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Heart Rate Variability Changes in Elderly Patients with Depression: A Systematic Review

Depresyonu Olan Yaşlı Hastalarda Kalp Hızı Değişkenliğinde Oluşan Değişiklikler: Sistematik Bir Derleme

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ABSTRACT

Depression is a prevalent and serious mood disorder that affects a person's mood and daily activities, often leading to severe symptoms. Beyond its impact on mood, depression can also dysfunctions in the autonomic nervous system function, particularly in elderly individuals, where such dysfunctions often complicate management and outcomes. Evaluating the autonomic nervous system in those diagnosed with depression is crucial for understanding the disease's progression. One non-invasive method for quantitatively assessing ANS is the computerized analysis of heart rate variability (HRV). Studies examining HRV changes in individuals with depression have yielded varied results. Although age is known to influence HRV, there is a lack of sufficient studies in the geriatric population. This systematic review aimed to examine HRV changes in elderly individuals diagnosed with depression. Among the 688 studies reviewed from databases including Wiley, Web of Science, Springer Link, Scopus, Science Direct, PubMed, APA PsycArticles and The Networked Digital Library of Theses and Dissertations (NDLTD) databases from 2017 to 10/09/2024, three randomized controlled studies met the inclusion criteria. Our systematic review found that different meditation and exercise programs applied to elderly depression patients may have varying effects on autonomic nervous system and HRV parameters. However, we did not find any study comparing HRV parameters between elderly depression patients and healthy controls, which was the primary focus of our review. This key limitation underscores the significant gap in the existing literature. Given the high prevalence of depression in older age groups, more research is needed in this area.

Keywords: Heart rate variability, depression, geriatric population

ÖZ

Depresyon, kişinin ruh halini ve günlük aktivitelerini etkileyen ve ciddi semptomlara neden olabilen yaygın bir duygudurum bozukluğudur. Depresyon yalnızca ruh halini etkilemekle kalmayıp aynı zamanda kişinin otonom sinir sisteminde işlev bozukluklarına da neden olabilir. Özellikle yaşlı bireylerde depresyon sıklıkla komplikedir ve yönetimi zorlaştırmaktadır. Depresyon tanısı alan bireylerde otonom sinir sisteminin değerlendirilmesi hastalığın seyri açısından büyük önem taşımaktadır. Otonom sinir sisteminin kantitatif değerlendirmesi için kullanılan invaziv olmayan yöntemlerden biri de kalp hızı değişkenliğinin (HRV) bilgisayarlı analizidir. Depresyon tanısı alan bireylerde HRV değişikliklerini inceleyen çalışmalarda farklı sonuçlar elde edilmiştir. Ayrıca yaşın HRV üzerinde etkili bir role sahip olduğu bilinmesine rağmen geriatrik yaş grubunda yeterli çalışmaya rastlanmamıştır. Bu sistematik derlemede depresyon tanısı almış ileri yaştaki bireylerdeki HRV değişimlerini incelemek amaçlanmıştır. Bu derlemeye; 2017 yılından10/09/2024 tarihine kadar Wiley, Web of Science, Springer Link, Scopus, Science Direct, PubMed, APA PsycArticles ve The Networked Digital Library of Theses and Dissertations (NDLTD) veritabanlarında taranan 688 çalışmadan, arama kriterlerini karşılayan 3 randomize kontrollü çalışma dâhil edildi. Sistematik incelememiz sonucunda yaşlı depresyon hastalarına uygulanan farklı meditasyon ve egzersiz programlarının otonom sinir sistemi ve HRV parametreleri üzerinde farklı etkileri olabileceği sonucuna ulaştık. Ancak derlememizin temel çıkış noktası olan yaşlı depresyon hastaları ile sağlıklı kontroller arasında HRV parametrelerindeki farklılıkları inceleyen bir çalışmaya rastlamadık. Çalışmamızdaki bu primer sınırlılık, aynı zamanda mevcut literatürdeki eksikliğin ciddiyetini açığa çıkarmaktadır. İleri yaşlarda depresyon oranının yüksek olduğu göz önüne alındığında bu konuda daha fazla çalışmaya ihtiyaç vardır.

Anahtar sözcükler: Kalp atış hızı değişkenliği, depresyon, yaşlı popülasyon

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Introduction

Depression, also known as depressive disorder, is a prevalent mental disorder characterized by a prolonged inability to enjoy or maintain interest in activities. Unlike typical mood swings and everyday feelings, depression can impact all aspects of life. It can affect anyone, but people who have experienced stressful events are more prone to developing depression. Research indicates that women are diagnosed with depression at a higher rate. Globally approximately 280 million people suffer from depression, representing about 3.8% of the world's population. Additionally, the incidence of depression is higher in adults over the age of 60 compared to younger adults (WHO 2024).

DSM 5 criteria are utilized to diagnose depression. Among these criteria, at least one of the first two items and at least five of the nine items must be present during a two-week period. The criteria include: feeling depressed, apathy, insomnia or hypersomnia, retardation or agitation, fatigue, overthinking or indecisiveness, and suicidal ideation. Although these criteria are critical for diagnosing depression, clinicians must conduct thorough evaluations. Gilzans et al. (2018) found that approximately 51% of depression cases among patients with diabetes mellitus were not accurately diagnosed, and only 31% of those diagnosed received adequate antidepressant treatment. Additionally, Boztaş and Arısoy (2010) highlighted the difficulty of assessing patients with major depression, noting that the vegetative or somatic symptoms used to diagnose major depression may also arise from other physical illnesses. They emphasized that the depression rates observed among different chronic patient populations in the literature support this observation. A review of the literature indicates that depression is one of the most common mental disorders in the elderly, with significant depressive symptoms observed in older adults, although approximately 10-15% does not receive a clinical diagnosis of depression (Thomas and O'Brien 2009). The presence of comorbidities, polypharmacy, and age-related metabolic changes that lead to various pharmacokinetic and pharmacodynamics alterations are believed to complicate the diagnosis of depression in older individuals. Furthermore, some depressive symptoms observed in elderly individuals are often regarded as a natural feature of aging by both family members and healthcare professionals, which may contribute to the difficulty in recognizing depression in this population (Sözeri-Varma 2012).

Depressive disorders disrupt the functioning of the axis between the hypothalamus and the pituitary gland, leading to neurotransmitter imbalances. This disruption shifts the autonomic nervous system balance towards a sympathetic tone and decreases the parasympathetic tone (Grippo and Johnson 2002). Carney and Freedland (2017), compared patients diagnosed with depression who were in good medical condition to healthy controls and found higher levels of plasma catecholamines and other functional markers in patients diagnosed with depression. In addition, studies on depressed patients with coronary heart disease have shown evidence of autonomic nervous system dysfunction as indicated by decreased HRV values and reduced baroreceptor sensitivity.

Depression is also a well-established risk factor for cardiovascular diseases (CVD) and mortality (Sgoifo et al. 2015). The mechanisms linking depressive disorders with CVD include autonomic nervous system dysfunctions (Tobaldini 2020). Individuals with depressive disorders have an increased risk of developing cardiovascular diseases, and HRV has been suggested as a potential measurement tool for assessing this comorbidity (Kidwell and Ellenbroek 2018).

The autonomic nervous system is crucial in precisely regulating tissue functions and organs, which is essential for survival in basic and challenging situations. It ensures optimal stress response, adaptive responses, and overall health. One of the most used non-invasive methods for quantitatively assessing autonomic nervous system activity is the computerized analysis of heart rate variability (Agorastos et al. 2023).

Heart Rate Variability (HRV) refers to the change in the time between RR waves observed in consecutive heartbeats and serves as an indicator of various pathological conditions related to cardiovascular health. Additionally, HRV analysis is a non-invasive technique used to assess the functioning of the autonomic nervous system by reflecting the balance between the sympathetic and parasympathetic nervous systems. (Tiwari et al. 2021).

HRV specifically measures the variability in the time intervals between consecutive heartbeats (McCraty and Shaffer 2015). A healthy heart does not beat like a metronome; its oscillations are complex and continually changing, with intervals between beats varying. HRV quantifies the extent of these variations (Goldberger1991), reflecting the changes in the RR intervals that indicate the ongoing interaction and balance between the sympathetic and parasympathetic nervous systems. Additionally, HRV analysis provides opportunities to evaluate changes in autonomic nervous system function at rest, in response to physiological

conditions, and during disease processes (Cygankiewicz and Zareba 2013). HRV is produced by continuously dynamic and nonlinear autonomic nervous system processes. In addition to reflecting the results of neurocardiac interactions, it also reveals the ability to adapt to environmental and psychological challenges (Gevirtz et al. 2016). Increased HRV is associated with states of rest, exercise, and effective recovery, whereas decreased HRV indicates stress or disease (Turcu et al. 2023). Furthermore, high heart rate variability is considered an indicator of good autonomic control of the heart (Kubota et al. 2017). HRV can be measured using three primary methods: the time domain, the frequency domain, and the non-linear method. Each method calculates different parameters (European Society of Cardiology1996).

The time domain method involves calculating HRV parameters from NN intervals between consecutive heartbeats. Key time domain parameters include SDNN (standard deviation of NN intervals), RMSSD (root mean square of successive RR interval differences), NN50 (number of successive RR intervals differing by more than 50 ms), and PNN50 (percentage of successive RR intervals differing by more than 50 ms). Frequency domain measurements estimate the distribution of absolute or relative power across four frequency bands: ultra-low frequency (ULF), very low frequency (VLF), low frequency (LF), and high frequency (HF) (Sammito and Böckelmann 2016). Frequency domain analysis indices describe periodic oscillations in heart rate signal decomposition of different amplitudes and frequencies expressed in milliseconds (ms). These indices include the very low-frequency band (VLF, <0.003-0.04 Hz, ms); low-frequency power (LF, 0.04–0.15 Hz, ms), which is a mixture of sympathetic and parasympathetic activity; high-frequency power (HF, 0.15-0.4 Hz, ms) defining the parasympathetic tone. Studies have shown that the LF/HF ratio, which reflects the balance of sympathetic and parasympathetic innervations, is a good indicator of the autonomic nervous system's sympathovagal balance. HF and LF power are calculated using fast Fourier transform (FFT) (Wang and Huang 2012). Various studies on individuals diagnosed with depression have produced different results regarding the LF/HF ratio. For instance, a study by Kumar et al. (2024), observed a significant increase in the LF/HF ratio in young adults with depression compared to healthy controls, whereas a meta-analysis by Wu et al. (2023) showed no significant differences in the LF/HF ratio between depressed adults and healthy controls. Lastly, the non-linear method assesses the unpredictability of a time series (Stein and Reddy 2005).

Numerous studies have investigated the relationship between HRV, which reflects the interaction between the sympathetic and parasympathetic nervous systems (Cygankiewicz and Zareba 2013), and depression, which can lead to autonomic nervous system dysfunctions (Carney and Freedland 2017). Meta-analyses have demonstrated that Major Depressive Disorder (MDD) is associated with reduced heart rate variability (Koch et al. 2019) and that the severity of depression is negatively correlated with HRV (Kemp et al. 2010). However, some studies argue that there is no significant relationship between depression and HRV (Sayar et al. 2002).

The results of research and meta-analyses vary depending on factors such as the age of the patients and their use of antidepressants. For instance, Kumar et al. (2024) observed a significant decrease in all HRV parameters and an increase in the LF/HF ratio among young adults aged 18-26 with depression who did not use antidepressants. Conversely, despite a high HF rate, significant changes in HRV time-domain parameters were not observed (Jangpangi et al. 2016).

Even within meta-analyses focused on young adult patient groups, inconsistencies in results are evident. For example, a meta-analysis published in 2023 reviewed studies up to December 2022 and found significant decreases in HRV parameters in patients with depression compared to healthy controls. However, no significant differences were observed in the LF/HF ratio (Wu et al. 2023). In the meta-analysis conducted by Koch et al. (2019), which reviewed studies up to July 2018, a comparison between patients with Major Depression (MD) and healthy controls revealed the most significant changes in the RMSSD parameter, with less pronounced changes observed in other HRV parameters. Moreover, an elevated LF/HF ratio was observed.

Conversely, the meta-analysis by Brown et al. (2018), the first to explore the relationship between HRV and depression specifically in the geriatric population, only found significant decreases in the LF parameter. This result was inconsistent with the findings from meta-analyses involving young adults. Brown et al. highlighted the limitations of their study and emphasized the need for better-designed research on depression and HRV in elderly individuals. These limitations influenced our decision to compile and review the current literature in this field. Another significant conclusion from Brown et al.'s research was that depression may affect the autonomic nervous system differently in older versus younger adults, with HRV parameters showing varying changes across different age groups. This systematic review aims to investigate the relationship between depression and HRV parameters in individuals over 60 years of age.

Methods

This systematic review was conducted according to the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Page et al. 2021)

Research Strategy

To conduct this review, we utilized databases including Wiley, Web of Science, Springer Link, Scopus, Science Direct, PubMed, APA PsycArticles and The Networked Digital Library of Theses and Dissertations (NDLTD). In continuation of the first and most comprehensive meta-analysis in this field conducted by Brown et al. (2018), which examined studies published up to November 2016, we included studies published from 2017 to October 9, 2024. This approach was taken to avoid data overlap and to ensure more accurate results. A systematic analysis was performed, focusing on randomized controlled studies that explored the relationship between heart rate variability and depression in geriatric patients. The review was limited to academic publications with full texts available in English and included studies involving human populations without restrictions on gender or ethnicity.

Keywords for the Search

The keywords for the search were selected using the Cochrane Library archive. They were combined using Boolean operators as follows: ("Heart Rate Variability" AND "Older with Depression" OR "Elder with Depression" OR "Geriatric with Depression" OR "Old Age with Depression" OR "Late Life Depression")

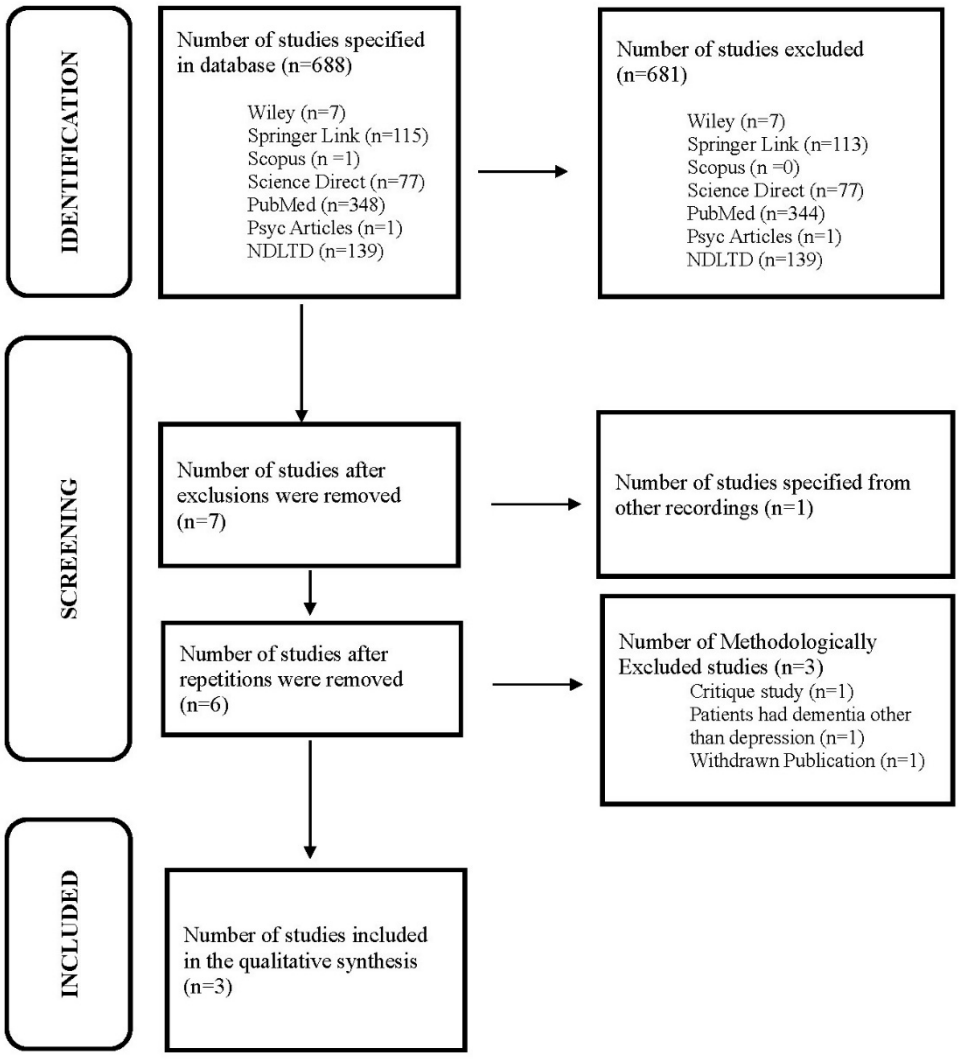

Figure 1. PRISMA 2020 flow diagram

Eligibility Criteria

For our systematic review, we included only randomized controlled trials published in English from 2017 onwards. The studies had to involve patients aged 60 and over, with no gender restrictions and be available in full text. Studies published in languages other than English, as well as case reports, traditional reviews, systematic reviews, and meta-analyses, were excluded.

Identification and Selection of Studies:

The search terms determined for this study were entered into the relevant databases, yielding 688 publications. After evaluating these publications according to the eligibility criteria and removing duplicate records, three publications were included in our systematic review. The PRISMA 2020 flow chart illustrating this process is presented in Figure 1.

Evaluation of the Methodological Quality of Studies

The methodological quality of the studies included in the systematic review was assessed using "The Joanna Briggs Institute Critical Appraisal Tools for Use in JBI Systematic Reviews: Checklist for Randomized Controlled Trials" (https://jbi.global/sites/default/files/2019-05/JBI_RCTs_Appraisal_tool2017_0.pdf). Studies that did not meet the criteria specified in the checklist were excluded from the review.

Limitations of the Research

Our systematic review focused on studies published in English from 2017 onwards, resulting in the inclusion of only three studies. Additionally, we faced limitations in accessing research that examined HRV parameters between healthy controls and older adults with depression, which was the primary focus of our investigation.

Results

Our systematic review identified three full-text randomized controlled studies published according to the search criteria on patients over 60 years of age since 2017. Two of these studies are from 2018 and one is from 2022. Due to the limited number of studies meeting our inclusion criteria, no statistical analysis was performed in our systematic review, only a qualitative evaluation was made.

Liu et al. (2018) examined the effect of Tai Chi on HRV parameters in older adults diagnosed with depression according to the Geriatric Depression Scale (GDS) (score of 10 or higher). The study involved 60 participants (32 female, 28 male) aged 60 and over, who had not previously tried Tai Chi, did not use antidepressants or alcohol, were diagnosed with depression and had not participated in any structured exercise program in the last 6 months. Participants were divided equally into two groups; experimental and control. The experimental group practised Tai Chi three times a week (60 minutes per session) for 24 weeks, while the control group maintained their usual lifestyle. At the end of the study, a five-minute ECG was recorded from all participants after a 20-minute rest period and HRV parameters were calculated. Both the control and experimental groups showed significant changes in LF, HF, and RMSSD parameters. The 24-week Tai Chi program (60 minutes per session, three sessions per week) was found to be effective in reducing depression among the elderly. Researchers suggested that this effect of Tai Chi may occur through the balance of the autonomic nervous system.

Chuang et al. (2018) developed a "Story-Centered Care" intervention based on the "Carefully Embracing the Story" theory for older adults living in long-term care facilities, where the rate of depression is high. This intervention Program employs narrative theory to help healthcare providers understand the challenges patients face with their health problems. When patients share their backgrounds, personal feelings and thoughts, and concerns about their health status with caregivers, the caregivers listen attentively and support them in taking steps towards their recovery goals. The researchers aimed to evaluate whether this intervention method was effective in addressing depressive symptoms, cognitive functions, and HRV in older adults living in a long-term care facility. The study included 70 participants over the age of 65 hospitalized in a care facility. The mean GDS-15 score of the patients was 2.9. Volunteers included conscious individuals, with normal hearing and speaking abilities, which were not using any antidepressants, were not clinically diagnosed with dementia, had a normal cognitive level and had not lost a loved one in the last three months. The participants were equally divided into two groups: experimental and control. The experimental group participants

underwent the "Story-Centered Care Intervention Program" once a week for 4 weeks, while the control group participants received health counseling from the researchers once a week for 4 weeks. Between January and August 2013, evaluations and tests were conducted to monitor the depression and cognition levels of the patients with 5-minute ECG recordings before, immediately after the intervention, and at 1- and 3-month follow-ups.

Analyses were carried out on the data of 60 participants (40 female, 20 male), as some volunteers withdrew from the intervention, and some had incomplete data due to health problems. After the intervention, significant decreases in depression, significant improvements in cognitive functions, and significant improvements in the SDNN and RMSSD values of HRV parameters were observed in the experimental group compared to the control group. The study concluded that this program could also be used to improve cognitive function in older adults receiving outpatient treatment. However, the researchers suggested that additional studies were needed to clarify the effectiveness of the Story-Centered Care Intervention Program on HRV.

Table 1. Summary of studies included in the systematic review

Author, Year, Country	Sample	Intervention	Duration	Aim	ECG Record Duration	Altered HRV Parameters	Depression Severity	Result
Liu et al. 2018, China	60 participants (32 female, 28 male) aged 60 years and older	Tai Chi	24 weeks	Effect of Tai Chi Exercise on HRV	5 minutes	LF, HF, RMSSD	GDS score ≥10	It has been shown that Tai Chi can alleviate depression in the elderly by regulating autonomic nervous system parameters or HRV
Chuang et al. 2018, Northern Taiwan	60 participants (40 female, 20 male) with a mean age of 84.3 years (± 5.98 years)	Story-Centered Care Intervention Program	4 weeks	The Impact of the Story-Centered Care Intervention Program on Elderly Individuals in Long-Term Care Facilities	5 minutes	SDNN, RMSSD	Mean GDS-15 score ≥2,9	Post-intervention, there was a significant reduction in participants' depression, an improvement in cognitive function, and a trend towards improvement in SDNN and RMSSD compared to the control group
Ayudhaya et al. 2022, Thailand	82 participants (65 female, 17 male) aged 60 years and older	Behavioral activation program	9 months	Changes in HRV in Patients with Subthreshold Depression Participating in a Behavioral Activation Program Compared to a Control Group	2,5 minutes	SDNN, LF, HF, LF/HF	TGDS score - mild to moderate	At the end of the intervention, comparisons between the experimental and control groups revealed significant changes in the HRV score and the SDNN parameter, but no significant difference in the LF/HF ratio between the groups

HRV: Heart Rate Variability SDNN: Standard Deviation of NN intervals RMSSD: Root Mean Square of Successive Differences LF: Low Frequency HF: High Frequency GDS: Geriatric Depression Scale TGDS: Thai Geriatric Depression Scale

Behavioral activation (BA) is a component of Cognitive Behavioral Therapy (CBT) and is a cost-effective and useful alternative therapy method for treating older adults with depression (Richards et al. 2016). Although BA shows the same effectiveness as CBT, unlike CBT, it is shorter and simpler, can be applied by non-specialists with minimal formal training, making it suitable for primary care services (Ekers et al. 2011, Orgeta et al. 2017). While CBT is supported as effective for treating depression and improving HRV (Kim W 2009), evidence for BA therapy's impact on HRV is lacking. In their study, Ayudhaya and colleagues (2022) aimed to examine the effect of BA therapy on HRV time and frequency domain parameters in older adults with subthreshold depression. They included 82 Thai participants (65 female, 17 male) over the age of 60 who had were identified

as having mild to moderate depression via the Thai Geriatric Depression Scale (TGDS). Participants were equally divided into two groups: experimental and control. ECG recordings for HRV were conducted continuously for 2.5 minutes (ultra-short duration) at 8.30 AM after resting for 5 minutes in a comfortable chair. HRV parameters including Standard Deviation of Normal-Normal interval (NN interval), High Frequency (HF), Low Frequency (LF) and Low Frequency/High Frequency ratio (LF/HF) were examined at 0, 3, 6 and 9 months. The study showed that BA led to an increase in SDNN time domain, HF and LF frequency domain parameters and significant changes in HRV by decreasing the LF/HF ratio. Summary information about the studies included in the systematic review is given in Table 1.

Discussion

This systematic review aims to examine the relationship between depression and heart rate variability (HRV) parameters in individuals aged 60 years and older. The review includes only randomized controlled trials (RCTs) published in English from 2017 onward. Inclusion criteria required participants to be 60 years or older, with no gender restrictions, and full-text accessibility. Conversely, studies published in languages other than English, case reports, narrative reviews, systematic reviews, and meta-analyses were excluded.

A comprehensive search was conducted across seven different databases, yielding a total of 688 studies published between 2017 and September 9, 2024. However, only three randomized controlled trials met the inclusion criteria and were included in the final analysis of this systematic review. The restriction to studies published in English from 2017 onward and the inability to identify research specifically examining HRV parameters in healthy controls versus older adults with depression represent key limitations of this review.

All the analyzed studies applied various methods to improve autonomic nervous system activity and reduce depressive symptoms in patients over 60 while assessing changes in HRV parameters as indicators of these improvements. The significant variations observed in HRV parameters across the studies suggest that different intervention methods may produce varying effects on the autonomic nervous system.

The autonomic nervous system responses to various interventions can differ, and this variability is inevitably reflected by changes in heart rate variability (HRV) parameters. Zou et al. (2018) conducted a meta-analysis demonstrating that Tai Chi and Yoga training positively affected HRV parameters and perceived stress. In a separate study, Blase and Waning (2019) found that six weeks of regular Shamatha meditation improved autonomic nervous system homeostatic regulation in 85% of the 20 participants while investigating its impact on HRV parameters. These results align with our conclusion that different types of exercise and meditation uniquely affect the autonomic nervous system and HRV parameters.

In their 2024 review, Göçen and Özden noted the prevalence of autonomic dysfunction in psychiatric disorders, suggesting that monitoring autonomic functions and HRV could help in reducing disease symptoms. Their review highlighted the scarcity of methods to evaluate autonomic dysfunction in psychiatric conditions and called for additional research, a conclusion that is consistent with our findings.

Evans and Mottram (2000) emphasized that the Brief Assessment Schedule (BASDEC), Geriatric Depression Scale (GDS), and Evans Liverpool Depression Rating Scale (ELDRS), are screening tools rather than diagnostic instruments, necessitating more detailed methods and interviews for an accurate diagnosis of depression (Evans and Mottram 2000). In our review, GDS scores were used for depression diagnosis, raising concerns about the validity of the diagnoses. Future studies should employ different diagnostic tools to enhance the reliability of findings. For instance, Krishnamoorthy, Rajaa, and Rehman's systematic review and meta-analysis of the GDS examined four versions: GDS-4, GDS-10, GDS-15, and GDS-30. They found that all four forms demonstrated high sensitivity and specificity for depression screening in the elderly, but the shorter forms, GDS-10 and GDS-15, yielded better results than the GDS-30 (Krishnamoorthy et al. 2020). This discrepancy may be due to GDS-4 being too brief for accurate assessment and GDS-30 containing too many questions, potentially discouraging elderly individuals from disclosing personal concerns and emotions (Evans and Mottram 2000). We believe that these challenges can addressed by using different techniques.

Moreover, the studies in our review show that various interventions not only reduced depressive symptoms but also improved HRV parameters, suggesting enhancement of the autonomic nervous system. ECG recordings can be long-term (24-hour Holter monitoring), while most standard ECG recordings take approximately 10 seconds for each derivation. Therefore, recording an average of 5 minutes for HRV data is not always feasible. McNames et al. (2006) compared HRV data from ECG recordings lasting from 10 seconds to 10 minutes with data from 5-minute recordings. Their study found that each HRV parameter was sensitive

to the acquisition time of the ECG derivations and that HF and RMSSD were the least affected parameters by acquisition time. They also suggested that MHR (mean heart rate) was more reliable and reproducible, especially in short-term acquisitions. Based on this study, in our systematic review, Lui et al. (2018) used a 5-minute ECG recording to evaluate HRV in terms of LF, HF and RMSSD parameters. Chuang et al.'s study also used a 5-minute ECG recording to evaluate SDNN and RMSSD parameters. In contrast, Ayudhava et al.'s (2022) study evaluated SDNN, LF, HF and LF/HF ratio from a 2.5-minute ECG recording. Thus, it is possible to discuss the reliability of HF and RMSSD results across all three articles.

Stein and Reddy (2009) found that cardiac autonomic function changes became evident in the 65-70 age group, manifested by decreased HRV frequency domain parameters, independent of cardiovascular heart disease risk. Ayudhaya et al. (2022), observed that BA therapy led to improvements in depression symptoms and increases in LF and HF parameters based on HRV frequency analysis. Although we lack HRV baseline data for healthy elderly people without depression, we can speculate that LF and HF values decrease with depression and at least partially increase after intervention, approaching the possible normal levels in the elderly.

Conclusion

In our systematic review, we aimed to examine the relationship between HRV parameters and depression in older adults, we observed that different meditation and exercise programs applied to elderly patients with depression had varying effects on the autonomic nervous system and HRV parameters. However, our primary goal of comparing HRV parameters between elderly patients with depression and healthy controls could not be achieved due to a lack of studies examining these differences. Given that depression is more prevalent among older adults due to changing life circumstances such as retirement, social isolation, loss of a spouse, children leaving home, and decreased mobility, it is evident that there is a significant gap in the literature regarding this issue. Future planning of randomized controlled, cross-sectional, and longitudinal studies comparing HRV parameters in healthy control groups and elderly individuals with mild, moderate, and severe depression, as well as investigating the relationship between different treatment protocols for depression and HRV would make a valuable contribution to the literature in this field.

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