DOI: 10.1590/1809-2950/20028628032021

ORIGINAL RESEARCH

Immediate physiological effects of listening to music before physical exercise in institutionalized older people with dementia

Efeitos fisiológicos imediatos de ouvir música antes do exercício físico em idosos com demência institucionalizados

Efectos fisiológicos inmediatos de escuchar música antes del ejercicio en ancianos institucionalizados con demencia

Tamires Ferri Izzo[1], Maria Juana Beatriz Lima Candanedo[2], Aline Yumi Higuti[3], Lucas Magalhães Corrêa[4], Dayane Melo Campos[5], Juliana Hotta Ansai[6]

ABSTRACT | The evolution of dementia is strongly related to cognitive, motor, and functional changes and to the presence of cardiovascular diseases. Disturbances vary according to phase of dementia and can limit instrumental and basic activities of daily living. The aim of this study was to analyze the immediate physiological effects of listening to music before physical exercise in institutionalized older people with moderate to advanced dementia. A randomized trial was conducted with 18 institutionalized older people with dementia (mean age was 79 years old, 52.6% were female), who were divided into a Training with Music Group (TWMG) and a Training without Music Group (TWtMG). The evaluation included heart rate (HR), blood pressure (BP) and HR variability (HRV). The assessment was conducted in a closed environment or in places with minimal visual and auditory stimulation. The TWMG was submitted to stimuli with music for 15 minutes and physical exercises for 30 minutes to improve/maintain their global mobility. The TWtMG performed the same physical exercises, however without music before physical exercise. The interventions lasted 12 weeks, and were performed individually once a week. In the TWMG, we observe a decrease in diastolic BP in the third session. In the sixth week, the HR increased after the session in both groups. TWMG improved HRV in the third session, with a difference between groups only after the session. After the sixth session, HRV values improved in both groups. In conclusion, listening to music before physical exercise is associated with positive effects in people with dementia, as it tends to maintain and improve physiological factors.

Keywords | Aged; Neurocognitive Disorders; Cardiovascular System; Exercise; Music.

RESUMO | A evolução da demência está fortemente relacionada a alterações cognitivas, motoras e funcionais e à presença de doenças cardiovasculares. Os acometimentos variam de acordo com a fase da demência e podem limitar atividades instrumentais e básicas de vida diária. Novos tipos de tratamentos em instituições de longa permanência são necessários para melhorar o desempenho fisiológico dos idosos com demência e a qualidade de vida dos idosos. O objetivo do estudo foi analisar os efeitos fisiológicos imediatos de escutar música antes da prática de exercício físico em idosos institucionalizados com demência moderada a avançada. Um ensaio randomizado foi realizado com 18 idosos com média de idade de 79 anos, 52,6% eram do sexo feminino, institucionalizados com demência, que foram divididos em Grupo de Treinamento com Música (TWMG) e

[1]Universidade Federal de Mato Grosso do Sul – Campo Grande (MS), Brasil. E-mail: tamiresizzo@hotmail.com. ORCID-0000-0002-9572-6204
[2]Universidade Federal de São Carlos – São Carlos (SP), Brasil. E-mail: beatrizlc96@gmail.com. ORCID-0000-0001-8438-685X
[3]Universidade Federal de Mato Grosso do Sul – Campo Grande (MS), Brasil. E-mail: alinehiguti@gmail.com. ORCID-0000-0001-6910-4826
[4]Universidade Federal de Mato Grosso do Sul – Campo Grande (MS), Brasil. E-mail: lcs-lucas2011@live.com. ORCID-0000-0003-4347-6431
[5]Universidade Federal de Mato Grosso do Sul – Campo Grande (MS), Brasil. E-mail: dayanecampos2824@gmail.com. ORCID-0000-0003-2220-0292
[6]Universidade Federal de São Carlos – São Carlos (SP), Brasil. E-mail: jhansai@ufscar.br. ORCID-0000-0001-9873-3509

Corresponding address: Juliana Hotta Ansai – Rodovia Washington Luiz, km 235 – São Carlos (SP), Brasil – Zip Code: 13565-905 – E-mail: jhansai@ufscar.br – Financing source: Capes – Conflict of interests: Nothing to declare – Presentation: Nov. 11th, 2020 – Accepted for publication: Sep. 8th, 2021 – Approval of the Ethics Committee: No. 135731/2017.

Grupo de Treinamento Sem Música (TWtMG). A avaliação incluiu um questionário sociodemográfico, frequência cardíaca (FC), pressão arterial (PA) e variabilidade da FC (VFC), avaliada por dispositivo de biofeedback cardiovascular (cardioEmotion). A avaliação ocorreu em ambiente fechado ou em lugares cujo estímulo visual e auditivo fosse o menor possível. Os participantes do TWMG foram submetidos a estímulos com música durante 15 minutos e a uma série de exercícios físicos por 30 minutos, a fim de melhorar/manter sua mobilidade global. O TWtMG realizou a mesma série de exercícios físicos, com a mesma duração e progressões, porém não foi submetido às músicas antes do exercício físico. As intervenções tiveram duração de 12 semanas e realizadas individualmente, uma vez por semana. No TWMG, houve diminuição da PA diastólica na terceira sessão. Na sexta semana, houve aumento da FC após a sessão em ambos os grupos. O TWMG melhorou a VFC na terceira sessão, com diferença entre os grupos somente após a sessão. Após a sexta sessão, a VFC melhorou em ambos os grupos. Como conclusão, escutar música antes do exercício físico associa-se a efeitos positivos em pessoas com demência, pois tende a manter e melhorar as respostas fisiológicas.

Descritores | Idoso; Transtornos Neurocognitivos; Sistema Cardiovascular; Exercício; Música.

RESUMEN | La evolución de la demencia está asociada con las alteraciones cognitivas, motoras y funcionales y con la presencia de enfermedades cardiovasculares. La manifestación varía según la etapa de la demencia y puede limitar las actividades instrumentales y básicas de la vida diaria. Se necesitan nuevos tipos de tratamiento en los centros de cuidados a largo plazo para mejorar el desempeño fisiológico de las personas mayores con demencia y su calidad de vida. El objetivo de este estudio fue analizar los efectos fisiológicos inmediatos de escuchar música antes de la práctica de ejercicio físico en ancianos institucionalizados con demencia de moderada a avanzada. Se realizó un ensayo aleatorizado con 18 ancianos institucionalizados con demencia, con edad media de 79 años, el 52,6% eran mujeres, y se dividieron a los participantes en Grupo de Entrenamiento con Música (TWMG) y Grupo de Entrenamiento sin Música (TWtMG). La evaluación se compuso de un cuestionario sociodemográfico, frecuencia cardíaca (FC), presión arterial (PA) y variabilidad de la FC (VFC), evaluada por el dispositivo de biofeedback cardiovascular (CardioEmotion). La evaluación tuvo lugar en un ambiente cerrado o en lugares donde la estimulación visual y auditiva fue lo más mínimo posible. Los participantes del TWMG recibieron estímulos con música durante 15 minutos y una serie de ejercicios físicos durante 30 minutos, con el fin de mejorar/mantener su movilidad global. El TWtMG realizó la misma serie de ejercicios físicos, con la misma duración y progresiones, pero no recibió estímulos con música antes del ejercicio físico. Las intervenciones tuvieron una duración de 12 semanas y se realizaron de forma individual, una vez por semana. La PA diastólica disminuyó en el TWMG en la tercera sesión. La FC aumentó después de la sesión en ambos grupos, en la sexta semana. El TWMG mejoró la VFC en la tercera sesión, con diferencias entre los grupos solamente después de la sesión. La VFC mejoró en ambos grupos después de la sexta sesión. Se concluye que escuchar música antes del ejercicio tuvo efecto positivo en personas con demencia pues mantuvo y mejoró sus respuestas fisiológicas.

Palabras clave | Anciano; Trastornos Neurocognitivos; Sistema Cardiovascular; Ejercicio; Música.

INTRODUCTION

The prevalence of older people with dementia doubles every 5 years and reaches 20% of people over 80 years old[1]. Dementia is a clinical syndrome resulting from chronic and progressive brain dysfunction. The disturbance of multiple cognitive functions interferes with daily activities, such as personal hygiene, clothing, eating and physiological activities[1]. The highest incidence of dementia is associated with cardiovascular diseases and their risk factors. The risk of acquiring Alzheimer's disease is 30% higher in individuals with cardiovascular disease, especially those with peripheral arterial disease, compared to healthy individuals[2]. Furthermore, the presence of angina pectoris, myocardial infarction and intermittent claudication are associated with poor cognitive function in people aged 46 to 68 years old[3]. In a sample people aged 85 years and over, the worst cognitive performance was seen in people with two or more cardiovascular diseases. Moreover, the treatment of systemic arterial hypertension decreases the incidence of cognitive impairment[3].

Full attention and monitoring are required in people with several functional impairments diagnosed with dementia, which are the main reasons for institutionalization. Long-term care facilities play a crucial role in supporting older people with dementia and their families. New types of treatments to improve quality of life among institutionalized people and professionals have been established. Among them, cognitive stimuli with music can provide social interaction and exchange of experiences in people with dementia and professionals[4]. Music can produce important physiological changes in the body, such as muscle activity, breathing, blood

pressure (BP), heart rate (HR) and immune system, and can alter neuronal activity in brain areas related to emotion, involvement and motivation[5]. Music selection can promote positive memories and influence desperate memories that lead to emotional and cardiovascular changes[6].

Music can affect mood, such as sadness and fear, make people more active and make physical activity more enjoyable[4,7]. Physical exercise brings positive physiological responses resulting from autonomic and hemodynamic adaptations, which influence the cardiovascular system[5,8]. The influence of the autonomic nervous system (ANS) on the heart depends on neural control linked to HR and baroreceptor reflex activity. The increase in HR is a consequence of greater action of the sympathetic pathway and lower parasympathetic activity. Changes in HR variability (HRV) are expected and indicate the heart's ability to respond to multiple physiological and environmental stimuli, including breathing, physical exercise, mental stress, hemodynamic and metabolic changes, sleep, orthostasis and disease-induced disorders[5].

The use of music in older people with advanced dementia is possible because perception, sensitivity, emotion, and memory of music may remain intact after other types of memory disappear. Its use has positive effects on behavior, cognitive function and possibly on physiological responses, which may persist for hours or days after stimulation. Older people can also perceive and manifest their memories and emotions through music, within their current motor and cognitive ability[4]. Studies involving cognitive stimuli with music are lacking in the literature as a supporting tool in the treatment of older people with dementia.

There is a need to understand acute effects of the combined intervention in different sessions, as older people with dementia can present different effects according to the period of intervention. The aim of this study was to analyze the immediate physiological effects of listening to music before physical exercise in institutionalized older people with moderate to advanced dementia. We hypothesized that there would be immediate positive physiological effects from listening to music before physical exercise compared to the training without music.

METHODOLOGY

Study design

A single blind randomized clinical trial was conducted with two groups: Training with Music Group (TWMG) and Training without Music Group (TWtMG). The research was conducted in a nursing home in the city of Campo Grande (MS-Brazil) in 2018-2019. It was approved by the Research Ethics Committee of the Federal University of Mato Grosso do Sul (135731/2017) and registered in the Brazilian Registry of Clinical Trials (RBR-5m3s2s). The participants' guardians signed the informed consent form.

Participants

The eligibility criteria were people aged 60 years old and over, institutionalized and resident in SIRPHA – Lar do Idoso (Campo Grande-MS). Inclusion criteria were dementia diagnosis, Clinical Dementia Rating (CDR)[9] score between 2 and 3 points (moderate and advanced stages of dementia) and willingness to participate in the proposed assessments. Exclusion criteria were severe uncorrected hearing impairment that prevents the participant from listening to music and any cardiovascular or infectious dysfunction present on the list of absolute contraindications of the Physical Activity Readiness Medical Examination (including ventricular tachycardia and other dangerous dysrhythmias)[10]. All participants maintained their routine of physical therapy sessions according to schedule of the nursing home.

The participants were divided into two groups (TWMG and TWtMG) randomly by variable size blocks (two and four) (allocation ratio: 1:1), using the Random Allocation software. According to the sequence of randomization, each participant corresponded to an opaque, sealed envelope, numbered in order, containing a card that indicated which group the individual would be inserted. Envelopes with dark color were used to render the envelope impermeable to intense light. The corresponding envelopes were opened only after the enrolled participants completed all baseline assessments. All randomization processes were performed by a researcher not related to the study.

Assessment

The assessment was performed preferably in a single period by trained evaluators and in a closed environment. All tests were explained in a clear, simple and objective way. The evaluators were blinded to the intervention, however participants and interventionists were aware of the allocation because of the characteristic of the protocol. Clinical and sociodemographic data were collected through medical records and interviews with

the responsible nursing team, including age, sex, education level, drugs in use, presence of morbidities, type of dementia, years of institutionalization and the CDR to identify the stage of dementia at baseline. Physiological outcomes (HR, BP and HRV) were collected before, during the cognitive stimuli with music and immediately after the intervention in sedestation, without any physical activity during the assessment.

HR was verified by palpation of the radial artery on the wrist for 60 seconds with the volunteer in sedestation. BP was measured by an aneroid sphygmomanometer and a stethoscope. CardioEmotion is a low-frequency cardiovascular biofeedback device of physiological self-modulation technique measured by the resonance between two mechanisms of cardiovascular regulation (baroreceptor reflex and respiratory sinus arrhythmia). This device can be used for mental health assessment and training. Heartbeats are captured and transmitted to a computer program that evaluates heart cycles and RR intervals and calculates HRV[11]. According to Coghi & Coghi[12], cardiac coherence is a state in which HRV is maximum and occurs close to 0.1 Hertz in the power density spectrum of HR. This happens when there are coupling and resonance between cardiorespiratory systems. In some situations, such as stress, mood alterations or anxiety, the Sympathetic Nervous System is activated, and the individual presents increased HR and respiratory frequency and reduced HRV.

CardioEmotion was used to indirectly assess physiological responses and mental health. The certification of the device was conducted by the Center for Innovation, Entrepreneurship and Technology (CIETEC) of the University of São Paulo and headed by PhD Professor Marco Fabio Coghi. He founded NEUROPSICOTRONICS, which was responsible for the final version of the cardioEmotion device. NEUROPSICOTRONICS filed an invention patent, registered trademark and copyright at the Brazilian National Institute of Intellectual Property. The device is widely used in Brazil and other countries of America and Europe[13]. CardioEmotion classifies performance from 0 to 10 points and provides cardiac coherence percentages in colors: Red (0-100) (without coherence); Blue (0-100) (almost coherent); or Green (0-100) (cardiac coherence). In the non-coherent state, HRV is low and the sympathetic nervous system is predominant. In the almost coherent state, the oscillation is close to 0.1 Hz, indicating the inhibition of the sympathetic system. In cardiac coherence, HRV is maximum and there is a balance between the sympathetic and parasympathetic systems[11-14]. The device was used to measure HRV. CardioEmotion is a cardiovascular biofeedback device of physiological self-modulation mediated by resonance between cardiovascular regulation mechanisms (baroreceptor reflex and sinus respiratory arrhythmia). Heartbeats are captured and transmitted to a computer program that evaluates heart cycles and RR intervals and calculates HRV. Spectral analysis is used for HRV data. The red, blue and green percentages are related from the worst to the best HRV performance, respectively. For data collection, a noninvasive sensor was placed on the patient's finger (the 2nd or 5th distal phalanx) or ear lobe for 5 minutes[11].

Interventions

The interventions lasted 12 weeks and were performed individually once a week by nonblinded researchers in an environment with minimal visual and auditory stimuli. The TWMG was submitted to a cognitive stimulus with music for 15 minutes. The volunteers listened to well-known music from their time on headphones; the songs and artists chosen were surveyed from the most played at their time, according to the participants' mean age and recruitment are. The songs were selected to bring possible pleasant memories. The playlist was standardized for all volunteers of the TWMG to reduce bias of interpretation.

After music, the volunteers performed a series of low-intensity physical exercises for 30 minutes to improve/maintain their overall mobility (shoulder rotation, hand flexion/extension, elbow pronation/supination, elbow flexion/extension, upper limbs across the chest, shoulder flexion, paddling, shoulder adduction/abduction and internal/external rotation, hip adduction/abduction, static gait, knee extension/flexion, dorsiflexion/plantar flexion, circular ankle movements, neck stretching)[15]. In the first weeks, physical exercises were done in sedestation in the same order, with progression every three weeks through increasing active movements, adding motor/cognitive tasks linked to functional activities, increasing multiarticular and complex movements, and stimulating orthostatism and gait, respecting individual limitations and capabilities of each volunteer. During the interventions, simple verbal commands were given for a better understanding and the volunteers were encouraged to get as involved as possible in all physical exercises by observing, trying to perform and directing attention for all physical exercises. Since the more advanced the stage of dementia, the greater the difficulty in concentration and focus due to cognitive impairment, music was worked separately to bring higher

individual focus on action and make physical and cognitive stimuli more potent and effective[16].

The TWtMG was not submitted to the initial cognitive stimuli with music. They performed the same series of physical exercises, in the same order, duration and progression.

Data analysis

The SPSS software (version 18.0; SPSS, Chicago, IL, USA) was used and a significance level of α=0.05 was adopted. The Kolmogorov-Smirnov normality test was applied to all continuous variables to verify data distribution. The chi-square association test and the independent t-test were used to verify differences in clinical and sociodemographic characteristics between groups. To verify interaction and immediate differences between groups and moments (pre- and post-session) in the first, third, sixth, ninth and twelfth sessions, the two-way Anova test was used. When there was interaction between factors, simple main effect analysis was performed. The repeated measures Anova test was used to verify differences between moments (pre-, during music and post-session) in the TWMG.

The sample size of this pilot study was calculated using the G*Power 3.1 software. Assuming a statistical power of 80%, an effect size of 0.40 and an alpha of 0.05, a minimum of 16 subjects would be needed for the total sample.

RESULTS

According to the selection criteria, 18 participants from 74 eligible individuals were included. After 12 weeks, 17 older people were reevaluated due to a death not related to the intervention (cardiac arrest) after the first week of training (Figure 1). No adverse effects were reported during interventions. Regarding adherence to treatment, the mean participation was 87.9% in the TWMG and 89.5% in the TWtMG.

Regarding clinical and sociodemographic data, we observed no significant differences between groups. The mean age of the participants was 79 years old and 52.9% were female. According to the CDR, 70.6% of the volunteers presented moderate dementia and with a prevalence of unspecified dementia (58.9%), followed by senile dementia and Alzheimer's disease (Table 1).

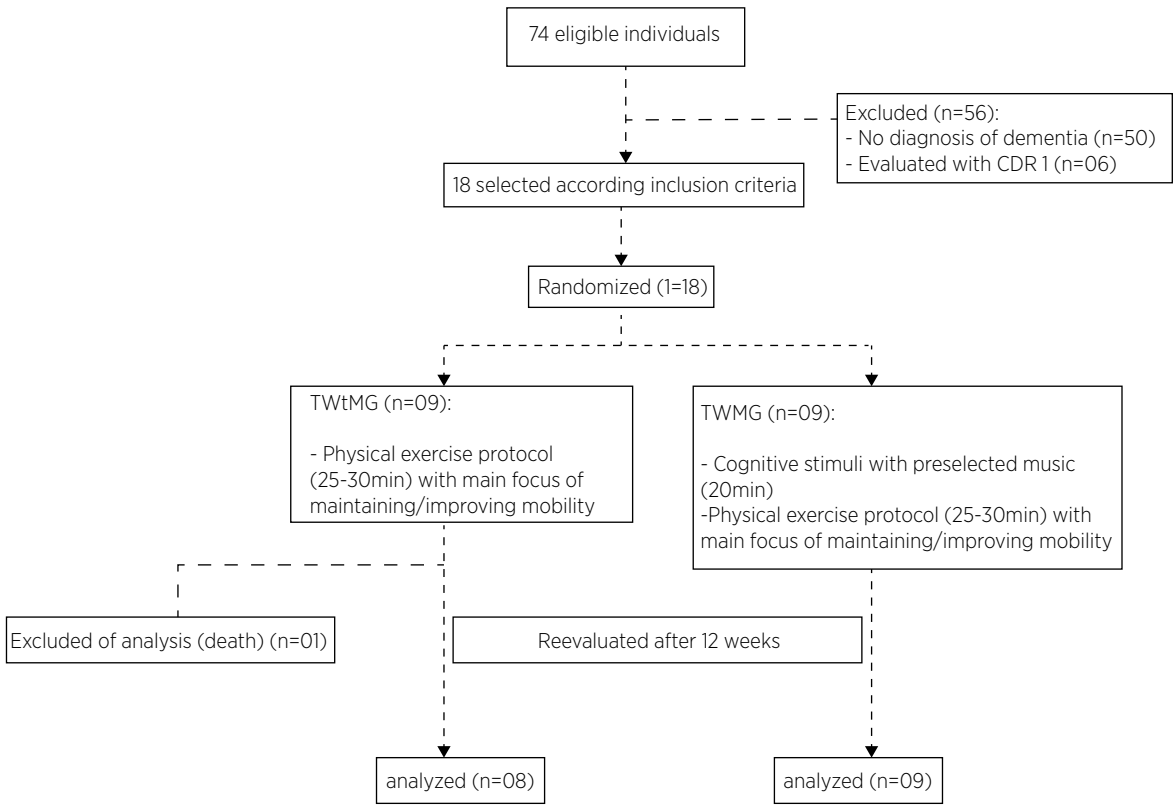

Figure 1. Flowchart of recruitment participants until final phase
CDR=Clinical Dementia Rating; TWMG=Training with Music Group; TWtMG=Training without Music Group.

Table 1. Clinical and sociodemographic data of the participants

Characteristics	TWMG (n=09)	TWtMG (n=08)	P Value
Age, M±SD	79.6±9.3	79.0±12.6	0.918
Female gender, n (%)	5 (55.6)	3 (37.5)	0.457
Literate, n (%)	6 (66.7)	3 (37.5)	0.229
Drugs in use, M±SD	3.7±2.7	5.0±2.7	0.290
Total of morbidities, M±SD	2.3±1.5	3.2±1.5	0.226
Hypertension, n (%)	3 (33.3)	4 (50.0)	0.486
Diabetes mellitus, n (%)	1 (11.1)	2 (25.0)	0.453
Time of institutionalization (years), M±SD	2.1±1.9	3.0±1.6	0.317
Type of dementia, n (%)			
Senile	4 (44.4)	2 (25)	0.446
Unspecified	5 (55.6)	5 (62.5)	
Alzheimer's	0 (00.0)	1 (12.5)	
CDR, n (%)			
2	6 (66.7)	6 (75.0)	0.707
3	3 (33.3)	2 (25.0)	

TWMG: Training with Music Group; TWtMG: Training without Music Group; M±SD: Mean±Standard Deviation; n (%): number (percentage); CDR: Clinical Dementia Rating.

Regarding BP and HR data, in the third week, a significant interaction between groups and moments in diastolic BP value was found (p=0.007). There was a significant increase in diastolic BP in the TWMG after the third session. In the sixth week, there was a significant increase in HR after session regardless of groups. No significant interaction and difference between groups and moments were found in other analyses (Table 2).

Table 2. Cardiovascular outcomes

Variables, M±SD	TWMG (n=09)		TWtMG (n=08)		P value, interaction Groups*Moments	P value Moments	P value Groups
	Pre	Post	Pre	Post			
Week 1							
HR	73.7±9.6	72.5±11.4	74.0±8.0	73.1±10.4	0.932	0.624	0.875
SBP	119.4±10.1	120.0±12.8	123.3±11.1	120.0±12.2	0.449	0.274	0.805
DBP	70.5±6.3	72.5±8.8	71.6±7.0	67.2±7.5	0.241	0.372	0.356
Week 3							
HR	75.7±12.2	76.1±16.8	73.0±8.7	74.7±13.2	0.715	0.592	0.114
SBP	116.6±15.0	117.2±18.5	120.0±14.1	121.8±12.5	0.797	0.637	0.325
DBP	68.8±7.8	75.0±11.7	73.1±10.3	67.5±6.5	**0.007**	**0.033 (TWMG)** 0.059 (TWtMG)	0.352 (pre) 0.131 (post)
Week 6							
HR	69.0±12.1	71.0±10.8	81.7±14.7	86.1±15.3	0.551	**0.016**	0.070
SBP	120.0±9.2	115.7±17.1	118.1±11.9	121.2±15.5	0.185	0.878	0.592
DBP	69.3±8.6	67.1±12.5	68.7±9.9	70.0±11.9	0.450	0.878	0.948
Week 9							
HR	68.2±13.1	69.3±13.8	76.2±5.2	79.2±11.6	0.534	0.681	0.201
SBP	120.0±9.2	118.5±8.9	122.5±13.8	119.2±12.3	0.929	0.482	0.848
DBP	73.1±7.0	78.5±12.1	68.7±12.4	67.1±11.1	0.813	0.813	0.183
Week 12							
HR	74.1±10.7	77.0±6.5	82.0±14.0	86.0±10.2	0.863	0.225	0.125
SBP	120.7±16.4	120.0±10.0	118.5±14.6	121.6±17.2	0.901	0.901	0.865
DBP	71.4±15.7	70.7±8.3	69.2±10.9	73.3±8.1	0.487	0.697	0.868

TWMG: Training with Music Group; TWtMG: Training Without Music Group; M±SD: Mean±Standard Deviation; n: number of participants; HR: heart rate; SBP: systolic blood pressure; DBP: diastolic blood pressure.

Regarding cardioEmotion data, in the third week, we observed a significant interaction between groups and moments in the green percentage (p=0.041). The TWMG increased the green percentage after the session, with significant difference between groups only after the session. Furthermore, in the TWMG, the green percentage was significantly higher at post-session compared to pre-session and during music. Moreover, in the third week, the TWMG obtained higher grade, higher blue percentage and lower red percentage compared to the TWtMG, regardless of moments. In the sixth week, we found a significant increase in grade (p=0.009) and green percentage (p=0.003), and a decrease in red percentage (p=0.044) after the session, regardless of groups. No significant differences were found in other weeks (Table 3).

Table 3. Heart rate variability outcomes

Variables, M+SD	TWMG (n=09)				TWtMG (n=08)		P value, interaction Groups*Moments	P value Moments	P value Groups
	Pre	During music	Post	P value Moments	Pre	Post			
					Week 1				
Grade	1.71±1.0	1.6±0.8	1.4±0.4	0.760	1.6±0.7	0.9±0.6	0.419	0.109	0.233
% Red	69.1±14.7	70.6±12.1	72.6±9.8	0.826	71.3±12.2	82.6±11.5	0.418	0.135	0.145
% Blue	27.3±10.8	25.2±6.9	25.3±10.7	0.897	25.3±10.1	15.8±10.6	0.377	0.184	0.108
% Green	3.5±6.8	4.1±5.3	2.0±2.0	0.416	3.25±2.4	1.5±2.0	0.921	0.208	0.809
					Week 3				
Grade	1.9±0.4	1.8±0.4	2.3±1.3	0.097	1.4±0.8	1.1±0.6	0.172	0.929	**0.022**
% Red	64.4±9.2	68.7±6.4	61.2±18.6	0.098	74.0±13.0	78.8±11.8	0.336	0.842	**0.021**
% Blue	31.8±10.3	25.8±4.2	29.8±12.4	0.171	22.5±10.4	19.7±10.1	0.914	0.495	**0.030**
% Green	3.6±3.7	4.5±3.3	8.8±7.4	**0.029**	3.5±4.0	1.3±2.4	**0.041**	**0.035 (TWMG)** 0.388 (TWtMG)	0.931 (pre) **0.016 (post)**
					Week 6				
Grade	1.6±1.1	1.6±0.5	1.9±1.0	0.188	1.1±0.6	1.9±0.3	0.166	**0.009**	0.630
% Red	69.1±19.9	66.6±10.3	66.1±16.8	0.649	74.8±8.7	64.6±7.9	0.241	**0.044**	0.789
% Blue	28.2±17.3	29.9±8.3	28.4±13.0	0.669	24.5±7.8	29.5±5.7	0.333	0.307	0.835
% Green	2.5±3.4	3.4±2.0	5.2±4.8	0.139	0.6±1.0	5.8±3.4	0.252	**0.003**	0.694
					Week 9				
Grade	1.8±0.6	1.6±0.4	1.7±5.9	0.922	1.2±0.6	1.4±0.8	0.483	0.645	0.165
% Red	66.1±12.0	70.4±7.7	66.8±10.3	0.768	77.0±12.5	72.2±15.5	0.531	0.643	0.155
% Blue	31.7±10.7	26.8±7.5	30.8±8.6	0.587	21.5±12.1	25.7±13.9	0.530	0.678	0.136
% Green	2.1±2.6	2.6±1.2	2.2±2.3	0.217	1.4±1.5	2.0±2.5	0.762	0.615	0.630
					Week 12				
Grade	1.5±0.6	1.0±0.6	1.3±0.8	0.122	1.2±0.8	1.5±0.5	0.418	0.858	0.733
% Red	70.5±10.4	73.2±23.8	74.7±13.9	0.826	76.6±14.7	72.1±8.7	0.334	0.967	0.744
% Blue	26.8±8.2	23.0±17.2	22.7±12.1	0.678	21.6±13.1	26.0±7.5	0.252	0.979	0.843
% Green	2.5±3.4	0.8±1.2	2.5±2.5	0.317	1.6±2.6	1.8±3.6	0.948	0.948	0.493

TWMG: Training with Music Group; TWtMG: Training without Music Group; M±SD: Mean±Standard Deviation; n: number of participants.

DISCUSSION

This study aimed to analyze immediate physiological effects of physical exercise associated with music in institutionalized older people with moderate to advanced dementia. As result, increases in BP and HR values and an improvement in some HRV data in specific sessions were found, mainly in the TWMG.

In this study, the percentage of women was 52.9% and the sample presented three types of dementia (non-specified dementia, senile dementia, and Alzheimer's disease). Women have a higher prevalence of dementia due to several factors, such as the feminization of aging; they live almost seven years longer than men[17]. Although our sample presented a low percentage of Alzheimer's disease, this type of dementia represents 70% of dementia cases in older people over 80 years old worldwide[1]. The prevalence of unspecified dementia in this sample can be related to the lack of specificity on medical records, inconclusive diagnostics, and little investigation of diseases in nursing homes[18].

Regarding BP and HR data, in the third week a significant increase in diastolic BP was found in the TWMG and both groups presented an increase in HR

after the session in the sixth week. In a non-randomized clinical trial, the immediate effects of mobility exercises associated with music performed in group once a week, were evaluated in institutionalized older people with moderated to advanced dementia. There was a significant increase in systolic BP when comparing pre- and post-first session, and pre- and post-session of one and two years. Other sessions were not analyzed[19]. In another non-randomized clinical trial, adults and older people were submitted to music therapy before ophthalmic surgical interventions. The authors found a decrease in anxiety and BP, HR and respiratory frequency values at the operation room compared to vital signs measured in the preoperative period[20]. Thus, cognitive stimuli with music may have a homeostatic effect of bringing BP and HR close to normal values.

Hypertensive individuals seem to keep the decrease in BP within 24 hours after physical exercise. BP reduction can be due to a decrease in peripheral vascular resistance, vasodilation in active and inactive muscles, accumulation of muscle metabolites and heat dissipation produced by physical exercise. However, the immediate acute effects expected from physical exercise an increase in HR and cardiac output and consequently an increase in systolic BP and a maintenance/decrease in diastolic BP. Such mechanisms are related to hemodynamic, humoral, and neural factors, which can be altered in older people with advanced dementia[2,5,8].

Beyond physical exercise influences on physiological measures, music can also lead to different immediate physiological responses in our body, for example heart tends to beat more or less accelerated according to the rhythm of music[21]. In a randomized clinical trial, 11 older people with advanced dementia attended in day centers or nursing homes were submitted to individualized cognitive stimuli with music according to their preferences twice a week for 30 minutes for 12 weeks. Immediate effects were found when comparing performances pre- and post-sessions, including improvement in psychological and behavioral symptoms, decrease in HR and increase in oxygen saturation[22]. This study focused on evaluating immediate effects in several sessions, since the results could be different across the interventions. Furthermore, we standardized the songs listened, which can justify the different findings.

Regarding cardioEmotion data, the TWMG presented an improvement in HRV after the third session compared to pre-session and during music, besides the TWMG had better HRV performance compared to the TWtMG, regardless of time. In the sixth week, HRV improved in both groups. In accordance with our findings, in a non-randomized clinical trial, 87 hospitalized older people with cerebrovascular disease and advanced dementia were divided into a group submitted to a cognitive stimuli with music and a control group. Cognitive stimuli with music occurred once a week for 45 minutes over 10 weeks and popular songs were chosen. Immediate effects were found between pre-, during music and post-session, with HRV increase between pre- and during music, and HRV decrease between during music and post-session. There were no significant changes in any HRV parameter in the control group. These findings suggest that music increased parasympathetic activities, attenuated sympathetic activities, and induced relaxation and distraction responses of limbic and hypothalamic brain systems[23].

The effect of motivational music on a 20-min sub-maximal cycle task was assessed in 18 untrained student volunteers. There were three experimental conditions: no music, non-motivational music and motivational music. Both music conditions increased in-task affective state and positive post-task attitudes towards physical exercise experience[24]. Although aging reduces HRV, regular physical activity improves vagal activity of the heart and attenuates the effects of aging on autonomic HR control. Older people with advanced dementia may present changes in autonomic nervous system responses, which require additional stimuli with physical exercise, such as music[23,24].

The effects of music (listening to 3 playlists based on their personal preferences) were analyzed in 99 individuals with different mental health symptoms, such as depression, anxiety and apathy, and types of dementia. Individuals with high depression levels and symptoms related to Alzheimer's disease presented higher sadness levels when listening to music. On the other hand, individuals with low depression levels and high apathy levels presented the best evidence of pleasure during music. People with severe cognitive impairment expressed lower pleasure levels during music[25]. Therefore, besides considering personal preferences, clinical history and mental health symptoms should be considered when individuals with dementia are exposed to music interventions. In the present study, the volunteers listened to popular music for their time and the songs were selected to bring possible pleasant memories. However, some songs may have activated negative memories in some volunteers, since they could have attached them to bad moment or depending on their mental health symptoms.

This study had some limitations, including the small sample size, the lack of information in medical records and inaccuracy of diagnoses and types of dementia. Moreover, we used a non-gold standard and relatively new assessment to analyze HRV and we could not adjust HRV values according to use of medications such as beta blockers, antiarrhythmics and calcium channel blockers. However, the cardiovascular biofeedback is easy to use in nursing homes, less expensive than polar tools, and it does not require long training to understand data. No volunteer presented ventricular tachycardia and other dangerous dysrhythmias that could influence HRV values. Our findings show that physical exercise associated with music has a positive impact on the treatment of older people with dementia. The improvement of physiological performance can influence the progression of common symptoms of dementia and the quality of life of older people with dementia and their caregivers. Future studies with larger sample sizes are needed for a better understanding of the effects of music in this population.

CONCLUSION

In conclusion, physical exercise associated with music had positive immediate effects on physiological responses (diastolic BP, HR, HRV) in older people with moderate to advanced dementia, mainly in the third and sixth weeks. Besides, HRV data improved during music and after session in the TWMG.

REFERENCES

1. Organização Mundial da Saúde. Older persons in emergencies [Internet]. Geneva: World Health Organization; 2008 [cited 2021 Sep 27]. Available from: https://bit.ly/3m5Dfuu
2. Newman A, Fitzpatrick AL, Lopez O, Jackson S, Lyketsos C, Jagust W, et al. Dementia and Alzheimer's disease incidence in relationship to cardiovascular disease in the Cardiovascular Health Study Cohort. J Am Geriatr Soc. 2005;53(7):1101-07. doi: 10.1111/j.1532-5415.2005.53360.x.
3. Singh-Manoux A, Britton A, Marmot M. Vascular Disease and Cognitive Function: Evidence from the Whitehall II Study. J Am Geriatr Soc. 2003;51(10):1445-50. doi: 10.1046/j.1532-5415.2003.51464.x.
4. Albuquerque MCS, Nascimento LO, Lyra ST, Figueredo Trezza MCS, Brêda MZ. The effects of music on aged Alzheimer patients in a long-term care facility. Rev Eletr Enf. 2012;14(2):404-13. doi: 10.5216/ree.v14i2.12532.
5. Vanderlei LCM, Pastre CM, Hoshi RA, Carvalho TD, Godoy MF. Basic notions of heart rate variability and is clinical applicability. Rev Bras Cir Cardiovasc. 2009;24(2):205-17. doi: 10.1590/S0102-76382009000200018.
6. Garrido S, Stevens C, Chang E, Dunne L, Perz J. Music and dementia: individual differences in response to personalized playlists. J Alzheimers Dis. 2018;64:933-41. doi:10.3233/jad-180084.
7. Rodrigues NS, Coelho Filho CAA. Influência da audição musical na prática de exercícios físicos por pessoas adultas. Rev Bras Educ Fis Esporte. 2012;26(1):87-95. doi: 10.1590/S1807-55092012000100009.
8. Monteiro MF, Filho DCS. Physical exercise and blood pressure control. Rev Bras Med Esporte. 2004;10(6):513-16. doi: 10.1590/S1517-86922004000600008.
9. Morris J. The Clinical Dementia Rating (CDR): current version and scoring rules. Neurology. 1993;43(11):2412-4. doi: 10.1212/wnl.43.11.2412-a.
10. British Columbia Ministry of Health. Physical Activity Readiness Medical Examination [Internet]. Ottawa: Canadian Society for Exercise Physiology; 2002 [cited 2021 Sep 27]. Available from: https://bit.ly/3uhsCbL
11. Gomes JS, Coghi M, Coghi PF. Cardiovascular biofeedback and its applications: review of literature. Av Psicol Latinoam. 2014;32(2):199-216. doi: 10.12804/apl32.2.2014.02.
12. Coghi PF, Coghi MF. Stress e Ansiedade: eles estão te consumindo? Paper presented at: 14th Congresso de Stress do ISMA; 2014 Jun 3rd-5th; Porto Alegre, RS. 2014 [cited 2021 Sep 27]. Available from: https://bit.ly/3kFXmjv
13. Leher PM. Biofeedback training to increase the heart rate variability. In: Leher PM, Woolfolk RL, Simew E. Principles and practice of stress management. 3rd ed. New York: The Guilford Press; 2007, 10:227-248.
14. Pickering TG, Hall JE, Appel LJ, Falkner BE, Graves J, Hill MN, et al. Recommendations for blood pressure measurement in humans and experimental animals: part 1: blood pressure measurement in humans: a statement for professionals from the Subcommittee of Professional and Public Education of the American Heart Association Council on High Blood Pressure Research. Circulation. 2005;111(5):697-716. doi: 10.1161/01.CIR.0000154900.76284.F6.
15. Mathews R, Clair A, Kosloski K. Keeping the beat: Use of rhythmic music during exercise activities for the elderly with dementia. Am J Alzheimers Dis Other Demen. 2001;16(6):377-80. doi: 10.1177/153331750101600608.
16. Winckel AV, Feys H, De Weerdt W, Dom R. Cognitive and behavioral effects of music-based exercises in patients with dementia. Clin Rehabil. 2004;18(3):253-60. doi: 10.1191/0269215504cr750oa.
17. Instituto Brasileiro de Geografia e Estatística (IBGE). Características gerais da população, religião e pessoas com deficiência [Internet]. Rio de Janeiro: IBGE; 2012 [cited 2021 Sep 27]. Available from: https://bit.ly/2Y890Ls
18. Parmera JB, Nitrini R. Investigation and diagnostic evaluation of a patient with dementia. Rev Med. 2015;94(3):179-84. doi: 10.11606/issn.1679-9836.v.94i3p179-184.
19. Takahashi T, Matsushita H. Long-term effects of music therapy on elderly with moderate/severe dementia. J Music Ther. 2006;43(4):317-33. doi: 10.1093/jmt/43.4.317.
20. Camara JG, Ruszkowski JM, Worak SR. The effect of live classical piano music on the vital signs of patients undergoing ophthalmic

surgery. Medscape J Med [Internet]. 2008 Jun. [cited 2021 Sep 27];10(6):149. Available from: https://bit.ly/39EDwPx

21. Nobre DV, Leite HR, Orsini M, Corrêa CL. Physiological responses to music stimuli: literature review. Rev Neurocienc [Internet]. 2012 [cited 2021 Sep 27];20(4):625-33. Available from: https://bit.ly/3ueyWAX
22. Maseda A, et al. Multisensory stimulation and individualized music sessions on older adults with severe dementia: effects on mood, behavior, and biomedical parameters. J Alzheimers Dis. 2018;63(4):1415-25. doi: 10.3233/JAD-180109.
23. Okada K, Kurita A, Takase B, Otsuka T, Kodani E, Kusama Y, et al. Effects of music therapy on autonomic nervous system activity, incidence of heart failure events, and plasma cytokine and catecholamine levels in elderly patients with cerebrovascular disease and dementia. Int Heart J. 2009;50(1):95-110. doi: 10.1536/ihj.50.95.
24. Melo R, Santos MD, Silva E, Quitério RJ, Moreno MA, Reis MS, et al. Effects of age and physical activity on the autonomic control of heart rate in healthy men. Braz J Med Biol Res. 2005;38(9):1331-8. doi: 10.1590/s0100-879x2005000900007.
25. Garrido S, Stevens CJ, Chang E, Perz J. Musical features and affective responses to personalized playlists in people with probable dementia. Am J Alzheimers Dis Other Demen. 2019;34(4):247-53. doi: 10.1177/1533317518808011.