for flexion, extension, rotation, and lateral inclinations (NRSm). Participants were also questioned on the last time they felt neck pain (chronicity of pain).

The NDI is an instrument that has been adapted and validated for the Brazilian population[18] and is composed of 10 questions that investigate neck pain and disability. Each question has 6 possible answers, corresponding to scores 0 to 5. Therefore, the score for the classification of pain-associated disability ranges from 0 to 50 points, with 0 to 4 equating to no disability; 5 to 14 indicating mild disability; 15 to 24 reflecting moderate disability; 25 to 34 indicating severe disability; and 35 to 50 equating to complete disability.[19]

The Catastrophic Thoughts about Pain Scale was used to assess pain-related catastrophizing and was adapted and validated for the Brazilian population.[20] The scale is composed of 9 items staggered on a Likert scale. The scale ranges from 0 to 5 points and has the words "almost never" and "almost always" at the extremities. The total score is the sum of the items divided by the number of items answered, and the minimum score is 0 and the maximum 5. Higher scores indicate an increased presence of catastrophic thoughts.

The Tampa Scale for Kinesiophobia is an instrument that is used to evaluate the fear of movement and recurrence of the lesion and has been validated for the Brazilian population.[21] The test consists of 17 pain statements, and the participant must answer to what extent they agree or disagree with each statement using a 4-point scale. The final score ranges between 17 and 68 points, with

Table 1. *Comparisons Between the Groups of Personal and Clinical Characteristics*

Variables	Neck Pain (n = 15)	Health (n = 15)	*P* Value
Age (y) [a]	22.46 (3.09)	23.73 (5.63)	.452
Sex (female) [b]	9 (60)	9 (60)	.999
Mass (kg) [a]	72.98 (19.48)	67.42 (15.04)	.390
Height (m) [a]	1.68 (0.11)	1.66 (0.10)	.546
BMI (kg/m^2) [a]	25.35 (4.87)	24.14 (3.81)	.454
Chronicity of pain (months) [a]	36.40 (22.58)	0 (0)	<.001 [c]
NRS			
Rest (score) [a]	3.33 (3.51)	0.46 (1.06)	.005 [c]
After movements (score) [a]	3.66 (2.58)	1.06 (1.33)	.002 [c]
NDI (score) [a]	8.80 (4.75)	1.06 (1.33)	.001 [c]
CTPS (score) [a]	1.06 (1.02)	0.19 (0.34)	.006 [c]
TSK (score) [a]	34.66 (7.52)	32.53 (5.96)	.397
BQ			
Ocupational (score) [a]	2.70 (0.35)	2.47 (0.40)	.117
Sports (score) [a]	2.15 (0.37)	2.11 (0.69)	.871
Leisure (score) [a]	2.65 (0.86)	2.73 (0.57)	.716
Total (score) [a]	7.50 (0.86)	7.32 (1.13)	.639
Mean (score) [a]	2.50 (0.28)	2.44 (0.38)	.633

BMI, body mass index; *BQ*, Baecke Questionnaire; *CTPS*, Catastrophic Thoughts about Pain Scale; *NDI*, Neck Disability Index; *NRS*, numerical rating scale; *TSK*, Tampa Scale for Kinesiophobia.
[a] Values presented as mean (standard deviation).
[b] Values presented as absolute number (percentage).
[c] Significant difference (*t* test for independent samples, $P < .05$).

higher scores indicating a greater degree of kinesiophobia and that the individual is fearful of moving because of neck pain.

Measurement of HRV

HR and R–R intervals (RRi) were continuously registered and recorded by a telemetry system using a Polar V800 cardio frequency meter (Polar Electro OY, Kempele, Finland). Each participant rested for 10 minutes before the start of data collection to ensure HR stabilization. The HR was then continuously recorded over a period of 10 minutes during supine, sitting, and standing positions. All participants were investigated in a quiet room from 7:30 AM to midday. All participants were instructed to avoid caffeinated and alcoholic beverages 12 hours before the test and not to perform activities requiring moderate to heavy physical exertion. Individuals were told not to talk and not to sleep during the procedure.

HRV Analysis

Heart rate signals were transferred to a microcomputer, and the RRi series were reviewed by visual inspection. Only segments with >90% purely sinusal beats were included in the final analysis. The RRi series were sampled again at a frequency of 5 Hz, and the data were filtered to remove variations below 0.04 Hz and above 1.0 Hz. The data were transferred to Kubios HRV analysis software, version 2 beta (MATLAB, Kuopio, Finland) and analyzed using a series of 256 sequential RRi, chosen as the stretch with the highest stability.

Frequency-domain and time-domain analyses were performed at rest using widely accepted indices, such as

Table 2. *Correlation Between Pain Measurement Variables and Heart Rate Variability (HRV) Indices in Supine, Sitting, and Standing Positions*

Variables	Chronicity	NRSr	NRSm	NDI	CTPS	TSK
HRV supine (linear)						
Mean RR intervals (ms)	*r* = -0.445 [a]	*r* = -0.057	*r* = -0.581 [a]	*r* = -0.421 [a]	*r* = -0.179	*r* = 0.215
STD-RR (ms)	*r* = -0.291	*r* = 0.031	*r* = -0.382 [a]	*r* = -0.391 [a]	*r* = -0.275	*r* = 0.166
Mean HR (bpm)	*r* = 0.431 [a]	*r* = 0.084	*r* = 0.603 [a]	*r* = 0.426 [a]	*r* = 0.192	*r* = -0.169
rMSSD (ms)	*r* = -0.272	*r* = -0.063	*r* = -0.331	*r* = -0.370 [a]	*r* = -0.346	*r* = 0.078
RR Tri	*r* = -0.286	*r* = 0.016	*r* = -0.477 [a]	*r* = -0.362 [a]	*r* = -0.251	*r* = 0.099
TINN (ms)	*r* = -0.231	*r* = 0.105	*r* = -0.257	*r* = -0.336	*r* = -0.272	*r* = 0.127
LF (nu)	*r* = -0.104	*r* = 0.153	*r* = -0.054	*r* = 0.081	*r* = 0.206	*r* = 0.236
HF (nu)	*r* = 0.104	*r* = -0.153	*r* = 0.052	*r* = 0.081	*r* = -0.203	*r* = -0.237
LF/HF	*r* = -0.027	*r* = 0.234	*r* = -0.021	*r* = 0.085	*r* = 0.349	*r* = 0.272
HRV supine (nonlinear)						
SD1 (ms)	*r* = -0.272	*r* = -0.063	*r* = -0.330	*r* = -0.370 [a]	*r* = -0.346	*r* = 0.078
SD2 (ms)	*r* = -0.283	*r* = 0.086	*r* = -0.387 [a]	*r* = -0.380 [a]	*r* = -0.211	*r* = 0.214
SD2/SD1 Ratio	*r* = 0.231	*r* = 0.108	*r* = 0.174	*r* = 0.243	*r* = 0.384 [a]	*r* = 0.177
Alpha 1	*r* = 0.149	*r* = -0.016	*r* = 0.132	*r* = 0.082	*r* = 0.205	*r* = 0.161
Alpha 2	*r* = 0.309	*r* = -0.003	*r* = 0.312	*r* = 0.335	*r* = 0.298	*r* = -0.112
ApEn	*r* = -0.010	*r* = -0.147	*r* = 0.125	*r* = 0.061	*r* = 0.025	*r* = 0.097
SampEn	*r* = -0.284	*r* = -0.168	*r* = -0.103	*r* = -0.157	*r* = -0.096	*r* = 0.125
HRV sitting (linear)						
Mean RR intervals (ms)	*r* = -0.333	*r* = -0.183	*r* = -0.551 [a]	*r* = -0.368 [a]	*r* = -0.258	*r* = 0.045
STD-RR (ms)	*r* = -0.167	*r* = 0.160	*r* = -0.336	*r* = -0.187	*r* = -0.090	*r* = 0.319
Mean HR (bpm)	*r* = 0.331	*r* = 0.210	*r* = 0.585 [a]	*r* = 0.372 [a]	*r* = 0.274	*r* = 0.005
rMSSD (ms)	*r* = -0.182	*r* = 0.002	*r* = -0.339	*r* = -0.249	*r* = -0.277	*r* = 0.244
RR Tri	*r* = -0.066	*r* = 0.217	*r* = -0.252	*r* = -0.097	*r* = -0.014	*r* = 0.301
TINN (ms)	*r* = -0.218	*r* = 0.298	*r* = -0.343	*r* = -0.175	*r* = 0.000	*r* = 0.332
LF (nu)	*r* = -0.242	*r* = 0.088	*r* = -0.056	*r* = -0.122	*r* = 0.187	*r* = 0.110
HF (nu)	*r* = 0.244	*r* = -0.089	*r* = 0.054	*r* = 0.121	*r* = -0.188	*r* = -0.110
LF/HF	*r* = -0.200	*r* = 0.190	*r* = -0.155	*r* = -0.060	*r* = 0.202	*r* = 0.188
HRV sitting (nonlinear)						
SD1 (ms)	*r* = -0.182	*r* = 0.002	*r* = -0.339	*r* = -0.249	*r* = -0.277	*r* = 0.244
SD2 (ms)	*r* = -0.148	*r* = 0.181	*r* = -0.304	*r* = -0.153	*r* = -0.034	*r* = 0.311

Table 2. (*continued*)

Variables	Chronicity	NRSr	NRSm	NDI	CTPS	TSK
SD2/SD1 ratio	*r* = 0.078	*r* = 0.139	*r* = 0.169	*r* = 0.114	*r* = 0.314	*r* = 0.128
Alpha 1	*r* = -0.001	*r* = 0.080	*r* = 0.188	*r* = 0.036	*r* = 0.254	*r* = 0.158
Alpha 2	*r* = 0.098	*r* = -0.103	*r* = 0.111	*r* = 0.170	*r* = -0.028	*r* = -0.303
ApEn	*r* = -0.026	*r* = -0.328	*r* = 0.110	*r* = -0.127	*r* = -0.213	*r* = -0.258
SampEn	*r* = -0.018	*r* = -0.320	*r* = -0.080	*r* = -0.173	*r* = -0.264	*r* = -0.139
HRV standing (linear)						
Mean RR intervals (ms)	*r* = -0.186	*r* = -0.065	*r* = -0.411 [a]	*r* = -0.251	*r* = -0.175	*r* = 0.100
STD-RR (ms)	*r* = 0.162	*r* = -0.184	*r* = -0.046	*r* = -0.185	*r* = -0.109	*r* = 0.141
Mean HR (bpm)	*r* = 0.178	*r* = 0.091	*r* = 0.432 [a]	*r* = 0.210	*r* = 0.158	*r* = -0.060
rMSSD (ms)	*r* = 0.147	*r* = -0.014	*r* = -0.010	*r* = -0.100	*r* = -0.100	*r* = 0.231
RR Tri	*r* = 0.139	*r* = -0.108	*r* = -0.093	*r* = -0.177	*r* = -0.105	*r* = 0.185
TINN (ms)	*r* = 0.124	*r* = -0.207	*r* = -0.104	*r* = -0.197	*r* = -0.173	*r* = 0.100
LF (nu)	*r* = -0.108	*r* = -0.394 [a]	*r* = -0.189	*r* = -0.283	*r* = -0.076	*r* = -0.156
HF (nu)	*r* = 0.109	*r* = 0.388 [a]	*r* = 0.182	*r* = 0.277	*r* = 0.070	*r* = 0.153
LF/HF	*r* = -0.041	*r* = -0.299	*r* = -0.103	*r* = -0.201	*r* = -0.078	*r* = -0.226
HRV standing (nonlinear)						
SD1 (ms)	*r* = 0.147	*r* = -0.014	*r* = -0.010	*r* = -0.100	*r* = -0.100	*r* = 0.231
SD2 (ms)	*r* = 0.161	*r* = -0.209	*r* = -0.052	*r* = -0.192	*r* = -0.107	*r* = 0.124
SD2-to-SD1 ratio	*r* = -0.087	*r* = -0.257	*r* = -0.083	*r* = -0.198	*r* = 0.005	*r* = -0.222
Alpha 1	*r* = -0.171	*r* = -0.276	*r* = -0.083	*r* = -0.240	*r* = -0.007	*r* = -0.100
Alpha 2	*r* = 0.089	*r* = -0.179	*r* = 0.161	*r* = -0.021	*r* = 0.074	*r* = 0.025
ApEn	*r* = -0.134	*r* = 0.056	*r* = -0.052	*r* = 0.041	*r* = -0.062	*r* = 0.138
SampEn	*r* = -0.111	*r* = 0.205	*r* = 0.017	*r* = 0.103	*r* = -0.035	*r* = 0.145

ApEn, approximate entropy; *CTPS*, Catastrophic Thoughts about Pain Scale; *HF*, normalized unit in the high-frequency band; *HRV*, heart rate variability; *LF*, normalized unit in the low-frequency band; *mean HR*, mean of heart rate; *NDI*, Neck Disability Index; *NRSm*, Numerical Rating Scale during cervical movements; *NRSr*, Numerical Rating Scale at rest; *STD-RR*, standard deviation of RR; *rMSSD*, root mean square differences of successive RR intervals; *RR Tri*, integral of the RR intervals histogram divided by the height of the histogram; *SampEn*, sample entropy; *SD*, standard deviation of instantaneous RR interval variability; *TINN*, baseline width of the RR intervals histogram; *TSK*, Tampa Scale for Kinesiophobia.

[a] Significant correlation (Pearson's correlation coefficient, $P < .05$).

the RRi mean and standard deviation (STD-RR) in ms; the square root of the square sum of the differences between the RRi in the registry, divided by the number of RRi in a given time, minus 1 (rMSSD) in ms; and the triangular index (RR Tri) and triangular interpolation of RR intervals in ms.[22] Spectral analysis of the RRi showed 2 main components: a low-frequency (LF) peak between 0.03 and 0.14 Hz and a high-frequency (HF) peak above 0.15 Hz, both of which were expressed in normalized units and as a LF-to-HF ratio to verify the sympathovagal balance.[23] The STD-RR is representative of the global HRV and reflects all the cyclic components that are responsible for variability in the recording period; rMSSD reflects changes in autonomic modulation that are predominantly vagal, and geometric indices of HRV reflect the overall total HRV.[23]

Approximate entropy (ApEn), sample entropy (SampEn),[24] and Poincaré plot[25] were analyzed in the nonlinear dynamics of the HRV. ApEn quantifies the regularity of time-series data and is represented as a simple index for the overall complexity and predictability of each time series. Higher ApEn values represent a better health status.[24] Nonlinear analysis of the Poincaré plot was applied and the following descriptors were used in the study: SD1, which provides information on the standard deviation of instantaneous beat-to-beat variability and is characterized as a parasympathetic marker of cardiac modulation, which is interpreted as a measure of short-term HRV; and SD2, which is the standard deviation measured by the dispersion of points along the identity line and is interpreted as both a short-term and a long-term HRV measure, thus representing the overall HRV.[25]

Statistical Analysis

Pearson's correlation coefficient was used to explore the association between the variables. To support the use of this test, some assumptions were considered in this study: bivariate normality (verified by the Shapiro-Wilk test), linear relationship between the variables, independence of observations, and data were from a random sample of data from the population. The SPSS software version 17.0 (SPSS Inc, Chicago, Illinois) was used for statistical processing. The level of significance was set at 5% for all statistical tests.

Results

A total of 30 individuals were recruited and included in the study. Of these, 15 had chronic neck pain and 15 were healthy, and all had not practiced physical activity for at least 12 months. Comparisons of the personal and demographic characteristics are described in Table 1. Individuals were predominantly composed of young-adult women who were eutrophic or slightly overweight and had a low level of habitual physical activity.

Table 2 shows the correlations between linear and nonlinear variables of HRV and painful experience measurements. Positive correlations indicate that the variables are directly proportional, therefore the higher the value of a HRV variable, the greater the value of the pain measurement variable (and vice-versa); whereas negative correlations indicate that the higher the value of a HRV variable, the lower the value of the pain measurement variable (and vice-versa).

When considering the collection of HRV when supine, the following significant correlations were observed: chronicity and mean RR (r = –0.445) and mean HR (r = 0.431); NRSm and mean RR (r = –0.581), STD-RR (r = –0.382), mean HR (r = 0.603), RR Tri (r = –0.477), and SD2 (r = –0.387); NDI and mean RR (r = –0.421), STD-RR (r = –0.391), mean HR (r = 0.426), rMSSD (r = –0.370), RR Tri (r = –0.362), SD1 (r = –0.370), and SD2 (r = –0.380); and Catastrophic Thoughts about Pain Scale and SD2-to-SD1 ratio (r = 0.384).

When considering the collection of HRV data from sitting participants, the following significant correlations were observed: NRSm and mean RR (r = –0.551) and mean HR (r = 0.585); and NDI and mean RR (r = –0.368) and mean HR (r = 0.372). Conversely, when considering the collection of HRV data from standing participants, the following significant correlations were observed: NRSr and LF (r = –0.394) and HF (r = 0.388); and NRSm and mean RR (r = –0.411) and mean HR (r = 0.432).

Discussion

In the present study, neck pain was correlated with worse linear and nonlinear HRV indices. To our knowledge, this is the first study to address these relationships. The results reinforce the clinical importance of the early evaluation of the cardiac nervous system function and its association with chronic pain, even if mild, given the implication that this pain already causes autonomic system issues.

The literature concerning the association between chronic pain conditions and altered nervous system function are robust, as assessed with the HRV indices.[26-28] The present study showed a significant correlation between pain and an increase of sympathetic activity in patients with chronic neck pain, as demonstrated using linear indices. Hallman et al[5] investigated the autonomic regulation in relation to physical activity and perceived symptoms during work and leisure time among workers with chronic neck pain. These authors observed abnormalities in HRV during sleep, which reflected an imbalanced autonomic regulation among workers with chronic neck and shoulder pain. Murphy et al[29] aimed to evaluate the influence of cervical manipulation on HRV using the linear LF-to-HF ratio and showed that cervical manipulation can significantly affect HRV by reducing the sympathetic tone and increasing the parasympathetic response. Similarly, Haneline et al[11] evaluated the sympathovagal response in volunteers with acute neck pain after manipulation therapy of the affected region and showed an improvement of this sympathovagal regulation. However, both studies only used analysis of the linear domains of HRV.

The linear analysis methods have some limitations in discriminating the contributions of the sympathetic and parasympathetic branches,[30] although the frequency domain analysis overcomes this by providing more information on the parasympathetic branch. However, linear analysis has limited potential because it does not consider the chaotic dynamics of HR.[30] Therefore, the nonlinear analysis of the HRV dynamics is superior when compared with the more conventional methods used in this analysis.[31] In this study, the nonlinear indices SD1 and SD2 correlated with the neck pain-associated disability, as measured by the NDI. These indices have shown to be potential early indicators of autonomic nervous system dysregulation.[25,32]

This study also presents clinical implications that should be considered. Researchers and professionals dealing with rehabilitation or physical exercise already know that sedentarism negatively affects the autonomic function and has repercussions on HRV indices. Therefore, it is assumed that the regular practice of physical exercise in this chronic pain population would be a strategy that would benefit the autonomic system; however, future clinical trials need to be well conducted methodologically to establish the effectiveness of physical exercise on the HRV indices. The nonlinear analysis has also provided a new insight into the dynamics of HRV in various physiological and pathophysiological conditions, providing additional and complementary prognostic information to traditional analyses.[33] Its use is encouraged in patients with chronic neck pain.

In the field of pain medicine, the analysis of HRV becomes of extreme importance once the chronic pain may lead directly to dysregulation in both the sympathetic and parasympathetic nervous systems, further diminishing the capacity to respond adaptively to threats. Parasympathetic tone decreased may place one at greater risk of chronic pain because of the diminished capacity to respond to sensory and emotional threats.[34]

There are some hypotheses that physiologically link the HRV with pain. In this sense, it is known that the descending inhibitory pathways of pain suppress the transmission of nociceptive information,[35] along with ascending pathways (vagal), which are responsible for transmitting signals harmful to the central nervous system. Thus, impaired vagal control, observed through indices that reflect the vagus,[36] may correspond to the interruption of the descending spinal inhibitory control, already known to be involved in chronic pain states that give rise to central sensitization.[34]

However, this study had limitations that must be considered. Sex is a factor influencing HRV and pain significantly and should be considered by researchers. Case-control studies should be performed in the future using larger samples to provide comparison between groups with adequate power of statistical test. Future studies should also consider HRV analysis by applying exercises in people with chronic neck pain and controls. Another important limitation concerns the study design because it was not possible to identify oscillations of pain and HRV over a certain period. Thus, we suggest the future conduct of longitudinal studies for this purpose.

Conclusion

The HRV indices are significantly associated with pain intensity, disability, and catastrophizing in individuals with chronic neck pain.

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Contributorship Information

Concept development (provided idea for the research): A.V.D.-F., D.B.
Design (planned the methods to generate the results): A.V.D.-F., C.d.S.S., C.A.F.d.P.G., D.B.
Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): A.V.D.-F., C.d.S.S., C.A.F.d.P.G., D.B.
Data collection/processing (responsible for experiments, patient management, organization, or reporting data): A.D.S.-d.-A., A.V.D.-F., S.N.d.S., E.V.d.A., J.N.d.S., J.S.P., D.B.
Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): A.D.S.-d.-A., A.V.D.-F., S.N.d.S., E.V.d.A., C.d.S.S., J.N.d.S., J.S.P., D.B.
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Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): A.V.D.-F., C.d.S.S., C.A.F.d.P.G., D.B.

Practical Applications

- Chronic neck pain, even when slightly incapacitating, adversely affects autonomic control.
- Neck pain-associated disability correlated with worse linear and nonlinear HRV indices.
- The results reinforce the clinical importance of early evaluation of the cardiac nervous system function and its association with chronic pain, even if mild, given the implication that this pain already causes autonomic system issues.

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